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Candidate Petition Project

FISH

PETITIONS TO LIST AS FEDERALLY ENDANGERED SPECIES

The following document contains the individual petitions for the 10 fish species to be listed as federally endangered species under the federal Endangered Species Act.

Arkansas darter	***Etheostoma cragini***
Cumberland Johnny darter	***Etheostoma susanae***
Pearl darter	***Percina aurora***
Yellowcheek darter	***Etheostoma moorei***
Zuni bluehead sucker	***Catostomus discobolus yarrowi***
Grotto sculpin	***Cottus sp.***
Smalleye shiner	***Notropis buccula***
Sharpnose shiner	***Notropis oxyrhynchus***
Chucky madtom	***Notorus sp.***
Rush darter	***Etheostoma phytophilum***

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PETITION TO LIST

Arkansas darter
(*Etheostoma cragini*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 1/6/89:	
CNOR 11/21/91:	
CNOR 11/15/94:	
CNOR 2/28/96:	C
CNOR 9/19/97:	C
CNOR 10/25/99:	C
CNOR 10/30/01:	C
CNOR 6/13/02:	C

TAXONOMY

Etheostoma is the largest genus of North American fishes, including both some of the rarest and most common North American fish species (Page and Burr 1991). The taxonomic status of the Arkansas darter, *Etheostoma cragini* (Percidae), as a valid species is uncontroversial (e.g., Page and Burr 1991).

NATURAL HISTORY

The Arkansas darter is a small and colorful fish. Eggs are laid in gravel bottoms. Snails constitute a significant portion of the diet.

The Arkansas darter typically lives in small streams with clear, cool water (generally less than 25 degrees C) in the vicinity of springs or groundwater seeps with abundant broad-leaved aquatic vegetation (Moss 1981). Usually this habitat is in pools or near-shore areas with little flow and a substrate of sand, pebbles or gravel, often overlain by silt, leaves, or other organic debris. Larger adults also have been found near undercut banks where terrestrial vegetation extends into flowing water (Taber et al. 1986). Moss (1981) suggested that on the plains most Arkansas darters occurred where the stream was directly exposed to sunlight, which likely is important for the growth of dense beds of aquatic vascular plants. He also observed habitat segregation of the young and adults. Young Arkansas darters occupied shallow, open areas where spawning occurred, while adults resided in aquatic vegetation.

The Arkansas darter is known from the Arkansas River and tributaries in Arkansas, Colorado, Kansas, Missouri, and Oklahoma (Blair 1959, Branson 1967, Cloutman 1971, 1980, Cross 1967, 1975, Pflieger 1975, Matthews and McDaniel 1981, Miller 1984). The most upstream collection of Arkansas darter is from a small unnamed drainage originating on the Fort Carson Military Reservation in El Paso County, Colorado (Miller 1984). The farthest downstream collection is from an unnamed spring run at the intersection of Arkansas Highway 112 and U.S. Highway 71 Bypass in Fayetteville, Washington County, Arkansas (Robison and Buchanan 1988).

POPULATION STATUS

Only 3,000 - 10,000 individuals exist on between 10,000 - 50,000 acres of private land (Busby and Hammerson 1998). The Arkansas darter is highly threatened across its range. The species and community are directly exploited and threatened by both natural and man-made forces. Threats include habitat loss due to lowering of the water table (caused by ground water pumping associated with irrigation and other water uses). Major habitat losses are occurring due to de-watering of the Ogallala Aquifer for irrigation and general development. Agricultural runoff from hog farms and cattle operations continue to threaten individual populations.

The future of the Arkansas darter is precarious in the extreme western portion west of Crooked Creek (Eberle and Stark 1998). In this region, groundwater is mined extensively from the underlying Ogallala aquifer (part of the High Plains Aquifer system), primarily for crop irrigation. Of the 420,872 ha in the two counties in this area, 24% (100,366 ha) were available for irrigation in 1984 (Kansas State Board of Agriculture [1985]). Water rights in this region have been over-appropriated, and Groundwater Management District #3 follows a policy of controlled depletions (Kansas Water Office 1994). As the water table continues to fall in this area, it causes some formerly perennial streams to become ephemeral, and it eliminates the groundwater seepage that maintains the summer temperature of the surface water at a level appropriate for the Arkansas darter (generally 25˚C or less) (Eberle and Stark 1998).

Arkansas darter populations in portions of the Ninnescah River Basin also may be at risk due to habitat loss as a result of groundwater withdrawals. From 1976 through 1984, the amount of land available for irrigation in four counties located in this basin more than doubled, from 29,988 ha to 64,388 ha (Kansas State Board of Agriculture [1977?], [1985?]) (Eberle and Stark 1998).

The U.S. Fish and Wildlife Service classifies the Arkansas darter as a candidate for Endangered Species Act protection with a listing priority number of 11. The Arkansas Natural Heritage Program ranks the Arkansas darter as Critically Imperiled. The Colorado, Kansas and Oklahoma Natural Heritage Programs rank the Arkansas darter as Imperiled, and the Missouri Natural Heritage Program ranks it as Vulnerable.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range:	Arkansas, Colorado, Kansas, Missouri, Oklahoma. It has been observed from the Arkansas River and tributaries in Arkansas, Colorado, Kansas, Missouri, and Oklahoma (Blair 1959, Branson 1967, Cloutman 1971, 1980), Cross 1967, 1975, Matthews and McDaniel 1981, Miller 1984, Pflieger 1975).
Current range:	Arkansas, Colorado, Kansas, Missouri, Oklahoma. The species may still be found throughout its range, though its spring-fed habitats have been reduced by groundwater depletions in some areas. Surveys in recent years indicate that the species persists at numerous locations within its historical range, including approximately 30 locations in Missouri (Pflieger 1992), and approximately 60 locations in southern Kansas and northern Oklahoma (Eberle and Stark 1998).
Land ownership:	With few exceptions, almost all Arkansas darter populations occur on privately owned land. At least one protected EO: Kingman Wildlife Area, Kansas; this species also occurs on U.S. military property in Colorado (Fort Carson).

Water depletion in required habitats appears to be the greatest threat facing the Arkansas darter today (Blair 1959, Cross et al. 1985, U.S. Fish and Wildlife Service 1989). Drying of spring-fed marshes may cause at least localized extirpations and has forced the darter to occupy less favorable habitats in some stream reaches (Pigg 1987). Agricultural and municipal development has contributed to habitat declines for the species, from increasing water demands to general quality degradations resulting from agriculture, livestock production, and wastewater use and discharge (Harris and Smith 1985, Moss 1981). A recent addition to these threats is the proposed development of large confined animal feeding operations, which have the potential to adversely impact the groundwater upon which Arkansas darter habitat is based.

Several municipalities in the western portion of the species' range resort to mandatory water conservation measures during hot summer months when water shortages may become significant. These threats could result in continued gradual extirpations from portions of the range. However, recent surveys indicate the species is still present at numerous locations (Eberle and Stark 1998, Pflieger 1992).

B. *Overutilization for commercial, recreational, scientific, or educational purposes.*

There is no evidence at this time to suggest overutilization of the Arkansas darter for any of these purposes.

C. ***Disease or predation.***

There is no evidence of threats to the Arkansas darter from disease. Sport fishery enhancement efforts by State agencies have resulted in increases in predatory sport fish in reservoirs and, subsequently, the streams within the range of the Arkansas darter. The effect of predation on the species is unknown at this time; however, due to the small, isolated habitats preferred by this species, occurrence of significant numbers of larger predators is unlikely.

D. ***The inadequacy of existing regulatory mechanisms.***

The species is designated as endangered in Oklahoma and threatened in Colorado and Kansas. Arkansas classifies it as a vulnerable (rare) species, and it is unlisted in Missouri. Therefore, the species is afforded some degree of protective status in several of the States in its range, limiting the extent of outright taking. However, the most persistent threats to this species are adverse impacts to habitat quantity and quality, which these State regulations do not adequately address.

Current Conservation Efforts: None.

E. ***Other natural or manmade factors affecting its continued existence.***

The specialized spring-fed habitat type typically occupied by Arkansas darters, plus the isolated nature of many populations, intensifies any impacts the species may suffer, and increases the time required for repopulation following temporary population reductions from other causes.

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PETITION TO LIST

Cumberland johnny darter (*Etheostoma susanae*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 9/18/85:	
CNOR 1/6/89:	
CNOR 11/21/91:	
CNOR 11/15/94:	
CNOR 10/25/99:	C
CNOR 10/30/01:	C
CNOR 6/13/02:	C

TAXONOMY

The Cumberland johnny darter, *Etheostoma susanae* (Percidae), was formerly treated as an extremely rare subspecies of *E. nigrum* (*E. nigrum susanae*), However, Strange (1998a,b) presented convincing data indicating that this taxon should be recognized as a full species, *E. susanae*.

NATURAL HISTORY

Morphology
This small fish has straw-yellow background body color with brown markings forming six evenly-spaced, dorsal (back) saddles and a series of X-, M-, or W-shaped markings on its sides. During spawning season, the overall body color of breeding males darkens and the side markings become obscure or appear as a series of blotches. Starnes and Starnes (1979) distinguished the Cumberland johnny darter from the johnny darter (*E. nigrum*) by the following characteristics: the top of head, opercles (gill coverings), and mid-belly of the Cumberland johnny darter are devoid of scales, and the pre-orbital stripe (a dark stripe extending from the eye to the upper lip) on the Cumberland johnny darter is usually interrupted at the nostrils (nares).

Habitat
This species inhabits shallow water in low velocity shoals and backwater areas of moderate to low gradient stream reaches with stable sand or sandy-gravel substrata. It is not found in areas with cobble or boulder substrata. All specimens that have been collected in recent years have been found in less than 15 centimeters (6 inches) of water (O'Bara 1988, Laudermilk and Cicerello 1998).

Distribution
The Cumberland johnny darter is endemic to the upper Cumberland River system, above Cumberland Falls, in Kentucky and Tennessee. Recent surveys by O'Bara (1988) and Laudermilk and Cicerello (1998) indicate that the Cumberland johnny darter is restricted to short reaches of 16 small streams in the upper Cumberland system in Whitley and McCreary counties, Kentucky, and only two small streams in Tennessee, one in Scott County and one in Campbell County. The species has apparently been extirpated from Little Wolf Creek, Whitley County, Kentucky, where it was recorded by Jordon and Swain (1883), and Gum Fork, Scott County, Tennessee, where it was recorded by Shoup and Peyton (1940). Also, although O'Bara (1988) recorded the Cumberland johnny darter from two sites in the mainstem of the Cumberland River, recent efforts to recollect the species from these sites have been unsuccessful (personal communication 1999 cited in U.S. Fish and Wildlife Service candidate assessment form). Previous records of the species in the Poor Fork portion of the Cumberland River drainage in Letcher and Harlan counties, Kentucky (Starnes and Starnes 1979), have been determined to be the johnny darter (*E. nigrum*) based a genetics study conducted by Strange (1998a). Records of the species from Martins Fork, Harlan County, Kentucky (Starnes and Starnes 1979), are also believed to be misidentifications; however, efforts to collect individuals from Martins Forks for genetic studies have been unsuccessful, suggesting that whichever taxon occurred in this system has apparently been extirpated.

POPULATION STATUS

Though the Cumberland johnny darter was recorded as abundant by Jordan and Swain (1883), it is now considered to be rare and extremely restricted in range. The remaining 16 occurrences are thought to form six population clusters that are isolated from one another by poor quality habitat, impoundments, or natural barriers.

The American Fisheries Society considers this species to be threatened. The Kentucky Nature Preserves Commission considers the species to be endangered within the State (personal communication 1999 cited in U.S. Fish and Wildlife Service candidate assessment form). The Kentucky and Tennessee Natural Heritage Programs rank the Cumberland Johnny Darter as Critically Imperiled.

The U.S. Fish and Wildlife Service classifies the Cumberland johnny darter as a candidate for Endangered Species Act protection with a listing priority number of 6. However, recognizing this taxon as a full species, as now seems warranted, would presumably result in a higher rank.

LISTING CRITERIA

A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.***

Historical range: Kentucky, Tennessee. The Cumberland johnny darter is endemic to the upper Cumberland River system, above Cumberland Falls, in Kentucky and Tennessee.

Current range: Kentucky, Tennessee. All 16 of the surviving occurrences of the Cumberland johnny darter are restricted to short stream reaches, with the majority believed to be restricted to less than 1.6 kilometers (1 mile) of stream.

Land ownership: The watersheds of the streams that still support populations of the Cumberland johnny darter are roughly 60 percent in private ownership and 40 percent public (the U.S. Forest Service's Daniel Boone National Forest). However, with the exception of Bunches Creek, Whitley County, Kentucky, which is primarily (about 90 percent) within the Daniel Boone National Forest, in most cases where portions of the streams' watersheds are within the boundaries of the National Forest, the U.S. Forest Service ownership is fragmented and often occurs on only one side of the stream.

Siltation, primarily from coal mining activities, but also from forestry and agricultural activities, road construction, and urban development, appears to be the major factor contributing to the decline of the Cumberland johnny darter throughout its range and the most significant threat to the species continued existence (O'Bara 1988). The habitat in which the species is primarily found is extremely susceptible to the effects of siltation. The low to moderate gradient, low velocity, shallow depth, and backwater nature of this habitat leads to this susceptibility. O'Bara (1988) reported that only 15 of the 70 sites that he sampled for the Cumberland johnny darter had not been impacted by siltation associated with mining and other poorly implemented land disturbance activities. Practices that affect sediment discharges into a stream system change the erosion or sedimentation pattern, which can lead to the destruction of riparian vegetation, bank collapse, and increased water turbidity and temperature. Excessive sediments are believed to impact the habitat of darters and associated fish species by making it unsuitable for feeding and reproduction. Sediment has been shown to abrade and or suffocate periphyton, disrupt aquatic insect natural processes, and, ultimately, to negatively impact fish growth, survival, and reproduction (Waters 1995).

B. *Overutilization for commercial, recreational, scientific, or educational purposes.*

The specific areas inhabited by the Cumberland River johnny darter are not presently known to the general public and the public is generally unaware of this fish's presence in the upper Cumberland River system. As a result, take of the Cumberland johnny darter by the general public has not been a problem. However, this fish exists only in small, restricted areas. Once its rarity becomes known, it could conceivably become attractive to collectors. Although scientific collecting is not presently identified as a threat, take by private and institutional collectors could pose a threat. Federal protection could help to reduce the negative impact of illegal or inappropriate take.

C. *Disease or predation.*

Although the Cumberland johnny darter is undoubtedly consumed by predators, predation by naturally occurring predators is a normal aspect of the population dynamics and is not considered to currently pose a threat to the species. However, to the extent that disease or predation occurs, they become a more important consideration as the total population decreases in number.

D. *The inadequacy of existing regulatory mechanisms.*

Federal listing would provide additional protection for the Cumberland johnny darter throughout its range by requiring Federal permits in order to take the species and by requiring Federal agencies to consult with the U.S. Fish and Wildlife Service when activities they fund, authorize, or carry out might affect the species.

Current Conservation Efforts: There are no written agreements currently in place for this species or its habitat. Marsh Creek supports an occurrence of the Cumberland elktoe mussel (*Alasmidonta atropurpurea*), federally listed as endangered, which provides some incidental protection. However, the nine other streams supporting surviving occurrences of the Cumberland johnny darter are not afforded this protection.

Both Tennessee and Kentucky prohibit the collection of the fish for scientific purposes without a valid State collecting permit. However, this requirement does not provide any protection to the species' habitat.

E. *Other natural or manmade factors affecting its continued existence.*

The existing Cumberland johnny darter populations are small in size and range, and are geographically isolated from one another. This patchy distribution pattern of populations in short stream reaches and small population size makes them much more susceptible to extirpation from single catastrophic events (such as toxic chemical spills). It also reduces their ability to recover from smaller impacts to their habitat or population size. Furthermore, this level of isolation makes natural repopulation of any extirpated population impossible without human intervention.

Population isolation also prohibits the natural interchange of genetic material between populations, and small population size reduces the reservoir of genetic diversity within populations. This can lead to inbreeding depression (Avise and Hamrick 1996). It is likely that some of the Cumberland johnny darter populations are currently below the effective population size (Soule 1980) required to maintain long-term genetic and population viability.

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PETITION TO LIST

Pearl darter
(*Percina aurora*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 11/21/91:	
CNOR 11/15/94:	
CNOR 10/25/99:	C
CNOR 10/30/01:	C
CNOR 6/13/02:	C

TAXONOMY

The Pearl darter, *Percina aurora* (Percidae), was described by Suttkus et al. in 1994. It was previously known as *Percina* sp. 3 and Pearl River channel darter (Ross and Brenneman 1991). The Pearl darter belongs to the subgenus *Cottogaster* and is closely allied to the channel darter (*Percina copelandi*).

NATURAL HISTORY

Morphology
The Pearl darter is a small percid fish with a blunt snout, horizontal mouth, large eyes situated high on the head, and a medial black caudal spot at the base of the caudal fin (Ross 2000). It is distinguished from the channel darter by its large average body size, lack of tubercles and heavy pigmentation of breeding males, high number of marginal spines on the modified belly scales of breeding males, and fully scaled cheeks. Breeding males have two dark bands across the spinous dorsal fin, a broad, diffuse, dusky marginal band, and a pronounced dark band across the fin near its base. Breeding females are devoid of pigmentation on the ventral surface of head and body. The Pearl darter reaches a maximum standard length of 57 millimeters (mm) (2.28 inches (in)) in females and 64 mm (2.56 in) in males (Suttkus et al. 1994).

Behavior
Pearl darter behavior is probably similar to that of the closely related channel darter. Seasonally, channel darters move into the slower current of pools to use the scattered rubble as spawning sites (Kuehne and Barbour 1983). Channel darters typically avoid deep sluggish pools,

headwater creeks, and lacustrine/palustrine environments (Burr and Warren 1986) with insufficient current to maintain a bottom of sand or sand mixed with gravel and rock (Page 1983). Channel darters most often remain at depths approaching 1 meter (3.28 feet) during the day but move to shallow water at night (Trautman 1957). Chironomids and small crustaceans are the most important food items (Kuehne and Barbour 1983).

Suttkus et al. (1994) found Pearl darters in the Pearl and Strong Rivers in Mississippi spawning in March and April in 1969. Collection data indicated that the species probably spawned in various locations of the Pearl River main stem and upper reaches of the middle Bogue Chitto River. In fish samples from the Pearl River, young-of-the year Pearl darters were collected in June. Females were sexually mature at 39 mm (1.56 in) standard length (SL), while males matured at 42 mm (1.68 in) SL. Five breeding males were collected from the Leaf River (Pascagoula system, Mississippi) during May in shallow water (15 cm (5.85 in)) over firm gravel and cobble in mid channel with a water temperature of 21 degrees C (69.8 degrees F) (Bart and Piller 1997). Most Pearl darters mature in one year.

Habitat

Little is known about the habitat requirements of the Pearl darter. Pearl darters have been collected from gravel riffles and rock outcrops; deep runs over gravel and sand pools below shallow riffles; swift (90 centimeters per second or 35.1 inches per second), shallow water over firm gravel and cobble in mid-river channels; and swift water near brush piles. A single post-spawning individual was collected in a deep sluggish run over silty sand (Bart and Piller 1997). The Pearl darter is believed to have comparable habitat requirements to the channel darter.

Habitat use of the Pearl Darter is likely centered on deeper runs and pools with larger substrate particle size (Schofield et al.1999). The channel darter generally inhabits rivers and large creeks in areas of moderate current, usually over sand and gravel substrates. Such conditions are often found at the lower ends of riffles or at the edges of deep channels.

Distribution

The Pearl darter is historically known only from localized sites within the Pearl and Pascagoula River drainages in Mississippi and Louisiana. Examination of site records of museum fish collections from the Pearl River drainage (Suttkus et al. 1994) suggest that this darter once inhabited the large tributaries and main channel habitats from St. Tammany Parish, Louisiana to Simpson County, Mississippi, including approximately 96 river miles of the Pearl River, 10 river miles of the Strong River, and 32 river miles of the Bogue Chitto River. Even before its description in 1994, the Pearl darter was considered rare and of conservation concern (Deacon et al. 1997) because it was uncommon, infrequently collected, and occurred in low numbers (Bart and Piller 1997). The Pearl darter was collected from only 14 percent of 716 fish collections from site-specific locations within the Pearl River drainage despite annual collection efforts by Suttkus from 1958 to 1973 (Bart and Suttkus 1996, Suttkus et al. 1994). No Pearl darters have been collected in the Pearl River drainage since 1973, even though Suttkus has made 64 fish collections over the last 25 years from the Pearl River (Bart and Piller 1997). Suttkus et al. (1994) attributed the loss of the Pearl darter from the Pearl River to increasing sedimentation caused by removal of riparian vegetation and extensive cultivation near the river’s edge.

Collection data from Bart and Piller (1997), Bart and Suttkus (1996), Suttkus et al. (1994), and Ross (2000) suggest that the Pearl darter is very rare in the Pascagoula River system. Bart and Piller (1997) examined Suttkus' work before 1974 and found that only 19 Pearl darters were collected out of 19,300 total fish in 10 Tulane University Museum of Natural History collections. Additionally, from the "Mississippi Freshwater Fishes Database", Dr. Stephen Ross (in Bart and Piller 1997) estimated the rarity of the Pearl darter within the Pascagoula drainage from 379 collections (81,514 fish specimens) since 1973, and found only one Pearl darter collected for every 4,795 specimens. Site records from museum fish collections suggest that the Pearl darter inhabited the main channels of large Pascagoula drainage tributaries from Jackson to Lauderdale Counties, Mississippi, and had a historical noninclusive range of about 30 river miles of the Pascagoula River, 24 river miles of Black Creek, 48 river miles of the Leaf River, 24 river miles of Okatoma Creek, 102 river miles of the Chickasawhay River, 24 river miles of the Bouie River, and 8 river miles of Chunky Creek.

Since 1983, Pearl darters have only been found in scattered sites within approximately 88 miles of the Pascagoula drainage, including the Pascagoula, Chickasawhay, Chunky, Leaf and Bouie Rivers and Okatoma and Black Creeks resulting in a decrease of range of approximately 66 percent (compiled from Bart and Piller 1997 and Ross 2000). Bart and Piller (1997) made 27 ancillary collections in 1996 and 1997 from the Pascagoula drainage and collected only 10 Pearl darters at four sites (the Leaf River at Estabutchie; lower Leaf River at Merril; Bouie River downstream of I-59 crossing; and Okatoma Creek at Collins). Three specimens were collected in the Leaf River at Estabutchie in the spring of 1998, whereas in December 1998, no Pearl darters were found in the upper reaches of the Leaf River between Estabutchie and north Hattiesburg (two 1998 personal communications cited in U.S. Fish and Wildlife Service candidate assessment form). Slack (Mississippi Museum of Natural Science 1999) found four Pearl darters in the Pascagoula River along a sandbar within a deep scour hole at the confluence with Big Black Creek (Dead Lake). This was the locality where Hildebrand collected Pearl darters in 1933 (Suttkus et al. 1994). No Pearl darters were found in selected sites of the Chunky River in 1995 and 1997 (personal communication 1999 cited in U.S. Fish and Wildlife Service candidate assessment form). Suttkus et al. (1994) speculated that portions of the Leaf River and possibly the lower Black Creek may continue to support reproducing populations, but no recent collecting attempts have been made.

POPULATION STATUS

No Pearl darters have been collected in the Pearl River drainage since 1973, even though Suttkus has made 64 fish collections over the last 25 years from the Pearl River (Bart and Piller 1997). Other populations of the fish are declining as well. Dr. Stephen Ross (in Bart and Piller 1997) estimated the rarity of the Pearl darter within the Pascagoula drainage from 379 collections (81.514 fish specimens) since 1973, and found only one Pearl darter collected for every 4,795 specimens.

The U.S. Fish and Wildlife Service classifies the Pearl darter as a candidate for Endangered

Species Act protection with a listing priority number of 5. The Mississippi Natural Heritage Program ranks the Pearl darter as Critically Imperiled.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range:	Louisiana, Mississippi. Known from the Pearl and Pascagoula river drainages, Mississippi and Louisiana. Site records from museum fish collections suggest that the Pearl darter inhabited the main channels of large Pascagoula drainage tributaries from Jackson to Lauderdale counties, Mississippi, and had a historical noninclusive range of about 30 river miles of the Pascagoula River, 24 river miles of Black Creek, 48 river miles of the Leaf River, 24 river miles of Okatoma Creek, 102 river miles of the Chickasawhay River, 24 river miles of the Bouie River, and 8 river miles of Chunky Creek.
Current range:	Pascagoula River drainage, Mississippi. The species is now rare and possibly extirpated in the Pearl River drainage; conservation status in the Pascagoula drainage probably is tenuous.
Land ownership:	The species is believed to currently inhabit only navigable waters of the Pascagoula River drainage, under the jurisdiction of the U.S. Army Corps of Engineers. The Pascagoula River drainage includes 9,700 square miles (U.S. Army Corps of Engineers 1987) with a wide variety of land uses. Much of the area is in private ownership and agricultural production. The U.S. Forest Service manages significant acreage in Desoto National Forest. The Mississippi Department of Wildlife, Fisheries and Parks owns or manages several wildlife management areas in the drainage.

Because of its restriction to the Pascagoula drainage and localization to specific habitats, the Pearl darter is vulnerable to non-point source pollution, changes in river and stream geomorphology, and other human-induced threats to its environment, such as dam construction. Non-point source pollution from land surface runoff can originate from virtually all land use activities, and may include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, oils and greases. Construction activities that involve significant earthworks typically increase sediment loads into nearby streams. Siltation sources include timber clear cutting, clearing of riparian vegetation, and mining and agricultural practices that allow exposed earth to enter streams. Practices that affect sediment and water discharges into a stream system change the erosion or sedimentation pattern, which can lead to the destruction of riparian vegetation, bank collapse, and increased water turbidity and temperature. Excessive sediments are believed to impact the habitat of darters and associated fish species by making the habitat unsuitable for feeding and reproduction. Sediment has been shown to abrade and or suffocate periphyton, disrupt aquatic insect natural processes, and, ultimately, to negatively impact fish growth, survival, and reproduction (Waters 1995).

In the Pascagoula drainage, water quality problems exist on the Leaf River from municipal runoff at Hattiesburg and dioxin contamination at New Augusta and on the Chickasawhay River from brine water releases from oil fields (U.S. Fish and Wildlife Service 1990). Permitted effluents to the Pascagoula River Basin include ammonia, chloride, sodium sulfate, toluene, cyclohexane and acetone (EPA 1989). Bart and Piller (1997) noted extensive algal growth during warmer months in the Leaf and Bouie rivers, suggesting nutrient and organic enrichment. Municipal and industrial discharges into the watershed, particularly during low water, concentrate pollutants. Releases from the Leaf River Paper Mill at New Augusta affect temperature, dissolved oxygen, and pH in the lower reaches of the Leaf River. Existing housing and urbanization along the banks of the Leaf River between I-59 and Estabutchie may contribute nutrient loading through sewage and septic water effluent.

The flora and fauna of many coastal plain streams have been adversely affected by accelerated geomorphic processes, specifically headcutting caused by in-stream sand and gravel mining (Patrick et al. 1993). The bed of the Bouie River is considered a significant natural resource by American Sand and Gravel (ASGC) (1995). Historically, ASGC has mined sand and gravel using a hydraulic suction dredge, which is operated within the banks of the Bouie River. Sand and gravel mining also has occurred within and adjacent to the Leaf River. Large sections of the river and its floodplain have been removed over the past 50 years resulting in the creation of very large open water areas that function as deep lake systems (ASGC 1995). Currently, only two permitted mines are operating within the Pascagoula drainage (personal communication 1998 cited in U.S. Fish and Wildlife Service candidate assessment form). However, due to the permit exemption category for mining of less than four acres and less than 1/4 mile from other mine sites, there are numerous non-permitted operators mining gravel throughout the Pascagoula and Pearl River drainages (personal communication 1998 cited in U.S. Fish and Wildlife Service candidate assessment form).

Hartfield (1993) and Patrick and Hartfield (1996) investigated the negative impacts of stream erosion due to headcutting on aquatic life in several Mississippi river drainages and believed that the drainages were also experiencing geomorphic instability caused by in-stream sand and gravel mining. Mining in active river channels typically results in incision upstream of the mine (by nickpoint migration) and sediment deposition downstream. The upstream migration of nickpoints or headcutting may cause undermining of structures, lowering of alluvial water tables, channel de-stabilization and widening, and loss of aquatic and riparian habitat. Geomorphic change, particularly headcutting, may cause the extirpation of riparian and lotic (flowing water) species (Patrick et al. 1993). Lyttle (1993) and Brown and Lyttle (1992) found that in-stream gravel mining reduces overall fish species diversity in Ozark streams and favors a large number of a few small fish species. Patrick et al. (1993) documented geomorphic changes that were adversely affecting the bayou darter, an endangered species endemic to the Bayou Pierre basin.

Bart and Piller (1997) attribute the decline of the Pearl darter in the Leaf and Bouie Rivers and Black Creek of the Pascagoula drainage to threats from siltation caused by unstable banks and loose and unconsolidated stream beds. Bank erosion and bar migration on the Leaf River at

Eastabutchie are apparently affecting the riffles where the only known spawning of the Pearl darter is occurring (personal communication 1999 cited in U.S. Fish and Wildlife Service candidate assessment form) .

The confluence of the Bouie and Leaf Rivers, within the Pascagoula drainage, possibly provides significant habitat for the Pearl darter. Fish collections from this area indicate that it may be a site critical for maintaining the current population of Pearl darters. The Bouie River at the confluence with the Leaf River, is being considered by the city of Hattiesburg to be dammed and used as a major water supply (The Clarion-Ledger, October 28, 1998, Jackson, Mississippi; Kemp Associates, PA, 2000). Such a project would substantially alter and fragment significant occupied habitat of the Pearl darter in the Bouie River. Locality records (1997) of the Pearl darter within the gravel mine area of the Bouie River in Hattiesburg place the species within the exact vicinity of the proposed dam (personal communication 1998 cited in U.S. Fish and Wildlife Service candidate assessment form). Pearl darters have not been collected in impounded waters and are intolerant of lentic (standing water) habitats.

B. *Overutilization for commercial, recreational, scientific, or educational purposes.*

In general, small species of fish such as the Pearl darter, which are not utilized for either sport or bait purposes, are unknown to the general public. Therefore, take of these species by the general public has not been a problem. Scientific collecting and take by private and institutional collectors are not presently identified as threats. Scientific collecting is controlled by the State through permits.

C. *Disease or predation.*

Predation upon the Pearl darter undoubtedly occurs; however, there is no evidence to suggest that disease or natural predators threatens this species. To the extent that disease or predation occurs, they become a more important consideration as the total population decreases in number.

D. *The inadequacy of existing regulatory mechanisms.*

There is currently no requirement within the scope of other environmental laws to specifically consider the Pearl darter or ensure that a project will not jeopardize its continued existence. Existing environmental laws and regulations are not effectively protecting the species.

Current Conservation Efforts: None.

E. *Other natural or manmade factors affecting its continued existence.*

The current range of the Pearl darter is restricted to localized sites within the Pascagoula River drainages. Consequently, genetic diversity has likely declined due to fragmentation and separation of Pearl darter populations. The long-term viability of a species is founded on conservation of numerous local populations throughout its geographic range (Harris 1984). This is essential for the species to recover and adapt to environmental change (Nosset al. 1994, Harris

1984). Interbreeding populations of Pearl darters are becoming increasingly disjunct. This disjunct distribution makes Pearl darter populations vulnerable to extirpation from catastrophic events, such as toxic spills, large in-stream-gravel mining projects, or changes in flow regime.

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PETITION TO LIST

yellowcheek darter
(*Etheostoma moorei*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 12/30/82:
CNOR 9/18/85:
CNOR 01/6/89:
CNOR 11/21/91:
CNOR 11/15/94:
CNOR 10/30/01: C
CNOR 06/13/02: C

TAXONOMY

First collected in 1959 from the Devils Fork tributary of the Little Red River, the yellowcheek darter (*Etheostoma moorei*, Percidae) was described by Raney and Suttkus in 1964, using 228 specimens from the Middle Fork, South Fork, and Devils Fork tributaries of the Little Red River. The yellowcheek darter is one of only two members of the subgenus *Nothonotus* known to occur west of the Mississippi River. The taxonomic status of the yellowcheek darter as a valid species is uncontroversial (e.g., Page and Burr 1991).

NATURAL HISTORY

Morphology

The yellowcheek darter is a small and compressed fish which attains a maximum length of about 64 mm (2.5 inches). It has a moderately sharp snout, deep body, and deep caudal peduncle. The back and sides are grayish brown, often with darker brown saddles and lateral bars. Breeding males are brightly colored with a bright blue or brilliant turquoise breast and throat and light green belly, while breeding females possess orange and red-orange spots but are not brightly colored (McDaniel 1984, Robison and Buchanan 1988).

A 1999 genetic study evaluated genetic and meristic variation among yellowcheek darter populations. The study revealed that although all known yellowcheek darter populations are genetically very similar, populations in the Turkey Fork reach of Devils Fork differed from

South Fork and Middle Fork populations, possibly indicating that the Turkey Fork population may represent an evolutionarily significant unit (Mitchell 1999). It was also noted that individuals captured in Turkey Fork exhibited a markedly larger body size and a longer spawning period, suggesting some variation between populations. Therefore, it has been suggested that the Turkey Fork population may represent a subspecies of the original yellowcheek darter populations in Devils Fork (Mitchell 1999), and that individuals migrated to the South and Middle Fork at a later time (personal communication cited in U.S. Fish and Wildlife Service candidate assessment form)

Behavior
Males and females reach sexual maturity at one year of age, and maximum life span is around four years (McDaniel 1984). Spawning occurs from late May through June in the swift to moderately swift portions of riffles, often around or under the largest substrate particles (McDaniel 1984), although ripe females have been found at the head of riffles in smaller gravel substrate (Wine et al. 2000). Spawning yellowcheek darters occupy large boulder substrate and turbulent water near the lower portion of riffles (Wine et al. 2000). During non-spawning months, there is a general movement to portions of the riffle with smaller substrate, such as gravel or cobble, and less turbulence (Robison and Harp 1981). A number of life history characteristics, including courtship patterns, specific spawning behaviors, egg deposition sites, number of eggs per nest, degree of male protection of the nest, and degree of territoriality, are unknown at this time; however, researchers have suggested that yellowcheek darters deposit eggs on the undersides of larger rubble in swift water (McDaniel 1984).

Habitat
The yellowcheek darter inhabits high gradient headwater tributaries with clear water, permanent flow, moderate to strong riffles, and gravel, rubble, and boulder substrates (Robison and Buchanan 1988). Yellowcheek darter prey items include aquatic dipteran larvae, stoneflies, mayflies, and caddisflies (McDaniel 1984).

Distribution
The yellowcheek darter is endemic to four tributaries of the upper Little Red River: Devils Fork (including the Turkey Creek and Beech Fork segments), the Middle Fork of the Little Red River, the South Fork of the Little Red River, and Archey Creek, in Cleburne, Searcy, Stone, and Van Buren counties, Arkansas (Robison and Buchanan 1988). In 1962, the construction of a dam on the Little Red River to create Greers Ferry Lake impounded much of the range of this species, including the lower reaches of Devils Fork, which was the collection site of the holotype. The lake flooded optimal habitat for the species, and caused the genetic isolation of the populations in the four tributaries (McDaniel 1984).

In the 1978-81 study by Robison and Harp (1981), yellowcheek darters occurred in greatest numbers in the Middle and South Forks of the Little Red River, with populations estimated at 36,000 and 13,500, respectively, while populations in both Devils Fork and Archey Fork were estimated at approximately 10,000 individuals (Robison and Harp 1981). During this study, the four major tributaries of the Little Red River supported an estimated 60,000 yellowcheek darters, and the species was considered the most abundant riffle fish present (Robison and Harp 1981).

Extensive sampling of the first two tributaries of Little Red River below Greers Ferry Dam (both named Big Creek) failed to yield yellowcheek darters, and no darters were found in immediately adjacent watersheds (Robison and Harp1981).

While collecting specimens for the 1999 genetic study, researchers discovered that yellowcheek darters were no longer the dominant riffle fish and were more difficult to find (Wine et al. 2000). Because optimal habitat had been destroyed by the creation of Greers Ferry Lake (McDaniel 1984), yellowcheek darters moved to upper stream reaches with lower summer flow, smaller substrate particle size, and reduced gradient (Wine et al. 2000). A thorough status survey conducted in 2000 found yellowcheek darters in only three of the four historic range tributaries in greatly reduced numbers (Wine et al. 2000). Populations in Middle Fork were estimated at approximately 6,000 individuals, 2,300 in South Fork, and 2,000 in Archey Fork.

No yellowcheek darters were collected from the Devils Fork system. Where yellowcheek darters were captured, they were fifth in abundance compared to other riffle fishes, while historically they dominated the fish community. Fish community composition was similar between the 1978-81 and 2000 studies, but the proportion of yellowcheek darters declined substantially. Fish known to co-exist with yellowcheek darter include the rainbow darter (*E. caeruleum*) and greenside darter (*E. blennioides*), which can use pool habitats during periods of low flow, as evidenced by the collection of these two species from pools during electroshocking activities. Electroshocking has not revealed any yellowcheek darters in pools, suggesting that they are unable to tolerate pool conditions. An inability to use pools during low flows would make them much more vulnerable to seasonal fluctuations in flows that reduce riffle habitat. As a result, researchers have suggested that declines in yellowcheek darters are more likely a species rather than a broader community phenomenon (Wine et al. 2000).

POPULATION STATUS

A thorough status survey conducted in 2000 found yellowcheek darters in only three of the four historic range tributaries in greatly reduced numbers(Wine et al. 2000). Populations in Middle Fork were estimated at approximately 6,000 individuals, with 2,300 in South Fork, and 2,000 in Archey Fork.

No yellowcheek darters were collected from the Devils Fork system. Where yellowcheek darters were captured, they were fifth in abundance compared to other riffle fishes, while historically they dominated the fish community. Fish community composition was similar between the 1978-81 and 2000 studies, but the proportion of yellowcheek darters declined substantially.

The U.S. Fish and Wildlife Service classifies the yellowcheek darter as a candidate for Endangered Species Act protection with a listing priority number of 2. The Arkansas Natural Heritage Program ranks the yellowcheek darter as Critically Imperiled.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range: Arkansas. Yellowcheek darters are endemic to four tributaries of the upper Little Red River: Devils Fork (including the Turkey Creek and Beech Fork segments), the Middle Fork of the Little Red River, the South Fork of the Little Red River, and Archey Creek, in Cleburne, Searcy, Stone, and Van Buren counties, Arkansas (Robison and Buchanan 1988).

Current range: Arkansas. A thorough status survey conducted in 2000 found yellowcheek darters in only three of the four historic range tributaries, and in greatly reduced numbers(Wine et al. 2000). Populations in Middle Fork were estimated at approximately 6,000 individuals, with 2,300 in South Fork, and 2,000 in Archey Fork.

Land ownership: The yellowcheek darter is known historically from four headwaters tributaries of the upper Little Red River in Cleburne, Searcy, Stone, and Van Buren counties, Arkansas. Approximately 93 percent of the upper Little Red River watershed is in private ownership, with the remaining 7 percent owned by the U.S. Army Corps of Engineers (4 percent), the U.S. Forest Service (2 percent), and the Arkansas Game and Fish Commission (1 percent).

Robison and Harp (1981), McDaniel (1984), and Robison and Buchanan (1988) have attributed the decline in populations of yellowcheek darters in the four headwater tributaries of the Little Red River to habitat alteration and degradation. The suspected primary cause of the species' decline is the impoundment of the lower reaches of the four tributaries of the Little Red River that form Greers Ferry Lake, areas that in the past provided optimal habitat for this species. The creation of Greers Ferry Lake in 1962 converted optimal yellowcheek darter habitat (clear, cool, perennial flow with large substrate particle size (Robison and Buchanan 1988)) to a deepwater, lacustrine environment.

This dramatic change in habitat flooded spawning sites, altered habitat radically, and changed chemical and physical characteristics in the streams which provide optimal habitat for this species. Impoundments profoundly alter channel characteristics, habitat availability, and flow regime with serious consequences for biota (Allan and Flecker 1993, Ward and Stanford 1995), change lotic to lentic waters, increase depths and sedimentation, decrease dissolved oxygen, drastically alter resident fish populations (Neves et al. 1997), disrupt fish migration, and destroy spawning habitat (Ligon et al. 1995).

Because it is endemic to only four headwater tributaries of the Little Red River, the yellowcheek darter is highly vulnerable to alterations in physical habitat characteristics and water quality degradation. As a result, yellowcheek darter numbers have declined by 83 percent in both the

Middle Fork and South Fork, and 60 percent in Archey Fork in the past 20 years. No yellowcheek darters were found in the Devils Fork during the 2000 status survey, the species having apparently been extirpated in that reach. A comparison of inhabited stream reaches in the 1981 survey versus the 2000 survey reveals that the largest decline occurred in the South Fork, where reaches formerly inhabited by the yellowcheek darter declined by 70 percent. The second largest decline occurred in the Archey Fork, where there was a 60 percent reduction in inhabited stream reach.

The Middle Fork showed the least decline in inhabited stream reach, at 22 percent. Ozark headwater streams typically exhibit seasonal fluctuations in flows, with flow rates highest in spring, and lowest in late summer and fall. The upper reaches of these small tributaries are most affected by seasonally fluctuating water levels (Robison and Harp 1981). As a result, they often lack consistent and adequate flows, and by late summer or fall are reduced to a series of isolated pools (Mitchell, Wine). Because the yellowcheek darter requires permanent flows with moderate to strong current (Robison and Buchanan 1988), seasonal fluctuations in stream flows that reduce lentic flows to a series of isolated pool habitats are a serious threat. Consequently, the 2000 status survey revealed yellowcheek darters in the lower reaches of only three of these four small headwater tributaries.

Secondary causes of yellowcheek declines include habitat degradation from land use activities in the watershed, including agriculture and forestry. Traditional farming practices, feed-lot operations, and associated poor land use practices contribute many pollutants, and agriculture affects 72 percent of impaired river kilometers in the United States (Neves et al. 1997). Nutrients, bacteria, pesticides, and other organic compounds generally are found in higher concentrations in agricultural areas than forested areas. Nutrient concentrations in streams may result in increased algal growth in streams, and a related alteration in fish community composition (Petersen et al. 1999). Major agricultural activities within the Little Red River watershed include poultry, dairy, swine, and beef cattle operations.

The Arkansas Natural Resources Conservation Service has identified animal wastes, nutrients, excessive erosion, loss of plant diversity, and declining species as water quality concerns associated with agricultural land use activities in the upper Little Red River watershed (NRCS 1999). Large poultry and dairy operations increase nutrient inputs to streams when producers apply animal waste to pastures to stimulate vegetation growth for grazing and hay production. Continuous grazing methods in the watershed allow unrestricted animal access to grazing areas, and on steeper slopes this results in increased runoff and erosion (NRCS 1999). Since pastures often extend directly to the edge of the stream, and lack a riparian zone of vegetation, runoff from pastures carry sediments and nutrients directly into streams. Livestock spend a disproportionate amount of time in riparian areas during hot summer months and trampling and grazing can change and reduce vegetation, and eliminate riparian areas by channel widening, channel aggradation, or lowering of the water table (Armour et al. 1991).

Timber harvesting activities involving clear cutting entire steep hillsides have been observed recently in the watershed (personal communication cited in U.S. Fish and Wildlife Service candidate assessment form). A lack of mandatory best management practices (BMP's) during timber harvests has resulted in water quality degradation and habitat alteration in stream reaches adjacent to harvesting operations. When timber harvests involve clear cutting to the water's edge, without leaving a riparian buffer, silt and sediment enter streams lying at the bottom of steep slopes. The lack of stream side vegetation also promotes bank erosion that alters streamcourses and introduces large quantities of sediment into the channel (Allan 1995). Timber harvest operations that use roads on steep slopes to transport timber can carry silt and sediment from the road into the stream at the bottom of the slope. Logging impacts on sediment production are considerable, but often erosion of access and haul roads produces more sediment than the land harvested for timber (Brim Box and Mossa 1999).

B. *Overutilization for commercial, recreational, scientific, or educational purposes.*

Over-collection is not thought to be a significant cause for decline, although it may contribute to an already declining population. The yellowcheek darter is a rare and unique species that has been collected by numerous researchers and students. The bridge over the Middle Fork of the Little Red River near Clinton, Arkansas, is a popular locality to collect this species. Because the yellowcheek darter is not used as a sport fish or for bait, collection by the general public is not considered a threat.

C. *Disease or predation.*

There is no evidence that disease or predation is a serious threat.

D. *The inadequacy of existing regulatory mechanisms.*

The Arkansas Department of Environmental Quality (ADEQ) has established water quality standards for surface waters in Arkansas, including specific standards for those.streams designated as "extraordinary resource waters" based on "a combination of the chemical, physical, and biological characteristics of a water body and its watershed, which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential and intangible social values" (State of Arkansas 1998). As described in ADEQ's Regulation 2, Section 2.203, extraordinary resource waters "shall be protected by (1) water quality controls, (2) maintenance of natural flow regime, (3) protection of in stream habitat, and (4) pursuit of land management protective of the watershed." This regulatory mechanism has precluded large scale commercial gravel mining in the watershed. Therefore, gravel mining is not considered a cause of habitat degradation or a threat in the Little Red River watershed. However, the applicable water quality standards have not protected yellowcheek darter habitat from the damaging habitat alterations and water quality degradation from activities such as timber harvesting and agriculture.

The Arkansas Forestry Commission is the state agency responsible for establishing best management practices for timber harvests in the state. BMPs for timber harvests in Arkansas consist only of recommendations and guidelines. Therefore, there is no requirement that timber harvesters include BMPs in timber operations. The BMPs are currently under revision (U.S. Fish and Wildlife Service candidate assessment form).

Current Conservation Efforts: No conservation agreements or conservation activities have been developed in the Little Red River watershed above Greers Ferry Lake. The Natural Resources Conservation Service administers the Environmental Quality Incentives Program, a conservation program of the 1996 Farm Bill that is intended to address natural resources concerns. A few projects designed to prevent water quality degradation from agricultural practices have been implemented in the watershed under this program, but broad scale conservation measures that would address the above identified threats have not been implemented.

E. ***Other natural or manmade factors affecting its continued existence.***

The Little Red River watershed has experienced moderate drought conditions over the last two to three years (Southern Regional Climate Center 2000), which has affected flows in its tributaries. Stage height and flow rates were one foot lower during the sampling period for the 2000 status survey than during the 1979-80 study (Wine et al. 2000). Streamflow is strongly correlated with important physical and chemical parameters that can be considered “master variables” that limit the distribution and abundance of riverine species (Power et al. 1995, Resh et al. 1988) and regulates the ecological integrity of flowing water systems (Poff et al. 1997). No yellowcheek darters were found in the upper reaches of any study streams or in the Turkey/Beech Fork reach of Devils Fork, which is a result of drought conditions and indicates a contraction of yellowcheek darter range to stream reaches lower in the watershed where flows are maintained for a greater portion of the year (Wine et al. 2000).

Since the impoundment of Greers Ferry Lake, populations of yellowcheek darters in the four tributaries of the Little Red River have been fragmented, such that genetic interchange no longer flows between subpopulations occurring in different tributaries, and each discrete subpopulation in each tributary reproduces only with other members in the same tributary. This fragmentation of the populations can reduce genetic diversity in the separated populations, promoting a loss of physiological or adaptive mechanisms that might improve the yellowcheek darter’s chances for withstanding stochastic events.

Genetic heterogeneity is lost when the natural interchange of genetic material between populations is prohibited. Population genetics has emphasized the profound negative effects the loss of genomic heterogeneity has on overall population viability of species with restricted and fragmented ranges (Chesser 1983, Gilpin and Soule 1986). Such isolation can eventually lead to inbreeding depression (Avise and Hamrick 1996), which can be a major detriment to a species’ recovery (Frankham 1995). Inbreeding often result in decreased fitness of multiple life stages, and the loss of genetic heterozygosity results in significantly increased risk of extinction in localized natural populations (Saccheri et al. 1998).

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PETITION TO LIST

Zuni bluehead sucker
(*Catostomus discobolus yarrowi*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 9/18/85:
CNOR 1/6/89:
CNOR 11/21/91:
CNOR 11/15/94:
CNOR 10/30/01: C
CNOR 6/13/02: C

TAXONOMY

Smith (1966) and Smith et al. (1983) postulated that the Zuni bluehead sucker subspecies, *Catostomus discobolus yarrowi* (Catostomidae) was of ancient hybrid origin following the capture of a headwater stream of the Rio Grande by upstream erosion of a headwater stream of the Zuni River during the late-Pleistocene (Propst 1999). This event would have brought the Rio Grande sucker (*Catostomus plebeius*) into contact with a resident bluehead sucker. Based on shared physical traits, Smith (1966) and Smith et al. (1983) believed this contact area was in the upper reaches of the Rio Nutria. Crabtree and Buth (1987) provided allozymic data supporting subspecific differentiation of upper Little Colorado River *Catostomus discobolus* from its conspecifics prior to introgression of *Catostomus discobolus* and *Catostomus plebeius* in the upper Rio Nutria. Regardless of the mechanism for differentiation of *Catostomus discobolus yarrowi*, its taxonomic status as a valid subspecies is uncontroversial (e.g., Page and Burr 1991; Propst 1999).

NATURAL HISTORY

Morphology
Propst (1999) describes the Zuni bluehead sucker as fusiform (torpedo shaped) and slender, with a terminal mouth. It has a bluish head with a silvery tan to dark green back with sides and abdomen yellowish to silvery white. Adults are mottled slate-gray, almost black, dorsally and cream white ventrally. Males during the spawning season may be differentiated by coarse tubercles on the anal and caudal fins and the caudal peduncle, and distinctive breeding

coloration; dorsally they are intense black with a bright red lateral band and a white abdomen (Smith 1966; Propst and Hobbes 1996). Propst and Hobbes (1996) reported that most suckers do not exceed 20.3 centimeters (cm) (8 inches (in)), however, some individuals may exceed 25 cm (9 in) total length.

Behavior

In the Zuni River drainage, the fish spawned April-early June when water temperature was 6-13 C; some individuals matured at age 1 and most were mature by age 2; few survived to age 4 (Propst et al. 2001).

Habitat

Hanson (1980) described Zuni bluehead sucker habitat as stream reaches having shade and pool and riffle habitats with coarse substrates; stream reaches with fine substrates (sand and silt) had few or no Zuni bluehead suckers. Propst and Hobbes (1996) reported that Zuni bluehead suckers were collected mainly in pool and pool-run habitats. Such habitat areas were typically shaded, and water velocity was less than 0.1 meter per second (0.3 feet per second). Most specimens were found in water that was 30 to 50 cm (12 to 20 in) deep, where the substrate ranged from cobble and boulders to bedrock. Pools were often edged by emergent aquatic vascular plants (mainly willows). Periphytic and perilithic algae were generally abundant in reaches where Zuni bluehead suckers were common. The Zuni bluehead sucker feeds primarily on algae that it scrapes from rocks, rubble, and gravel substrates (Winter 1979; Sublette et al. 1990).

Distribution

The Zuni bluehead sucker is endemic to the headwaters of the Little Colorado River in east-central Arizona and west-central New Mexico (Smith 1966; Smith et al. 1983; Crabtree and Buth 1987; Propst and Hobbes 1996; Propst 1999). This fish was once common in the Little Colorado and Zuni river drainages, but its range has been reduced by over 90 per cent (Propst 1999), and its numbers by about 90 percent, in the last 20 years. The sucker is now found in low numbers in Kin Li Chee Creek in Arizona (*in litt.* 2000 cited in U.S. Fish and Wildlife Service candidate assessment form), and is now restricted to five semi-isolated populations in the upper Rio Nutria drainage in west-central New Mexico (Propst 1999).

New Mexico

The type specimen of the Zuni bluehead sucker was collected from the Zuni River near the Zuni Pueblo, New Mexico in 1873 (Cope 1874). It was not subsequently collected in New Mexico until W.J. Koster (University of New Mexico, Museum of Southwestern Biology) collected the species in the Rio Nutria in 1948 and the Rio Pescado in 1960 (Propst 1999). Several chemical treatments were made in the Zuni River drainage in New Mexico during the 1960's to remove green sunfish, fathead minnow, and suckers from the Rio Nutria to aid in the establishment of a rainbow trout sport fishery in reservoirs on the Zuni Pueblo (Winter 1979). These treatments eliminated the Zuni bluehead sucker from most of the Zuni River drainage. However, the population of suckers in the Rio Nutria was maintained by dispersal of individuals from upstream, untreated reaches, such as Aqua Remora (Winter 1979; Propst 1999).

In New Mexico, Hanson (1980) documented the primary areas of occurrence to be Radosevich

Creek (renamed Agua Remora), upper Rio Nutria (from the mouth of Nutria Box Canyon near the eastern boundary of the Zuni Indian Reservation upstream), and the confluence of the Rio Pescado and Rio Nutria. Elsewhere in the Zuni River drainage, the sucker was rare or absent. By the late 1970's the Zuni bluehead sucker's range had been reduced by at least 50 percent and the species was limited to the upper Zuni River drainage and Kin Li Chee Creek (Hanson 1980; Smith *et al.* 1983).

Arizona
In Arizona, Smith (1966) reported the subspecies in four small streams (Propst 1999). Smith et al. (1979) collected Zuni bluehead suckers in Arizona from East Clear Creek and Kin Li Chee Creek for genetic analysis. By the early 1980's, the range in Arizona was apparently reduced to only Kin Li Chee Creek (Smith et al. 1983). Crabtree and Buth (1987) confirmed that the sucker still persisted in Kin Li Chee Creek in 1987.

POPULATION STATUS

New Mexico
The sucker currently persists mainly as five semi-isolated populations in a small fraction (9 miles, 15 kilometers) of its former range, and occurs mainly upstream of the mouth of the Rio Nutria Box Canyon (Propst 1999; Propst et al. in press). Within this area, it is most common near the Rio Nutria Box Canyon mouth; the confluence of the Rio Nutria and Tampico Draw; Agua Remora), and the uppermost Rio Nutria (Stroh and Propst 1993; Propst and Hobbes 1996; Propst 1999; Propst et al. in press). The sucker was very rare or absent elsewhere in the Zuni River drainage in New Mexico (Hanson 1980; Stroh and Propst 1993). Fish surveys from 1990 - 1993 found that the sucker populations in Agua Remora and upper Rio Nutria were stable. The population at the Zuni River confluence with the Rio Nutria and Rio Pescado was declining, and the populations in the Rio Pescado and lower Zuni River almost depleted (Stroh and Propst 1993).

Propst et al. (in press) stated that dispersal of the sucker from upstream populations may augment downstream populations, but upstream movement is generally blocked by physical obstructions, such as irrigation diversions and impoundments. The irregular occurrence of the sucker in reaches downstream from the mouth of Nutria Canyon indicates limited downstream dispersal from currently occupied stream reaches. No suckers were found in the Rio Nutria between the canyon mouth and the confluence of the Rio Pescado. In the confluence area, a few large individuals were occasionally collected. The absence of smaller individuals suggests that it is the dispersal of larger individuals from upstream reaches that maintains the sucker in this area (Propst et al. in press).

Arizona
In year 2000, Zuni bluehead suckers have been collected again from Kin Li Chee Creek (U.S. Fish and Wildlife Service candidate assessment form). A genetic evaluation is being conducted to confirm that these specimens are indeed the Zuni bluehead sucker subspecies. This would be a

very important addition to the current known distribution of the species.

Population Estimates A general decline in sucker numbers is apparent from 1978 (475 suckers) to 1993 (55 suckers). This is about a 90 percent decrease in numbers in the last 20 years. A majority of the suckers were collected from the upper Rio Nutria and Agua Remora. Fish surveys were not conducted in Agua Remora in 1990, 1992, and 1993. This lack of fish survey data hinders the population trend analysis of the fish, but the overall trend is downward. After 1978, the sucker was not collected from the Zuni River and is presumed to be extirpated from this water course. In addition, there has been a significant decrease in sucker numbers in the Rio Pescado from 1978 (93 suckers) to 1993 (four suckers). Based on this fish collection information, and the biology of the species, there are likely only a few hundred suckers remaining.

To confirm the population trend for the sucker, an additional monitoring effort was conducted in April, 2000. This inventory confirmed the extirpation of the sucker from the Zuni River and Rio Pescado. Sucker populations have persisted in the Rio Nutria and Tampico Draw. A sucker survey was conducted in Kin Li Chee Creek in Arizona on the Navajo Reservation. This is a historical collection site that had not been sampled since 1987 when the sucker was last documented (Crabtree and Buth 1987). One hundred and ninety suckers were collected from the creek. The suckers are tentatively identified as Zuni bluehead suckers, but genetic evaluation will be used to confirm their identity. If this identification is confirmed, this will represent an important remaining population of the sucker. The sucker is most likely still present in Aqua Remora.

The sucker is listed as Endangered by the State of New Mexico (NMDGF 1999), and the State fishing regulations (NMDGF 1998) prohibit take of endangered species. The sucker is listed as a species of special concern by the State of Arizona (Arizona Game and Fish Department 1996). The U.S. Forest Service (1985) classifies the sucker as sensitive.

The U.S. Fish and Wildlife Service classifies the Zuni bluehead sucker as a candidate for Endangered Species Act protection with a listing priority number of 3. The New Mexico Natural Heritage Program ranks the Zuni bluehead sucker as Critically Imperiled.

LISTING CRITERIA

A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.***

Historic range:	Arizona; New Mexico. Little Colorado and Zuni River drainages (Propst et al. 2001).
Current range:	Arizona; New Mexico. The Zuni bluehead sucker was once common in the Little Colorado and Zuni River drainages, but its range has been reduced by over 90 percent in the last 20 years (Propst 1999).

Land ownership**:** The Zuni bluehead sucker habitat remaining is estimated at 9 stream miles (15 km). The last remnant of sucker stream habitat is located on the Cibola National Forest (3 percent), Zuni Indian Reservation (26 percent), and private lands (71 percent). Currently, most of the suckers reside in the upper Rio Nutria and Agua Remora. Rio Nutria: Private: The Nature Conservancy: 5 miles, 8.1 km (56 percent). Tribal: ZuniPueblo: 1.2 miles, 2 km (13 percent).Tampico Draw: Private: 0.1 miles, 0.2 km (less than 1 percent). Agua Remora: Federal: Cibola National Forest: 0.25 miles, 0.4 km (3 percent). Private: 1.3 miles, 2.1 km (15 percent). Rio Pescado: Tribal: Zuni Pueblo: 1.2 miles, 2 km (13 percent).

The species has become imperiled in the last 100 years due to adverse affects of human activities in the watershed including: logging, road construction, over-grazing by livestock, reservoir construction, irrigation withdrawals, and stocking of exotic fishes (Hanson 1980; NMDGF 1988, 1994; Propst and Hobbes 1996; Propst 1999). The NMDGF (1988; 1994) and Propst (1999) reported that the quality of the Zuni River drainage fish habitat has declined in the last 20 years to a point that sucker populations are now highly disjunct and greatly reduced in numbers and distribution.

In New Mexico, the documented historic fish fauna of the Zuni River drainage consists of three species: roundtail chub, speckled dace, and Zuni bluehead sucker (Propst 1999). Roundtail chub.no longer occur in the Zuni River and speckled dace may be extirpated from the Zuni River drainage (Propst 1999). Zuni bluehead sucker survives in New Mexico only in the Rio Nutria and its small tributaries (Propst 1999).

The Zuni bluehead sucker is a stream obligate and does not live in lentic waters (lakes and ponds). It currently occupies 9 river miles (15 km) in 4 areas (Rio Nutria-Nutria Box, Rio Nutria at Tampico Draw confluence, uppermost Rio Nutria, and Agua Remora) (Propst et al. in press). Sucker range reduction and fragmentation was caused by discontinuous surface water flow, separation of inhabited reaches by reservoirs, and habitat degradation from fine sediment deposition (Propst and Hobbes 1996). Fine sediments reduce or prevent production of periphyton (algae), the primary food of the species. Fine sediments, if mobilized during the spawning season, may smother recently spawned eggs (Propst and Hobbes 1996).

According to Merkel (1979), both the Rio Nutria and Rio Pescado drainages have been drastically altered by man’s activities. Many small impoundments, built primarily for watering livestock, occur in the headwaters, preventing some flows from reaching the main streams. Logging, road construction, and over-grazing by livestock have destroyed much of the ground cover. This has caused serious erosion problems, stream flows to fluctuate widely, and the reservoirs to accumulate large quantities of sediment (Merkel 1979).

Reservoirs and diversion dams for irrigation not only have depleted stream flows but also have inundated a number of reaches of stream (Merkel 1979; Hanson 1982). The Rio Nutria and Rio Pescado drainages are dry much of the year except for those reaches that are fed by perennial springs (Merkel 1979). Forest Road 50, which is in the upper watershed of sucker habitat, was in the process of being upgraded in1999 (U.S. Fish and Wildlife Service candidate assessment form). Road construction activities may have direct adverse effects on the watershed from soil erosion and sedimentation to the streams. Indirect adverse effects from fine sediment input will be caused by interrelated actions, such as ranchette development, logging, grazing, off-road vehicles, and other activities.

Livestock grazing is another imminent threat to the suckers residing in Agua Remora. Agua Remora on the Cibola National Forest was fenced to exclude livestock in 1978 (Merkel 1979), and the riparian habitat and stream morphology have shown considerable improvement since livestock were excluded (Stefferud 1985). However, the private landowner is apparently continuing to graze livestock in the riparian zone of the creek despite the riparian areas being fenced (U.S. Fish and Wildlife Service candidate assessment form). Livestock grazing in riparian zones has been found to negatively affect water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife (Belsky, et al. 1999). In addition, the Forest Service has not had access to Agua Remora on the Cibola National Forest lands since 1992, when the same private property owner would no longer allow them to cross his private property. The U. S. Forest Service (FS) is attempting to exchange FS land for the private land where the Zuni bluehead sucker occurs in Agua Remora.

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

The Zuni bluehead sucker is not a gamefish and does not have recreational or commercial value. In addition, it is listed as Endangered by the State of New Mexico (NMDGF 1999), and the State fishing regulations (NMDGF 1998) prohibit take of endangered species. There is no indication that overcollection for any purpose is a contributing factor to its imperiled status.

C. ***Disease or predation.***

Non-native predatory fishes (primarily green sunfish, *Lepomis cyanellus*) have contributed to the displacement or elimination of the species from much of its historic range. Since about 1850, seventy-six species of non-native fishes have been introduced into New Mexico waters that compete with or prey upon native fishes (Nico and Fuller 1999). Propst and Hobbes (1996) reported that several non-native fish species had been established in the Zuni River drainage by the late 1970's. Fathead minnow (*Pimephales promelas*), plains killifish (*Fundulus zebrinus*), and green sunfish were all common in the Zuni River drainage. In addition, non-native predator fishes (green sunfish, northern pike (*Esox luscius*), and largemouth bass (*Micropterus salmoides*)) enter the Zuni River drainage from several impoundments connected to the river (Hanson 1980). The Zuni bluehead sucker occurs only in stream habitats that are comparatively free of non-native fishes (Propst and Hobbes 1996).

D. ***The inadequacy of existing regulatory mechanisms.***

Regulatory mechanisms currently in effect do not provide adequate protection for the Zuni bluehead sucker and its habitat. Existing regulatory mechanisms that could potentially provide some protection for the sucker include: (1) New Mexico Wildlife Conservation Act; (2) Arizona Non-Game and Endangered Species Program; (3) National Environmental Policy Act; (4) National Forest Management Act; (5) Federal Endangered Species Act; and (6) Zuni Pueblo Law and Order Code.

State
The Zuni bluehead sucker is listed as endangered in New Mexico (NMDGF 1999). Under the New Mexico Wildlife Conservation Act of 1974, take of these species is prohibited, but the statute does not provide additional habitat protection or designation of critical habitat (NMDGF 1988, 1998). This sucker is listed as a species of special concern by the State of Arizona (Arizona Game and Fish Department 1996), but this statute does not prohibit take and also lacks habitat protection. Therefore, the effectiveness of the New Mexico and Arizona statutes to protect listed species and their habitats is problematic.

Federal
Agua Remora provides the only stream habitat (0.25 miles, 0.4 km) for the Zuni bluehead sucker on public land (Cibola National Forest). The U.S. Forest Service (1985) classifies the sucker as sensitive in Arizona and New Mexico, which provides some limited protection. The National Forest Management Act requires the Forest Service to prepare management plans for each National Forest; and a plan has been completed for the Cibola National Forest (U. S. Forest Service 1985). Forest plans must meet the requirements of the Natural Resources Multiple-Use Act to address such issues as recreation, range, timber, biological diversity, and economic and social factors in agency decision making. The 1985 Cibola National Forest Plan includes a discussion for protection of the Zuni bluehead sucker.

The Plan indicated that fencing would protect sucker riparian habitat, but improved range management was needed to restore the entire watershed. In 1980, the U.S. Fish and Wildlife Service and the NMDGF explored the possible listing of the sucker as an endangered species, but Federal listing did not occur (U.S. Fish and Wildlife Service 1980a, 1980b; NMDGF 1980). The ESA can sometimes incidentally afford protection to a species if it coexists with species already listed as threatened or endangered under the Act, but no listed species are known to occur in the remaining Zuni bluehead sucker habitats.

Zuni Pueblo
The Zuni bluehead sucker, speckled dace, and grass carp are protected from fishing in Pueblo lakes (Zuni Pueblo Law and Order Code S7-5-3 par. 36). In addition, stream fishing is prohibited on the Pueblo. These regulations protect the species from take by fishing, but do not include regulations to protect sucker habitats.

Current Conservation Efforts: For several years, the NMDGF has been the lead agency to develop a conservation plan for Zuni bluehead sucker (Propst and Hobbes 1996). A new study funded through ESA section 6 funds with the U.S. Fish and Wildlife Service and NMDGF was initiated in year 2000 and will continue through 2005 (U.S. Fish and Wildlife Service candidate assessment form). The grant includes the development and implementation of a Zuni Bluehead Sucker Conservation Plan, as well as the acquisition of additional information on distribution, life history, and species associations with the Zuni bluehead sucker. At this time, the potential cooperators for the conservation appear to be the Silva Family, Zuni Pueblo, U.S. Forest Service, The Nature Conservancy, NMDGF, and U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service candidate assessment form). In April 2000, 182 bluehead suckers were collected (57 retained for genetic analysis and 125 released) from Kin Li Chee Creek on the Navajo Reservation. If these bluehead suckers are confirmed to be the Zuni subspecies through genetic analysis (currently in progress), then the Navajo Nation would also be a potential cooperators in the plan (U.S. Fish and Wildlife Service candidate assessment form).

In addition, Zuni Pueblo personnel conducted Zuni bluehead sucker surveys of the Pueblo and other historic habitats in cooperation with the U.S. Fish and Wildlife Service, Navajo Nation, and the NMGF in year 2000, and were funded by the U.S. Fish and Wildlife Service for additional surveys in 2001. Zuni Pueblo personnel will attempt to survey East Clear Creek in cooperation with the Arizona Game and Fish Department in 2001. East Clear Creek is the only historic Zuni bluehead sucker locality that was not resurveyed in 2000.

E. *Other natural or manmade factors affecting its continued existence.*

Hanson (1980) noted that the sucker habitat within the Zuni River drainage is vulnerable to habitat deterioration from poor water quality, low flows, flood flows, and poor watershed management. These factors taken singly or in combination could eliminate one or more of the remaining sucker populations. Furthermore, additional proposed impoundments in the Zuni River drainage potentially threaten the species remaining stream habitat (Stroh and Propst 1993). Fish toxicants were used repeatedly in the Nutria and Pescado Rivers in the 1960's and 1970's to eradicate green sunfish and fathead minnows (Merkel 1979). One of these treatments inadvertently killed substantial numbers of Zuni bluehead suckers in the upper Rio Nutria in 1967, and another sucker kill occurred in 1962 in Cebolla Creek in the Rio Pescado drainage (Merkel 1979).

Vandalism to endangered species and their habitats may be a serious threat to the Zuni bluehead sucker in New Mexico. During dry periods, the Zuni bluehead sucker is restricted to a few shallow pools, which make the species extremely vulnerable to poisoning or other forms of vandalism.

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PETITION TO LIST

grotto sculpin
(*Cottus* sp.)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 6/13/02: C

TAXONOMY

The grotto sculpin has not yet been formally described as a distinct species, but publication of a description is anticipated in the near future following the results of planned genetic analyses (personal communication 2002 cited in U.S. Fish and Wildlife Service candidate assessment form). The grotto sculpin is clearly closely related to the banded sculpin (*Cottus carolinae*), but lives only in six cave systems in central Perry County, Missouri, and, uniquely for the family Cottidae, exhibits numerous morphological and other features associated with cave-dwelling fish (Burr et al. 2001).

Even if the grotto sculpin were not recognized as a distinct species and instead interpreted as a form of banded sculpin, there can be no doubt that it would qualify for listing under the federal Endangered Species Act as a distinct population segment (DPS) under even the most stringent interpretation of the criteria that must be met to qualify as a DPS. It is clearly "discrete" since it is markedly separated from populations of the banded sculpin as a consequence of a variety of physical, ecological, behavioral, and physiological factors associated with its deep cave-dwelling habit (Burr et al. 2001; U.S. Fish and Wildlife Service candidate assessment form), and many of these differences must result from genetic differences distinguishing the grotto sculpin from all other cottids. Given that the grotto sculpin presents the only known example of cave adaptation among all cottids, its biological and ecological significance is indisputable.

NATURAL HISTORY

The grotto sculpin is a relatively small fish within the banded sculpin (*Cottus carolinae*) complex that exhibits distinct cave-adapted features. The banded sculpin complex includes both hypogean (below surface) and epigean (surface, primarily non-cave dwelling) forms. The grotto sculpin appears to be the only hypogean form within the banded sculpin complex and can be distinguished from epigean fish within this complex by a variety of features associated with cave-dwelling. These features include reduced eyes, reduced skin pigmentation, smaller optic nerves, larger anterior portion of the brain, and lower metabolic rates, among others (Burr et al. 2001; U.S. Fish and Wildlife Service candidate assessment form). The occurrence of the banded sculpin in subterranean waters is well known (Poly and Boucher 1996) and Burr et al. (2001) reported the presence of banded sculpins in 25 caves from seven states with known karst environments. None of these sculpins, however, show evidence of cave adaption, and none are known to be permanent cave residents. Burr et al. (2001) have clearly demonstrated that the grotto sculpin is distinct from the epigean forms of banded sculpin.

The cave systems inhabited by the grotto sculpin contain pools and riffles with moderate stream flow and low to moderate stream depth. These fish can be found in the open water or hidden under rocks and occur over a variety of substrates including silt, gravel, cobble, rock rubble that originated from cave breakdown material or solid bedrock. The particular cave systems in which these fish are found formed beneath a sinkhole plain that provides substantial organic input, and Burr et al. (2001) suggest that these may be the only habitats that provide enough food (these caves provide an abundance of invertebrates) and sustained water flow for the species.

POPULATION STATUS

The grotto sculpin is restricted to two karst areas (limestone regions characterized by sink holes, abrupt ridges, caves and underground streams), the Central Perryville Karst and Mystery-Rimstone Karst in Perry County, southeast Missouri. In determining the overall distribution of grotto sculpin, Burr et al. (2001) sampled 27 cave streams within six karst regions in Perry County and documented the species in only five cave systems (Crevice, Moore, Mystery, Rimstone River, and Running Bull). More than 153 additional caves in Arkansas, Illinois, Indiana, Missouri, Tennessee, Virginia, and West Virginia have been searched for grotto sculpin and epigean or hypogean forms of banded sculpin. Of these, banded sculpin complex fish were documented from 25 caves, but only fish in the five Perry County caves listed above exhibited the cave adaptations reported for grotto sculpin (Burr et al. 2001). The current overall range of grotto sculpin has been estimated to encompass approximately 260 square kilometers (100 square miles) (U.S. Fish and Wildlife Service candidate assessment form). The total number of grotto sculpin that currently exist is unknown, but based on estimates obtained from Mystery and Running Bull Caves, the population probably does not exceed a few thousand fish (Burr et al. 2001; U.S. Fish and Wildlife Service candidate assessment form).

The U.S. Fish and Wildlife Service classifies the grotto sculpin as a candidate for Endangered Species Act protection with a listing priority number of 2.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range: Missouri.

Current range: Six cave systems in central Perry County, Missouri.

Land ownership: The entire known range of grotto sculpin is under private ownership.

Caves containing grotto sculpin are located downgradient of the city of Perryville, Missouri; dye trace studies of water movement suggest that urban runoff from Perryville and the surrounding area enters cave streams occupied by grotto sculpins (Burr et al. 2001). Vandike (1985) detected a variety of agriculture-assocated chemicals within the Perryville Karst area, reporting the presence of ammonia, nitrite/nitrate, chloride, and potassium from surface sources at levels high enough to be detrimental to aquatic life. Of the five cave systems documented to have grotto sculpins, populations in one cave system (Running Bull Cave) have likely been eliminated, presumably as the result of point source pollution. When the cave was searched in the spring of 2000, a mass mortality of grotto sculpin was noted and subsequent visits to the cave have failed to document a single live grotto sculpin (Burr et al. 2001; personal communication 2002 cited in U.S. Fish and Wildlife Service candidate assessment form). Burr et al. (2001) conducted surveys in Running Bull Cave prior to the above-mentioned die-off and estimated the overall population within this system to be 150 sculpin. The loss of grotto sculpins from Running Bull Cave would result in a 20 percent decrease in the number of populations. Although the fish kill in Running Bull Cave affected a relatively small percentage of the overall population of grotto sculpin, because there are so few extant populations the overall loss in genetic diversity represented by these populations may have been catastrophic.

The recent point source pollution event that may have eliminated one of the five known populations of grotto sculpin suggests that the threat from chemical contamination is immediate and of a high magnitude. Furthermore, as noted above, there is evidence (Vandike 1985) that this area is highly susceptible to additional sources of contamination that threaten the remaining four populations. The comment from Burr et al. (2001) that more than half of the sinkholes in Perry County "contain anthropogenic refuse, ranging from household cleansers and sewage to used pesticide and herbicide containers," provides further evidence of the high magnitude and imminent threats to this species from chemical contamination.

Further compounding the threats to the grotto sculpin are predation by predatory fish (such as channel catfish), development pressures from the nearby city of Perryville, and a recent loss of genetic diversity.

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

Although some specimens of grotto sculpin have been taken for scientific investigations, such collecting activities do not appear to be at a level that poses a significant threat to this fish.

C. ***Disease or predation.***

Predatory fish occur in all of the caves occupied by grotto sculpin; these fish are potential predators on the eggs and young of sculpin (Burr et al. 2001). The predatory fish found in grotto sculpin caves include: common carp (*Cyprinus carpio*), fat-head minnow (*Pimephales promelas*), yellow bullhead (*Ameiurus natalis*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*) (Burr et al. 2001). These potential predators, normally excluded from cave environments, may escape surface farm ponds that unexpectedly drain through sinkholes into the underground cave systems and enter grotto sculpin habitat. Burr et al. (2001) note that these escaped fishes have increased potential predation pressure on grotto sculpin.

D. ***The inadequacy of existing regulatory mechanisms.***

We are unaware of any existing regulatory mechanisms that provide protection to the grotto sculpin. Because the grotto sculpin has not been formerly recognized as a distinct taxonomic entity, it is currently not being tracked as a species of conservation concern (Missouri Natural Heritage Program 2001) by the Missouri Department of Conservation and is not protected under the Wildlife Code of Missouri (Conservation Commission of Missouri 2001).

Current Conservation Efforts: No conservation agreements are currently in place for the grotto sculpin. The Missouri Department of Conservation may develop either a State Conservation Agreement or Candidate Conservation Agreement for this fish involving all stakeholders and private land owners in Perry County within the range of the sculpin (personal communication 2002 cited in U.S. Fish and Wildlife Service candidate assessment form).

E. ***Other natural or manmade factors affecting its continued existence.***

Karst regions are unique in that sinkholes, a significant component of the habitat, allow chemicals and pollutants to reach ground water directly, without being filtered. Furthermore, given that Burr et al. (2001) state that more than half of the sinkholes in Perry County "contain anthropogenic refuse, ranging from household cleansers and sewage to used pesticide and herbicide containers." Potential water contamination from various sources of point and non-point pollution poses a significant threat to the grotto sculpin. Additionally, as the city of Perryville expands closer to grotto sculpin caves, potential threats from these sources of pollution become greater. The small population size and endemism (i.e., restricted to five cave systems in one county) of the grotto sculpin makes it vulnerable to extinction due to genetic drift, inbreeding depression, and random or chance changes to the environment (Smith 1990). Inbreeding depression can result in death, decreased fertility, smaller body size, loss of vigor, reduced fitness, and various chromosome abnormalities (Smith 1990). Despite evolutionary adaptations for rarity, habitat loss and degradation increase a species' vulnerability to extinction (Noss and Cooperrider 1994). Numerous authors (e.g., Noss and Cooperrider 1994; Thomas 1994) have noted that the probability of extinction increases with decreasing habitat availability. Although natural changes in the environment may cause populations to fluctuate, small and low-density populations are more likely to fluctuate below a minimum viable population (i.e., the minimum or threshold number of individuals needed in a population to persist in a viable state for a given interval; Gilpin and Soule 1986; Shaffer 1981; Shaffer and Samson 1985). Current threats to the habitat of the grotto sculpin may exacerbate potential problems associated with its low population numbers and increase the likelihood of extinction.

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PETITION TO LIST

smalleye shiner
(*Notropis buccula*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 01/06/89:
CNOR 11/21/91:
CNOR 11/15/94:
CNOR 06/13/02: C

TAXONOMY

The smalleye shiner (*Notropis buccula*) was originally described as a subspecies of the Red River shiner (*N. bairdi*), an endemic of the Red River system in Texas and Oklahoma, but was subsequently elevated to species status (Cross 1953; Hubbs 1957; Gilbert 1980; Page and Burr 1991).

NATURAL HISTORY

Morphology
The smalleye shiner is a small (35 to 44 millimeter (1.4 to 1.7 inches (in)), pallid minnow endemic to the Brazos River Basin in Texas. Adult smalleye shiners have a long snout (greater than the distance from anterior tip of mandible to posterior tip of maxillary), eight principal dorsal fin rays, seven principal anal fin rays, and eight pelvic fin rays (Cross 1953).

As with other fishes of the family Cyprinidae, the smalleye shiner can be difficult to separate from closely related congeners. Moss and Mayes (1993) found this confusion in historic collections to be most common with the chub shiner (*N. potteri*), the silver band shiner (*N. shumardi*), and the sand shiner (*N. stramineus*=*N. ludibundus*). For the identification of the smalleye shiner, it was determined that the silverband shiner differs in body shape, depth of the caudal peduncle, and fin ray counts. The chub shiner is distinguished from the smalleye shiner through a comparison of tooth count (0,4-4,0 in the smalleye shiner), squamation patterns, and the smalleye shiner’s posteriorly broadened upper lip. The report of sand shiner from the Brazos

River (Anderson et al. 1983) may be erroneous, due to the lack of supporting records (Moss and Mayes 1993). Although geographically separated, the smalleye shiner is apparently closely related to the Red River shiner and the federally threatened Arkansas River shiner (*N. girardi*), which occurs in the Canadian River in Texas, and may share life history characteristics of these native prairie fishes.

Habitat

Smalleye shiners require habitats almost identical to those of several other obligate riverine fishes native to Texas prairie streams (e.g., the sharpnose shiner (*N. oxyrhynchus*)). Preferred habitat includes fairly shallow water (38 to 82 centimeters (15 to 32 in) in depth) in broad, open sandy channels with a moderate current (Moss and Mayes 1993). Ostrand (2000) found abiotic factors associated with smalleye shiner habitat to include specific conductance < 30 mS, relatively high current velocity (> 0.20 m/s)(0.65 feet/s) and high turbidity (> 41 NTU). Within their preferred habitat, smalleye shiners are most often found using the center of the channel, avoiding the shallow depth and slow velocity of the stream edges (Moss and Mayes 1993). Their diet consists mainly of aquatic insects, dominated by dipterans, and sand/silt suggesting they forage among the substrate (Marks et al. 2001). Although very little is known about the life history of this species, they are thought to spawn in early spring and summer and to be short-lived (Moss and Mayes 1993). Life history traits may be similar to those of congeners that inhabit prairie streams such as the Arkansas River shiner (*N. girardi*), the Red River shiner, and the sharpnose shiner, which are thought to spawn primarily during flood events (Moore 1944; Moss and Mayes 1993).

POPULATION STATUS

The Brazos River watershed extends from eastern New Mexico southeasterly to the Gulf of Mexico. The basin is approximately 1,030 kilometers (km)(640 miles(mi)) in length, encompasses approximately 118,103 square kilometers (45,600 square mi) (Dunn and Raines 2001), ranges in width from 1.6 to 193 km (1.0 to 120 mi), and drains all or portions of 69 counties in Texas (Cronin et al. 1973) and three counties in New Mexico. The predominant land use within the basin is agriculture, dominated by cotton, corn, and sorghum, and open rangeland (Dunn and Raines 2001). Within the Middle Brazos River Basin, a large percentage of agriculture consists of concentrated animal feeding operations (CAFOs) (Armstrong 1998). The Brazos River is a typical prairie stream. The main stem originates in the upper reach from the confluence of the Salt and Double Mountain Forks. This upper region of the watershed is highly variable with regard to flow and often becomes intermittent, forming isolated pools within the channel (Echelle, et al. 1972; Ostrand 2000; Ostrand and Wilde 2001). The river traverses through the Edwards Plateau Ecosystem and extends southeastward through the East Texas and Texas Gulf Coast Ecosystems (U.S. Fish and Wildlife Service 1994). Since the early 1900s, significant reservoir construction has occurred within the Brazos River Basin. By 1986, 1,165 minor and 13 major reservoirs, three of which occur on the main stem of the Brazos River, were listed in the Texas Natural Resource Conservation Commission's (TNRCC) dam inventory (Dunn and Raines 2001). From 1941 to 1969, the rate of reservoir construction increased substantially and included Possum Kingdom Reservoir in 1941, Whitney Reservoir in 1951, and Granbury Reservoir in 1969, which are located on the main stem Brazos River, as well as six other major reservoirs within the watershed (Dunn and Raines 2001). A new reservoir, Alan Henry Reservoir, impounded the Double Mountain Fork of the Brazos River in October 1993 (Wilde and Ostrand 1999), to serve as a future water supply for the City of Lubbock (Llano Estacado Water Planning Group 2001). The effects of reservoir construction in the Brazos River Basin since 1953 have resulted in significant temporal changes to its fish assemblage (Anderson et al. 1995; Hubbs et al. 1997; Wilde and Ostrand 1999).

Historic Distribution

Historically, the smalleye shiner occurred throughout the Brazos River proper, the Double Mountain and Salt Forks of the Upper Brazos River drainage and within the Lampasas River, a tributary of the Brazos (Moss and Mayes 1993). The type locality is from the main stem Brazos in Palo Pinto County, where 14 specimens were collected in 1952 (Cross 1953). A population may exist in the Colorado River above Buchanan Reservoir (Hubbs et al. 1991) and is presumed to be introduced; however, information on the status of this population is lacking. Moss and Mayes (1993) conducted an extensive study of the distribution of the smalleye shiner and sharpnose shiner (*N. oxyrhynchus*) within the Brazos River Basin. The study included a review of known museum, university, and other collections (from 1951 to 1986) to determine the historical distribution of both species. Their review indicated the smalleye shiner historically occurred at nine main stem sites, six sites on the Double Mountain Fork of the Brazos River, 14 sites on the Salt Fork of the Brazos River, one site on the North Fork Double Mountain Fork, and one site on the Lampasas River. The collections included specimens from the Upper, Middle, and Lower Brazos River systems (Texas Parks and Wildlife Department 1996), ranging from the upper reach of the North Fork Double Mountain Fork in Garza County, Texas, to the southernmost site in Brazos County, Texas. Of the known historical records of smalleye shiners from the Brazos River Basin examined by Moss and Mayes (1993), 24 collections were taken from the Upper Brazos River drainage, the majority of which were located on the Double Mountain and Salt Forks of the Brazos River. The Double Mountain Fork collections (one sample from 1978 and five from 1986) consisted of 351 specimens collected from sites in Garza, Kent, Fisher, Stonewall, and Haskell Counties. The Salt Fork collections (two samples from 1951, one from 1953, one from 1960, one from 1968, one from 1984, and eight from 1986) contained 492 specimens collected from locations in Kent, Stonewall, Knox, Baylor, and Young Counties. Main stem records from the Upper Brazos consisted of a single specimen collected in 1986 from one site in Young County, and 26 specimens collected from three sites (one sampled in 1951 and two in 1952) in Palo Pinto County. The Palo Pinto County collection includes the holotype and paratypes from the original description. The remaining nine historical records reviewed by Moss and Mayes (1993) included 16 specimens collected from one site on the Middle Brazos River (Bosque County) in 1952, and 79 specimens collected at eight sites between 1940 and 1976 from the Lower Brazos River (Bell, Brazos, and Burleson Counties). The Lower Brazos specimens include the sample from the Lampasas River in Bell County.

Current Distribution

Moss and Mayes' (1993) assessment of the declining distribution of the smalleye shiner within the Brazos River Basin was based on the historical records compared with their sampling of the basin from October 1988 through August 1991. Sampling sites were selected based on all known localities of the smalleye shiner within the basin (37 sites), most of which (26 sites) were located in the Upper Brazos River Basin, including 24 sites upstream of Possum Kingdom Reservoir. From these upstream samples, a total of 2,388 smalleye shiners were collected from nine sites on the Salt Fork (Kent, Stonewall, Knox, Baylor, and Young Counties), four sites on the Double Mountain Fork (Garza, Kent, Fisher, and Stonewall Counties), three sites on the North Fork Double Mountain Fork (Garza County), and one site on Croton Creek (Kent County), a tributary of the Salt Fork. Two samples taken from the main stem Brazos downstream from Possum Kingdom Reservoir in Palo Pinto County and collections made on two sites on the Clear Fork of the Brazos River (Shackelford and Fisher Counties) did not include smalleye shiners. The smalleye shiner has apparently never been documented from the Clear Fork. The remaining 11 sampling sites were located within the Middle (Parker and Falls Counties) and Lower Brazos River Basin (Milam, Brazos, Washington, Austin, Fort Bend, and Bell Counties), which included two sites on the Lampasas River. No smalleye shiners were discovered among the collections made at these sites. Although the smalleye shiner is currently one of the dominant fishes at certain sites within the Upper Brazos drainage and historically occurred within the Middle and Lower Brazos River, it has apparently been extirpated from the basin downstream of Possum Kingdom Reservoir. Ostrand (2000) estimated the current population of smalleye shiners within the Upper Brazos to represent 17% of the fish assemblage. Surveys were conducted at two sites on the North Fork Double Mountain Fork (Garza County), three sites on the Double Mountain Fork (Garza, Kent, and Fisher Counties), five sites on the Salt Fork (Kent and Stonewall Counties), and three sites 5 on the Brazos River proper (Knox County). Smalleye shiners were present at all 13 sites (6,558 collected) where they represented one of the seven dominant species within the study area (Ostrand 2000). The few recent surveys that have been made within the Middle and Lower Brazos do not provide evidence of the persistence of the smalleye shiner within this region. A survey from the Lampasas River (Lampasas and Bell Counties) for the purpose of conducting an index of biotic integrity was completed in 1998 (Armstrong 1998). From two sites on the Lampasas River, a total of twenty-two species of fish were identified. No smalleye shiners were collected. The smalleye shiner has apparently not been collected from the Lampasas River since 1951. Winemiller and Gelwick (1999) conducted an assessment of stream integrity in 1998 using fish collected within the Middle and Lower Brazos River, including many of the river's tributaries. Six sites utilized in the study were on the main stem Brazos River in McLennan, Falls, Robertson, Washington, and Fort Bend Counties. These collecting efforts produced 53 species of fish; however, no smalleye shiners were collected. Most recently, a survey was conducted specifically for sharpnose shiner in the Middle (Falls County) and Lower Brazos River (Austin, Brazos, Fort Bend, and Robertson Counties), including two sites on the Lampasas River, in 2000 and 2001. The sharpnose shiner is an endemic fish of the Brazos River that utilizes habitats similar to those used by the smalleye shiner. The results of the survey indicated that no smalleye shiners were present within this portion of their historical range (unpublished data cited in U.S. Fish and Wildlife Service candidate assessment form). The population of smalleye shiners within the Upper Brazos River drainage (upstream of Possum Kingdom Reservoir) is apparently stable. Downstream from the reservoir, the shiner has not been collected since 1976 and in all likelihood is completely extirpated representing a reduction of approximately 64% of its historical range.

The U.S. Fish and Wildlife Service classifies the smalleye shiner as a candidate for Endangered Species Act protection with a listing priority number of 5.

LISTING CRITERIA

A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.***

Historical distribution:	Upper, middle, and lower Brazos River drainage; Colorado River drainage, Texas.
Current distribution:	Upper Brazos River drainage, Texas.
Land ownership:	The smalleye shiner occurs in rivers, which are owned by the State of Texas. The majority of the riparian land ownership within the documented range of the shiner is private, with minor areas owned by the State (Parks), and Federal (Corps of Engineers) governments.

The most significant threat to the existence of the smalleye shiner is the ongoing modification of its habitat due to anthropogenic factors. These factors include reservoir construction, irrigation and water diversion, sedimentation, industrial and municipal discharges, and agricultural activities.

Reservoirs
River impoundments adversely affect downstream fisheries by altering temperature regimes, flow rates, substrate, water quality, and nutrient availability (Anderson et al. 1983). The downstream effects of impoundments often create a benign habitat within the channel, restricting its use to those species that proliferate in deep, incised channels. The significant changes to fish assemblages, including the local extinction of species, produced by downstream effects have been well documented (Gore and Bryant 1986; Anderson et al. 1983). Reservoirs also fragment riverine habitat, prohibiting the completion of the life cycle for those species that require an unimpeded stream for spawning and/or migration. The downstream effects of reservoirs have altered the habitat within the Brazos River, impacting the fish assemblage. The Morris Sheppard Dam, which impounds Possum Kingdom Reservoir, incorporates hydroelectric generators, which utilize stored water through releases from the dam dependent on pool elevation and local power needs. These hypolimnial releases have modified the thermal regime up to 120 km (75 mi) downstream and along with the associated chemical modifications are likely responsible for the extirpation of at least four species of fish in the downstream reach (Anderson et al. 1983). In addition to the thermal and chemical alterations affecting fish assemblages, flow regime regulated by dams restricts habitat availability for many fish species (Bain et al. 1988). The

marked decrease in fish diversity, and decrease in abundance of cyprinids, documented within the Brazos River Basin are also likely due to habitat modifications such as reservoir construction (Anderson et al. 1995). Changes in channel morphology and substrate have also taken place within the Brazos River due to major impoundments. Restriction of natural stream flow and sediment transport often contributes to channel incision and widening. The transport of sand through the Brazos River system has decreased in part due to reservoirs (Mathewson and Minter 1981; Dunn and Raines 2001). Mathewson and Minter (1981) suggested that the major reservoirs trap approximately 76% of all sand produced within the Brazos River Basin. Collections made by Moss and Mayes (1993) revealed a distinct difference between the fish assemblage upstream and downstream from Possum Kingdom Reservoir. They suggested that the effects of reservoir construction on the downstream channel have modified the habitat, excluding many native prairie cyprinids while generalist cyprinids have prospered. Anderson et al. (1983) noted the change created by the construction of the reservoir from sandy bottom and high turbidity (typical smalleye shiner habitat) to clear, gravel bottom habitat for a distance of 30 km (19 mi) downstream from the Morris Sheppard Dam. Within this reach, seven species not normally found in the non-impacted reaches of the Brazos River (i.e., upstream from the reservoir), including two exotic species, had invaded the modified channel (Anderson et al. 1983). In addition to the impacts of Possum Kingdom Reservoir on the Brazos River, two other impoundments occur on the main stem Brazos. Granbury Reservoir, approximately 258 km (160 mi) downstream from Possum Kingdom, and Whitney Reservoir, approximately 92 km (57 mi) downstream from Granbury, have also contributed to the modified habitat within the Middle and Lower Brazos River, which is most likely no longer suitable for the smalleye shiner. Reservoir construction on rivers also affects instream habitat and biotic communities upstream of the impoundment, which may include the extirpation of obligate riverine fish (e.g, Winston et al. 1991). Ecological imbalances can occur when facultative riverine fish propagate in reservoirs and disperse into upstream reaches (Winston et al. 1991). Impoundments also present a barrier, preventing upstream migration and/or dispersal, and may cause local extirpations in upstream areas (i.e., headwaters) subject to drought or other natural disturbances (Wilde and Ostrand 1999). A study of the effects of the recently constructed Alan Henry Reservoir on the Double Mountain Fork of the Brazos River (Garza County) on prairie stream fish was carried out by Wilde and Ostrand (1999). This segment of the Double Mountain Fork is in a semi-arid region (precipitation 46-71 cm/yr) where flow is intermittent and dependent on rain events. During the absence of flow, the stream is characterized by isolated pools that provide the only habitat for fish until the next rain event, which may not occur for several months. Following the impoundment of the river, the upstream reach showed a dramatic change in the fish assemblage, including a decrease in cyprinids and increase in abundance of cyprinodontids (Wilde and Ostrand 1999). This study indicated that one species of fish has been extirpated from the upstream reach, and another, the smalleye shiner, has been significantly reduced in numbers, and may soon be extirpated. The disappearance of the fish is attributed to the lack of reproduction and/or survival occurring in isolated pools combined with the inability of the downstream population to recolonize the area due to the barrier created by the impoundment.

Future Reservoir Development

As required by Senate Bill 1 (enacted by the 75th Texas Legislature in 1997), Water Planning

Regions within the State of Texas have developed and finalized Regional Water Plans for the purpose of addressing future water needs. The Regional Water Plans are to be incorporated into an overall State Water Plan addressing water management, development, and conservation for the 50-year period from 2000 to 2050. The majority of the Brazos River Basin falls within the Regions G (Brazos) and O (Llano Estacado) Water Planning Areas. Among the water management strategies detailed in the Region G Water Plan six potential major reservoirs are included as feasible for providing water supply for the region. The potential major reservoirs listed in the plan are as follows:

• Breckenridge Reservoir (= Reynolds Bend), would be located in Throckmorton County and impound the Clear Fork of the Brazos River just downstream from the confluence with Paint Creek and is anticipated to store 600,000 acre feet of water;

• South Bend Reservoir, would be located in Young County immediately upstream from the confluence of the main stem and the Clear Fork of the Brazos River, capturing flow from both channels, and storing up to 745,800 acre feet of water;

• Paluxy Reservoir in Somervell County, would impound the Paluxy River, a tributary of the Brazos, and store 99,700 acre-feet of water;

• Bosque Reservoir, would be located in Bosque County on the North Bosque River, a tributary of the Brazos, approximately 6.4 km (4 mi) upstream from the City of Meridian and would store 102,900 acre-feet of water;

• Millican Reservoir, which was originally authorized by the U. S. Congress in 1968 and has subsequently been studied for feasibility at two sites on the Navasota River; the Panther Creek site, located approximately 21 km (13 mi) southeast of the City of Bryan (Brazos, Madison, and Grimes Counties), would store 1,973,000 acre-feet of water, and the Bundic Dam site, located between SH 21 and US 79 (Brazos, Robertson, Madison, and Leon Counties), would store 228,000 acre-feet of water;

• Little River Reservoir would be located in Milam County on the Little River just upstream from the confluence with the Brazos River and would store between 180,000 and 903,000 acre-feet of water.

In addition to these major reservoirs, the Region G Water Plan lists three minor reservoirs (estimated firm yields from 100 to 1,000 acre-feet/year) that would impound tributaries within the Brazos River Basin for water supply needs for the Cities of Throckmorton, Woodson, and Cisco. Included in the Region G Water Plan are five off-channel reservoirs for water supply projects. An off-channel reservoir would divert water from a primary stream during high flows to a reservoir for storage. The off-channel reservoirs are Meridian, Somervell, Groesbeck, Little River, and Peach Creek. Of these reservoirs, Meridian and Somervell are alternatives considered for the Bosque and Paluxy Reservoirs, respectively. The water rights for Groesbeck Reservoir have been obtained and authorize the diversion of 2,500 acre-feet of water per year from the

Navasota River in Limestone County. Peach Creek Reservoir would serve Brazos County by the impoundment of Peach Creek and water diversion from the Navasota River for the storage of 14,511 acre-feet. The newly proposed Little River Off-Channel Reservoir would be constructed on Beaver Creek, a tributary of the Little River, and store 202,500 acre-feet of water. The water management strategies for the Region O Planning Area include the construction of Post Reservoir on the North Fork Double Mountain Fork of the Brazos River in Garza County. Post Reservoir has been authorized by the Texas Natural Resource Conservation Commission (TNRCC), with a permit expiration date in 2008, and would impound 57,420 acre-feet of water. An additional reservoir, not included in the Regional Water Plans, is under consideration by Knox, Nolan, Fisher, Stonewall, Haskell, and Kent Counties for future water supply. The proposed Double Mountain Fork Reservoir is in the initial stages of planning with potential dam sites located on the Double Mountain Fork upstream from the confluence with the Salt Fork in Stonewall County (Freese and Nichols 2001). The historical habitat within the Middle and Lower Brazos River has effectively been converted from habitat that once supported the smalleye shiner to habitat characterized by thermal, physical, and morphological parameters no longer suitable to the shiner, largely resulting from impoundments within the basin. Although the last known record of the smalleye shiner from the main stem downstream of Possum Kingdom Reservoir occurred over twenty years ago, remnant populations may still exist in areas of suitable habitat. However, the suitable habitat remaining may be fragmented to the extent that any surviving populations are no longer viable. The continued effects of the existing impoundments coupled with the potential future water management strategies outlined in the Regional Water Plans cast serious doubt on the possibility of recovery of the shiner in the Middle and Lower Brazos River under current conditions. Within the Upper Brazos River system, smalleye shiners are most common within the higher order streams (Ostrand 2000) with suitable flow and conductivity. The flow within the headwater reaches of the Double Mountain and Salt Forks is intermittent and often restricted to large pools within the channel. Under the harsh conditions that accompany the non-flow periods, smalleye shiners are among the first species to be eliminated within the pools (Ostrand and Wilde 2001).

The isolated pools of the Upper Brazos tributaries are probably not suitable for successful reproduction of the smalleye shiner (Wilde and Ostrand 1999). The species' persistence in these upper reaches is most likely the result of recolonization from populations occurring downstream during times of normal flow (Wilde and Ostrand 1999; Ostrand and Wilde 2001). However, the headwaters may be significant to the reproductive success of the shiner. Reproduction may be triggered by flood events, allowing shiners to move into the headwaters where eggs would be released and transported by currents downstream to perennial areas (personal communication cited in U.S. Fish and Wildlife Service candidate assessment form). Reservoir construction on the Upper Brazos tributaries would create a barrier between the base population and the upper reaches, preventing recolonization and potentially reducing reproductive success.

The headwaters of the Double Mountain Fork of the Brazos River in Garza County were isolated from the downstream reach in 1991 by the construction of the John T. Montford Dam, which impounds Alan Henry Reservoir. Upstream of the reservoir, the once common smalleye shiner has apparently disappeared following the completion of the dam (Wilde and Ostrand 1999). A similar situation could occur on the Double Mountain Fork downstream of Alan Henry Reservoir and on the North Fork Double Mountain Fork, should the Double Mountain Fork and Post Reservoir projects be implemented. The potential direct impacts to the shiner resulting from construction of these reservoirs include 1) the inundation of occupied habitat, 2) the local extinction of upstream populations, and 3) the loss of habitat downstream from the dams due to the modification of necessary abiotic components (flow regime, thermal regime, substrate, conductivity, etc.).

Chloride Control Reservoirs

The streams of the Upper Brazos River Basin are characterized by natural salts that originate within the salt and gypsum terrain and an underlying brine aquifer within this region. Because the salt entering the Brazos River in this area limits its use as a practical water supply, several studies on the feasibility of salt control have been conducted (e.g., Johnson et al. 1982). Options within the Region G Water Plan for the control of naturally occurring chlorides include deep well injection of recovered brine from the aquifer and the construction of Kiowa Peak Reservoir for the disposal of recovered brine. The Kiowa Peak Reservoir would be located on North Croton Creek just upstream from the confluence with the main stem Brazos (Stonewall and King Counties) and have a storage capacity of 659,650 acre-feet. The original design and study on Kiowa Peak was done by the U.S. Army Corps of Engineers and included the two additional salt retention reservoirs - Dove, located on Haystack Creek (Stonewall and King Counties), and Croton, located on Croton Creek in Stonewall and Kent Counties (Johnson et al. 1982). The smalleye shiner evolved to prosper in the saline and turbid conditions naturally occurring in the Brazos River. The various chloride control projects proposed for the Upper Brazos for the conversion of the natural saline waters to a quality available for human consumption would modify the chemical characteristics conducive to smalleye shiner habitat. Additionally, those projects that require the construction of brine retention reservoirs may also inundate shiner habitat and reduce instream flows to the major tributaries (e.g., the Salt Fork), as well as the Brazos River proper.

Existing Reservoir Enhancement

An alternative to water management within the Brazos River Basin is expanding the available yield in an existing reservoir by increasing the conservation pool level, water diversion to temporary storage, and construction of a new embankment downstream from the current one. Within the Brazos River Basin, Region G projects related to existing reservoir supply include increasing the storage of Leon Reservoir (conservation pool raise) in Eastland County, water diversion from California Creek into Stamford Reservoir (Haskell County), water diversion from Sweetwater Creek into Sweetwater Reservoir (Nolan County), water diversion from Battle Creek into Cisco Reservoir (Eastland County), and increasing the storage in Fort Phantom Hill Reservoir (new downstream embankment) in Jones County. These projects would contribute to the documented effects impoundments cause to river systems, especially regarding flow regime, within the existing range of the smalleye shiner.

Discharges and Sedimentation

In 1996, 329 domestic facilities (i.e., municipal wastewater) and 172 industrial facilities held permits by the state (TNRCC 1996) within the Brazos River Basin. Permits held by domestic and industrial facilities allow for the discharge of treated and untreated effluent into the basin. Within the Upper Brazos River drainage alone, the sum of permitted facility discharges is more than 6,670 million gallons of effluent per day (unpublished data cited in U.S. Fish and Wildlife Service candidate assessment form). These discharges modify water quality and add to the continued alteration of the Brazos River channel, affecting its morphology and substrate composition. Adverse conditions within the channel, such as low dissolved oxygen causing fish kills, result from these discharges when sewage facilities fail. Sediment entering streams via stormwater runoff is the primary source of impairment to surface waters in the United States (Zweig 2000). The predominant land use within the Brazos River Basin is agriculture. The practices that accompany agricultural operations, including harvesting, tilling, and native vegetation clearing contributes to sediment entering the Brazos River system and the conversion of the natural substrate to silt and mud bottom. This source, along with other development projects involving significant earth disturbance resulting in excessive sedimentation within the Brazos River, reduces the available habitat for the smalleye shiner. In 1996, 282 agricultural facilities (i.e., CAFOs) were permitted by the state (TNRCC 1996) within the Brazos River Basin. The wastes associated with CAFOs are typically high in nutrients (i.e., nitrogen and phosphorus compounds) and historically discharges of these wastes to surface water bodies have resulted in degraded water quality and wildlife mortality (Baker et al. 1998). CAFOs are not permitted to discharge into Waters of the United States except during severe weather events that exceed in intensity a 25-year rainfall event in a 24-hour period. In addition, during periods of intense rainfall and high flooding, retention structures can fail and lead to severe pollution to water bodies that results in fish kills due to the inability of the watershed to filter or dilute the heavy nutrient load. Although discharge from CAFOs is not allowed by permit under normal conditions, unlawful discharge does occur. For example, from 1993 to 1998, the Environmental Protection Agency (EPA), under the Clean Water Act, documented 24 discharges from permitted CAFOs into Waters of the United States in Texas. Thirteen of these discharges were caused by chronic storm events and reported to the EPA, and the remaining eleven were illegal discharges. From 1992 to 1999, the Texas Parks and Wildlife Department investigated over 60 fish kills attributable to anthropogenic causes (sewage discharge, oil spills, fertilizers, pesticides, etc.) and resulting in approximately 1,100,000 mortalities within the Brazos River Basin (Texas Parks and Wildlife 2002).

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

There is no current information that would suggest smalleye shiners are overutilized for commercial, recreational, scientific, or educational purposes. Minnows of the genus *Notropis* are undoubtedly used as bait fishes and are probably harvested in the commercial bait industry. Commercial bait harvesters are required to obtain a permit and report annually on the species and numbers collected. However, the permit does not restrict the quantity of nongame fishes that can be harvested, and furthermore, the list of nongame fishes allowed for harvest under the permit specifies “*Notropis* spp.,” which is likely the most detail submitted in an annual report. Currently, four permits have been issued for the harvest and sale of minnows from the Brazos River. Only two permittees reported a harvest in 2001. The impacts the commercial bait industry may have on the smalleye shiner are unknown.

C. ***Disease or predation.***

The impact of disease or predation on the smalleye shiner is not known. The State introduces game fish within the Brazos River and its impoundments, including some exotic species, which likely prey on smalleye shiners. However, the extent of the effects of predation has not been determined.

D. ***The inadequacy of existing regulatory mechanisms.***

State law does not provide protection for the smalleye shiner. There are no regulatory mechanisms for persons harvesting these minnows for use as bait fish, with the exception of a State fishing license and Nongame Fish Permit. Permitted individuals are not restricted in quantity for bait fish harvests. See also the discussion under A. above.

Current Conservation Efforts: None.

E. ***Other natural or manmade factors affecting its continued existence.***

In recent years, the Brazos River has experienced massive blooms of golden algae (*Prymnesium parvum*) resulting in several fish kills. The alga kills by way of toxins released into the water that have a lethal effect on gill-breathing animals. Although little is known about the causes of golden algal blooms, as with many other algae they may be triggered by excessive nutrient loading from point source and non-point source events such as industrial and municipal discharges and runoff from agricultural operations. The effects of the golden algae may be insignificant, but further information is needed. Within the Lower Brazos River, sand and gravel operations have mined the channel for many years (Dunn and Raines 2001). The significance of the effects of these operations to the smalleye shiner is not known.

The current limited distribution of the smalleye shiner within the Upper Brazos River Basin makes it vulnerable to catastrophic events occurring in this region. The shiner maintains populations within the harsh conditions of this area and can recover from droughts, provided the conditions of its habitat remain suitable. Catastrophic events such as the introduction of competitive species or prolonged drought would increase the likelihood of extinction. The potential for the introduction of competitive species is high due to the reports of such unintentional introductions by anglers and commercial bait fishermen. For example, the Red River shiner (*N. bairdi*) was apparently introduced into the range of the threatened Arkansas River shiner, and may seriously threaten its status. The Red River shiner is currently not known from the Brazos River, but the probability of introduction is high, since the Red River Basin is immediately to the north of the current population of smalleye shiners. Currently, there is no evidence that introduced species within the Brazos River effectively compete with the smalleye shiner.

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PETITION TO LIST

sharpnose shiner
(*Notropis oxyrhynchus*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 12/30/82:
CNOR 01/06/89:
CNOR 11/21/91:
CNOR 11/15/94:
CNOR 06/13/02: C

TAXONOMY

The sharpnose shiner (*Notropis oxyrhynchus*) was first collected from the Brazos River in 1938, but was not described until 1951 by Hubbs and Bonham, who speculated that its closest relative was the emerald shiner (*N. percobromus* (= *atherinoides*)), which occurs in the Red River system to the north of the Brazos River drainage and in systems to the east (Gilbert 1980).

NATURAL HISTORY

The sharpnose shiner is a small, slender minnow, endemic to the Brazos River Basin in Texas (Hubbs et al. 1991). Adult sharpnose shiners are approximately 30 to 50 millimeters (1.2 to 2.0 inches (in)) in standard length, have a strongly curved ventral contour, oblique mouth, and pointed snout (Hubbs and Bonham 1951). They are silver in color, with a faint lateral stripe extending from the gills to the tail. The anal fin is slightly falcate and usually has no more than nine rays; the dorsal fin has eight rays and begins behind the insertion of the pelvic fin (Hubbs and Bonham 1951).

Sharpnose shiners are obligate riverine fish that occur in fairly shallow water (38 to 82 centimeters (15 to 32 in) in depth) in broad, open sandy channels with moderate current (Moss and Mayes 1993). Ostrand (2000) found abiotic factors associated with sharpnose shiner habitat to include specific conductance < 30 mS, relatively high current velocity (> 0.20 m/s)(0.65 feet/s) and high turbidity (> 41 NTU). They generally feed on aquatic invertebrates dominated by dipterans, ostracods, trichopterans, odonata, coleopterans, hemipterans, and various terrestrial arthropods (Marks et al. 2001). They often consume a large amount of sand/silt, which would indicate foraging behavior occurs among the sediment, as well as on drift in the water column (Marks et al. 2001). Very little is known about the life history of this species, though it is assumed to be similar to that of congeners that inhabit prairie streams such as the federrally threatened Arkansas River shiner (*N. girardi*), the Red River shiner (*N. bairdi*), and the smalleye shiner (*N. buccula*), which are thought to spawn primarily during flood events (Moore 1944; Moss and Mayes 1993).

The Brazos River watershed extends from eastern New Mexico southeasterly to the Gulf of Mexico. The basin is approximately 1,030 kilometers (km)(640 miles(mi)) in length, encompasses approximately 118,103 square km (45,600 square mi) (Dunn and Raines 2001), ranges in width from 1.6 to 193 km (1.0 to 120 mi), and drains all or portions of 69 counties in Texas (Cronin et al. 1973) and three counties in New Mexico. The predominant land use within the basin is agriculture, dominated by cotton, corn, and sorghum, and open rangeland (Dunn and Raines 2001). Within the Middle Brazos River Basin, a large percentage of agriculture consists of concentrated animal feeding operations (CAFOs) (Armstrong 1998). The Brazos River is a typical prairie stream. The main stem originates in the upper reach from the confluence of the Salt and Double Mountain Forks. The upper region of the watershed is highly variable with regard to flow and often becomes intermittent, forming isolated pools within the channel (Echelle et al. 1972; Ostrand 2000; Ostrand and Wilde 2001). The river traverses through the Edwards Plateau Ecosystem and extends southeastward through the East Texas and Texas Gulf Coast Ecosystems (U.S. Fish and Wildlife Service 1994).

POPULATION STATUS

Since the early 1900s, significant reservoir construction has occurred within the Brazos River Basin. By 1986, 1,165 minor and 13 major reservoirs, three of which occur on the main stem of the Brazos River, were listed in the Texas Natural Resource Conservation Commission's (TNRCC) dam inventory (Dunn and Raines 2001). From 1941 to 1969, the rate of reservoir construction increased substantially and included Possum Kingdom Reservoir in 1941, Whitney Reservoir in 1951, and Granbury Reservoir in 1969, which are located on the main stem Brazos River, as well as six other major reservoirs within the watershed (Dunn and Raines 2001). A new reservoir, Alan Henry Reservoir, impounded the Double Mountain Fork of the Brazos River in October 1993 (Wilde and Ostrand 1999), to serve as a future water supply for the City of Lubbock (Llano Estacado Water Planning Group 2001). The effects of reservoir construction in the Brazos River Basin since 1953 have resulted in significant temporal changes in its fish assemblage (Anderson et al. 1995; Hubbs et al. 1997; Wilde and Ostrand 1999).

The sharpnose shiner historically occurred throughout the Brazos River system, including the Double Mountain and Salt Forks of the Upper Brazos River drainage, and has also been documented in the South and North Forks of the Wichita River within the Red River Basin (see Moss and Mayes 1993). Hubbs and Bonham's (1951) description of the sharpnose shiner (82 specimens collected) reported the fish at four sites on the main stem Brazos River (Brazos County), as well as in its tributaries the Navasota River and Little Brazos River in Brazos County between 1938 and 1941. An additional collection was made on the Brazos downstream from Towash Creek (Hill/Bosque Counties) in 1940. An introduced population may exist in the Colorado River above Buchanan Reservoir (Hubbs et al. 1991); however, the validity of this population is still in question (e.g., Moss and Mayes 1993).

A biological study of the Upper Brazos drainage conducted in 1979 for the purposes of analyzing effects of the proposed Brazos River Natural Chloride Control Project estimated a population of 1,611 sharpnose shiners in the Salt Fork of the Brazos River, and a population estimated at 451 individuals from Croton Creek, a tributary of the Salt Fork (Johnson et al. 1982).

Moss and Mayes (1993) conducted an extensive study of the distribution of the sharpnose shiner and smalleye shiner within the Brazos River system. The study included a review of known museum, university, and other collections (from 1951 to 1986) to determine the historical distribution of both species. Their review indicated the sharpnose shiner historically occurred at 15 main stem sites (not including sites from the original description), three sites on the Double Mountain Fork of the Brazos River, nine sites on the Salt Fork of the Brazos River, and two sites on the Wichita River (from 1953 and 1955), which drains into the Red River Basin. The historical collections included specimens from the Upper, Middle, and Lower Brazos River systems (Texas Parks and Wildlife Department 1996), ranging from the upper reaches on the Double Mountain and Salt Forks in Kent County, Texas, to the southernmost site in Fort Bend County, Texas.

Of the historical records of sharpnose shiners from the Brazos River Basin examined by Moss and Mayes (1993), 18 collections were taken from the Upper Brazos River drainage, the majority of which were located on the Double Mountain and Salt Forks of the Brazos River. The Double Mountain Fork samples (one sample from 1951 and three from 1986) consisted of 177 specimens from sites in Kent, Fisher, and Haskell Counties. The Salt Fork collections (two samples from 1951, one from 1953, one from 1984, and six from 1986) contained 1,181 specimens from locations in Kent, Knox, Baylor, and Young Counties. Main stem records from the Upper Brazos included 24 specimens collected from two sites in Young County in 1951 and 1986, and 67 specimens collected from two sites in Palo Pinto County from 1951 to1952. The remaining 15 historic records include four collections of 90 specimens collected between 1951 and 1953 from the Middle Brazos River (Somervell, Bosque, and McLennan Counties), and 11 records collected from the Lower Brazos River. The Lower Brazos River collections include 947 specimens collected between 1951 and 1967 from six sites in Brazos, Burleson, Grimes, Waller, and Fort Bend Counties and 268 specimens collected between 1970 and 1986 from five sites in Robertson, Brazos, Waller, and Washington Counties.

Moss and Mayes' (1993) assessment of the declining distribution of the sharpnose shiner within the Brazos River Basin was based on the historical records compared with their sampling of the basin from October 1988 through August 1991. Sampling sites were selected based on all known localities of the smalleye shiner within the basin (37 sites), most of which (26 sites) were located in the Upper Brazos River Basin, including 24 sites upstream of Possum Kingdom Reservoir. From these upstream samples, a total of 2,056 sharpnose shiners were collected from seven sites on the Salt Fork (Stonewall, Knox, Baylor, and Young Counties), three sites on the Double Mountain Fork (Kent, Fisher, and Stonewall Counties), and three sites on the North Fork Double Mountain Fork (Garza County). Two sites sampled in the main stem Upper Brazos below Possum Kingdom Reservoir in Palo Pinto County did not include sharpnose shiners. Additional surveys within the Upper Brazos drainage that failed to collect sharpnose shiner include collections from Croton Creek (Kent County), which drains into the Salt Fork of the Brazos River, and two sites on the Clear Fork of the Brazos River (Shackelford and Fisher Counties). The sharpnose shiner historically occurred in Croton Creek, but has apparently never been documented from the Clear Fork. The remaining 11 sampling sites were located within the Middle (Parker and Falls Counties) and Lower Brazos River Basin (Milam, Brazos, Washington, Austin, Fort Bend, and Bell Counties). These sampling efforts produced only 27 specimens from six sites within the Lower Brazos River. Sampling was also conducted within the Red River Basin on the Wichita River (Baylor and Wichita Counties), North Wichita River (Knox County), and South Wichita River (Knox County), but no shiners were collected. The sharpnose shiner has not been collected from the Wichita River drainage since the 1950s (Moss and Mayes 1993). Current information on the status of the sharpnose shiner continues to show a drastic contrast between the Upper Brazos (upstream of Possum Kingdom Reservoir) and Middle/Lower Brazos River. Extensive sampling at thirteen sites within the Upper Brazos by Ostrand (2000) in 1997 and 1998, produced 2,791 sharpnose shiners at 10 sites (Garza, Kent, Fisher, Stonewall, and Knox Counties), where they represented one of the seven dominant species. The population of sharpnose shiners upstream from Possum Kingdom Reservoir is estimated to represent 8% of the fish assemblage (Ostrand 2000). Downstream of Possum Kingdom Reservoir, the population of sharpnose shiners has apparently declined to a fraction of the historic abundance. Since Moss and Mayes' (1993) survey of the Middle and Lower Brazos River system which produced only 27 specimens, limited research has been conducted in this region. Sampling efforts in 1994 reported two sharpnose shiner specimens from the lower Brazos River in Robertson/Milam Counties (Texas Parks and Wildlife Department 1996); however, this study did not produce any other sharpnose shiners within the river.

In the mid 1990s, collecting efforts at a single site on the lower Brazos River (Burleson/Brazos Counties) yielded four specimens from two sampling dates in 1993, one specimen from four sampling dates in 1994, and six specimens from three sampling dates in 1995 (unpublished data cited in U.S. Fish and Wildlife Service candidate assessment form). The specimens collected at this site in 1995 are apparently the last known records of the sharpnose shiner downstream of Possum Kingdom Reservoir. Winemiller and GelwickV (1999) sampled 26 sites within the Middle (McLennan and Falls) and Lower (Milam, Robertson, Brazos, Burleson, Washington, Waller, Austin, Fort Bend, Grimes, and Limestone Counties) Brazos River drainages between September and October 1998, including six main stem sites, three sites on the Navasota River, and one site on the Little Brazos River. These collecting efforts produced 53 species of fish; however, no sharpnose shiners were collected. Most recently, a survey was conducted specifically for sharpnose shiner in the Middle (Falls County) and Lower Brazos River (Austin, Brazos, Fort Bend, and Robertson Counties) in 2000 and 2001. The results of the survey indicated that no sharpnose shiners were present within this portion of their historical range (unpublished data cited in U.S. Fish and Wildlife Service candidate assessment form).

Historically, the sharpnose shiner existed throughout the Brazos River and several of its major tributaries within the watershed. Current information indicates that the population within the Upper Brazos River drainage (upstream of Possum Kingdom Reservoir) is apparently stable, while the population within the Middle and Lower Brazos River Basins may only exist in remnant areas of suitable habitat, or may be completely extirpated, representing a reduction of approximately 64% of its historical range.

The U.S. Fish and Wildlife Service classifies the sharpnose shiner as a candidate for Endangered Species Act protection with a listing priority number of 5.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range:	Upper, middle, and lower Brazos River drainage.
Current range:	Upper Brazos River drainage.
Land ownership:	The sharpnose shiner occurs in rivers and streams that are owned by the State of Texas. The majority of the riparian land ownership within the documented range of the shiner is private, with minor areas owned by the State (Parks), and Federal (Corps of Engineers) governments.

The most significant threat to the existence of the sharpnose shiner is the ongoing modification of its habitat due to anthropogenic factors. These factors include reservoir construction, irrigation and water diversion, sedimentation, industrial and municipal discharges, and agricultural activities.

River impoundments often adversely affect downstream fisheries by altering temperature regimes, flow rates, substrate, water quality, and nutrient availability (Anderson et al. 1983). The downstream effects of impoundments often create a benign habitat within the channel, restricting its use to those species that proliferate in deep, incised channels. The significant changes to fish assemblages, including the local extinction of species, produced by downstream effects have been well documented (Gore and Bryant 1986; Anderson et al. 1983). Reservoirs also fragment riverine habitat, prohibiting the completion of the life cycle for those species that require an unimpeded stream for spawning and/or migration.

The downstream effects of reservoirs have altered the habitat within the Brazos River, impacting the fish assemblage. The Morris Sheppard Dam, which impounds Possum Kingdom Reservoir, incorporates hydroelectric generators, which utilize stored water through releases from the dam dependent on pool elevation and local power needs. These hypolimnial releases have modified the thermal regime up to 120 kilometers downstream and along with the associated chemical modifications, are likely responsible for the extirpation of at least four species of fish in the downstream reach (Anderson et al. 1983). In addition to the thermal and chemical alterations affecting fish assemblages, flow regime regulated by dams restricts habitat availability for many fish species (Bain et al. 1988). The marked decrease in fish diversity and decrease in abundance of cyprinids documented within the Brazos River Basin are also likely due to habitat modifications such as reservoir construction (Anderson et al. 1995).

Changes in channel morphology and substrate have also taken place within the Brazos River due to major impoundments. Restriction of natural stream flow and sediment transport often contributes to channel incision and widening. The transport of sand through the Brazos River system has decreased in part due to reservoirs (Mathewson and Minter 1981; Dunn and Raines 2001). Mathewson and Minter (1981) suggested that the major reservoirs trap approximately 76% of all sand produced within the Brazos River Basin. Collections made by Moss and Mayes (1993) revealed a distinct difference between the fish assemblage upstream and downstream from Possum Kingdom Reservoir. They suggested that the effects of reservoir construction on the downstream channel have modified the habitat, excluding many native prairie minnows while generalist cyprinids have prospered. Anderson et al. (1983) noted the change created by the construction of the reservoir from sandy bottom and high turbidity (typical sharpnose shiner habitat) to clear, gravel bottom habitat for a distance of 30 km (19 mi) downstream from the Morris Sheppard Dam. Within this reach, seven species not normally found in the non-impacted reaches of the Brazos River (i.e., upstream from the reservoir), including two exotic species, had invaded the modified channel (Anderson et al. 1983).

In addition to the impacts Possum Kingdom Reservoir has created within the Brazos River, two other impoundments occur on the main stem Brazos. Granbury Reservoir, located approximately 258 km (160 miles(m)) downstream from Possum Kingdom, and Whitney Reservoir, located approximately 92 km (57 mi) downstream from Granbury, have altered the habitat within the Middle and Lower Brazos River, which is most likely no longer suitable for the sharpnose shiner. Reservoir construction on rivers also affects instream habitat and biotic communities upstream of the impoundment, which may include the extirpation of obligate riverine fish (e.g., et al., Winston 1991). Ecological imbalances can occur when facultative riverine fish propagate in reservoirs and disperse into upstream reaches (Winston et al. 1991). Impoundments also present a barrier, preventing upstream migration and/or dispersal, and may cause local extirpations in upstream areas (i.e., headwaters) subject to drought or other natural disturbances (Wilde and Ostrand 1999).

A study of the effects of the recently constructed Alan Henry Reservoir on the Double Mountain Fork of the Brazos River (Garza County) on prairie stream fish was carried out by Wilde and Ostrand (1999). This segment of the Double Mountain Fork is in a semi-arid region (precipitation 46-71 cm/yr) where flow is intermittent and dependent on rain events. During the absence of flow, the stream is characterized by isolated pools that provide the only habitat for fish until the next rain event, which may not occur for several months. Following the impoundment of the river, the upstream reach showed a dramatic change in the fish assemblage, including a decrease in cyprinids and increase in abundance of cyprinodontids (Wilde and Ostrand 1999). This study indicated that at least two fish species have, or will be, extirpated from the upstream reach. The disappearance of the fish is attributed to the lack of reproduction and/or survivorship occurring in isolated pools combined with the inability of the downstream population to recolonize the area due to the barrier created by the impoundment.

As required by Senate Bill 1 (enacted by the 75th Texas Legislature in 1997), Water Planning Regions within the State of Texas have developed and finalized Regional Water Plans for the purpose of addressing future water needs. The Regional Water Plans are to be incorporated into an overall State Water Plan addressing water management, development, and conservation for the 50-year period from 2000 to 2050.

The majority of the Brazos River Basin falls within the Regions G (Brazos) and O (Llano Estacado) Water Planning Areas. Among the water management strategies detailed in the Region G Water Plan six potential major reservoirs are included as feasible for providing water supply for the region. The potential major reservoirs listed in the plan are as follows:

• Breckenridge Reservoir (= Reynolds Bend), would be located in Throckmorton County and impound the Clear Fork of the Brazos River just downstream from the confluence with Paint Creek and is anticipated to store 600,000 acre feet of water;

• South Bend Reservoir, would be located in Young County immediately upstream from the confluence of the main stem and the Clear Fork of the Brazos River, capturing flow from both channels, and storing up to 745,800 acre feet of water;

• Paluxy Reservoir in Somervell County, would impound the Paluxy River, a tributary of the Brazos, and store 99,700 acre-feet of water;

• Bosque Reservoir, would be located in Bosque County on the North Bosque River, a tributary of the Brazos, approximately 6.4 km (4 mi) upstream from the City of Meridian and would store 102,900 acre-feet of water;

• Millican Reservoir, which was originally authorized by the U. S. Congress in 1968 and has subsequently been studied for feasibility at two sites on the Navasota River; the Panther Creek site, located approximately 21 km (13 mi) southeast of the City of Bryan (Brazos, Madison, and Grimes Counties), would store 1,973,000 acre-feet of water, and the Bundic Dam site, located between SH 21 and US 79 (Brazos, Robertson, Madison, and Leon Counties), would store 228,000 acre-feet of water;

• Little River Reservoir would be located in Milam County on the Little River just upstream from the confluence with the Brazos River and would store between 180,000 and 903,000 acre-feet of water.

In addition to these major reservoirs, the Region G Water Plan lists three minor reservoirs (estimated firm yields from 100 to 1,000 acre-feet/year) that would impound tributaries within the Brazos River Basin for water supply needs for the Cities of Throckmorton, Woodson, and Cisco.

Included in the Region G Water Plan are five off-channel reservoirs for water supply projects. An off-channel reservoir would divert water from a primary stream during high flows to a reservoir for storage. The off-channel reservoirs are Meridian, Somervell, Groesbeck, Little River, and Peach Creek. Of these reservoirs, Meridian and Somervell are alternatives considered for the Bosque and Paluxy Reservoirs, respectively. The water rights for Groesbeck Reservoir have been obtained and authorize the diversion of 2,500 acre-feet of water per year from the Navasota River in Limestone County. Peach Creek Reservoir would serve Brazos County by the impoundment of Peach Creek and water diversion from the Navasota River for the storage of 14,511 acre-feet. The newly proposed Little River Off-Channel Reservoir would be constructed on Beaver Creek, a tributary of the Little River, and store 202,500 acre-feet of water. The water management strategies for the Region O Planning Area include the construction of Post Reservoir on the North Fork Double Mountain Fork of the Brazos River in Garza County. Post Reservoir has been authorized by the TNRCC, with a permit expiration date in 2008, and would impound 57,420 acre-feet of water.

An additional reservoir, not included in the Regional Water Plans, is under consideration by Knox, Nolan, Fisher, Stonewall, Haskell, and Kent Counties for future water supply. The proposed Double Mountain Fork Reservoir is in the initial stages of planning with potential dam sites located on the Double Mountain Fork upstream from the confluence with the Salt Fork in Stonewall County (Freese and Nichols 2001).

The historical habitat within the Middle and Lower Brazos River has effectively been converted from habitat that once supported the sharpnose shiner to habitat characterized by thermal, physical, and morphological parameters no longer suitable to the shiner, largely resulting from impoundments within the basin. Although current records of the fish from the main stem downstream of Possum Kingdom Reservoir are sparse, remnant populations may still exist in areas of suitable habitat. However, the suitable habitat remaining may be fragmented to the extent that any surviving populations are no longer viable. The continued effects of the existing impoundments coupled with the potential future water management strategies outlined in the Regional Water Plans cast serious doubt on the possibility of recovery of the shiner in the Middle and Lower Brazos River under current conditions.

Within the Upper Brazos River system, sharpnose shiners are most common within the higher order streams (Ostrand 2000) with suitable flow and conductivity. The flow within the headwater reaches of the Double Mountain and Salt Forks is intermittent and often restricted to large pools within the channel. Under the harsh conditions that accompany non-flow periods, sharpnose shiners are the first species to be eliminated within the pools (Ostrand and Wilde 2001).

The isolated pools of the Upper Brazos tributaries are probably not suitable for successful reproduction of the sharpnose shiner. Its persistence in these upper reaches is most likely the result of recolonization from populations occurring downstream during times of normal flow (Wilde and Ostrand 1999; Ostrand and Wilde 2001). However, the headwaters may be significant to the reproductive success of the shiner. Reproduction may be triggered by flood events, allowing shiners to move into the headwaters where eggs would be released and transported by currents downstream to perennial areas (personal communication cited in U.S. Fish and Wildlife Service candidate assessment form). Reservoir construction on the Upper Brazos tributaries would create a barrier between the base population and the upper reaches, preventing recolonization and potentially reducing reproductive success. The potential Double Mountain Fork and Post Reservoir projects could have significant adverse effects on the stable population of sharpnose shiners within the Upper Brazos. The construction of the John T. Montford Dam, which impounds Alan Henry Reservoir (Garza County), in 1991 resulted in the disappearance of two common fishes within the river's headwaters (Wilde and Ostrand 1999). A similar situation could occur on the Double Mountain Fork downstream of Alan Henry Reservoir and the North Fork Double Mountain Fork, should the Double Mountain Fork and Post Reservoir projects be implemented. The potential direct impacts to the shiner resulting from construction of these reservoirs include 1) the inundation of occupied habitat, 2) the local extinction of upstream populations, and 3) the loss of habitat downstream from the dams due to the modification of necessary abiotic components (flow regime, thermal regime, substrate, conductivity, etc.).

Chloride Control Reservoirs

The streams of the Upper Brazos River Basin are characterized by natural salts that originate within the salt and gypsum terrain and an underlying brine aquifer within this region. Because the salt entering the Brazos River in this area limits its use as a practical water supply, several studies on the feasibility of salt control have been conducted (e.g., Johnson et al. 1982). Options within the Region G Water Plan for the control of naturally occurring chlorides include deep well injection of recovered brine from the aquifer and the construction of Kiowa Peak Reservoir for the disposal of recovered brine. The Kiowa Peak Reservoir would be located on North Croton Creek just upstream from the confluence with the main stem Brazos (Stonewall and King Counties) and have a storage capacity of 659,650 acre-feet. The original design and study on Kiowa Peak was done by the U.S. Army Corps of Engineers and included the two additional salt retention reservoirs; Dove, located on Haystack Creek (Stonewall and King Counties), and Croton, located on Croton Creek in Stonewall and Kent Counties (Johnson et al. 1982).

The sharpnose shiner evolved to prosper in the saline and turbid conditions naturally occurring in the Brazos River. The various chloride control projects proposed for the Upper Brazos for the conversion of the natural saline waters to a quality available for human consumption would modify the chemical characteristics conducive to sharpnose shiner habitat. Additionally, those projects that require the construction of brine retention reservoirs may also inundate shiner habitat and reduce in stream flows to the major tributaries (e.g., the Salt Fork), as well as the Brazos River proper.

Existing Reservoir Enhancement
An alternative to water management within the Brazos River Basin is expanding the available yield in an existing reservoir by increasing the conservation pool level, water diversion to temporary storage, and construction of a new embankment downstream from the current one. Within the Brazos River Basin, Region G projects related to existing reservoir supply include increasing the storage of Leon Reservoir (conservation pool raise) in Eastland County, water diversion from California Creek into Stamford Reservoir (Haskell County), water diversion from Sweetwater Creek into Sweetwater Reservoir (Nolan County), water diversion from Battle Creek into Cisco Reservoir (Eastland County), and increasing the storage in Fort Phantom Hill Reservoir (new downstream embankment) in Jones County. These projects would contribute to the documented effects impoundments cause to river systems, especially regarding flow regime, within the existing range of the sharpnose shiner.

Discharges and Sedimentation
In 1996, 329 domestic facilities (i.e., municipal wastewater) and 172 industrial facilities held permits by the state (TNRCC 1996) within the Brazos River Basin. Permits held by domestic and industrial facilities allow for the discharge of treated and untreated effluent into the basin. Within the Upper Brazos River drainage alone, the sum of permitted facility discharges is more than 6,670 million gallons of effluent per day (unpublished data cited in U.S. Fish and Wildlife Service candidate assessment form). These discharges modify water quality and add to the continued alteration of the Brazos River channel, affecting its morphology and substrate composition. Adverse conditions within the channel, such as low dissolved oxygen causing fish kills, result from these discharges when sewage facilities fail.

Sediment entering streams via stormwater runoff is the primary source of impairment to surface waters in the United States (Zweig 2000). The predominant land use within the Brazos River Basin is agriculture. Practices that accompany agricultural operations, including harvesting, tilling, and native vegetation clearing contribute to sediment entering the Brazos River system and the conversion of the natural substrate to silt and mud bottom. This source, along with other development projects involving significant earth disturbance resulting in excessive sedimentation within the Brazos River, reduces the available habitat for the sharpnose shiner.

In 1996, 282 agricultural facilities (i.e., confined animal feeding operations (CAFOs)) were permitted by the state (TNRCC 1996) within the Brazos River Basin. The wastes associated with CAFOs are typically high in nutrients (i.e., nitrogen and phosphorus compounds) and historically discharges of these wastes to surface water bodies have resulted in degraded water quality and wildlife mortality (Baker et al., 1998). CAFOs are not permitted to discharge into Waters of the United States except during severe weather events that exceed in intensity a 25- year rainfall event in a 24-hour period. In addition, during periods of intense rainfall and high flooding, retention structures can fail and lead to severe pollution to water bodies that results in fish kills due to the inability of the watershed to filter or dilute the heavy nutrient load. Although discharge from CAFOs is not allowed by permit under normal conditions, unlawful discharge does occur. For example, from 1993 to 1998, the Environmental Protection Agency (EPA), under the Clean Water Act, documented 24 discharges from permitted CAFOs into Waters of the

United States in Texas. Thirteen of these discharges were caused by chronic storm events and reported to the EPA, and the remaining eleven were illegal discharges.

From 1992 to 1999, the Texas Parks and Wildlife Department investigated over 60 fish kills attributable to anthropogenic causes (sewage discharge, oil spills, fertilizers, pesticides, etc.) and resulting in approximately 1,100,000 mortalities within the Brazos River Basin (Texas Parks and Wildlife 2002).

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

There is no current information that would suggest sharpnose shiners are overutilized for commercial, recreational, scientific, or educational purposes. Minnows of the genus *Notropis* are undoubtedly used as bait fishes and are probably harvested in the commercial bait industry. Commercial bait harvesters are required to obtain a permit and report annually on the species and numbers collected. However, the permit does not restrict the quantity of nongame fishes that can be harvested, and furthermore, the list of nongame fishes allowed for harvest under the permit specifies "*Notropis* spp.," which is likely the most detail submitted in an annual report. Currently, four permits have been issued for the harvest and sale of minnows from the Brazos River. Only two permittees reported a harvest in 2001. The impacts the bait industry may have on the sharpnose shiner are unknown.

C. ***Disease or predation.***

The impact of disease or predation upon the sharpnose shiner is not known. The State introduces game fish within the Brazos River and its impoundments, including some exotic species, which likely prey upon sharpnose shiners. However, the extent of the effects of predation has not been determined.

D. ***The inadequacy of existing regulatory mechanisms.***

State law does not provide protection for the sharpnose shiner. There are no regulatory mechanisms for persons harvesting these minnows for use as bait fish, with the exception of a State fishing license and Nongame Fish Permit. Permitted individuals are not restricted in quantity for bait fish harvests. See also discussion under A. above.

Current Conservation Efforts: None.

E. ***Other natural or manmade factors affecting its continued existence.***

In recent years, the Brazos River has experienced massive blooms of golden algae (*Prymnesium parvum*) resulting in several fish kills. The alga kills by way of toxins released into the water that have a lethal effect on gill-breathing animals. Although little is known about the causes of golden algal blooms, as with many other algae they may be triggered by excessive nutrient loading from point source and non-point source events such as industrial and municipal discharges and runoff from agricultural operations. The effects of the golden algae may be insignificant, but further information is needed.

Within the Lower Brazos River, sand and gravel operations have mined the channel for many years (Dunn and Raines 2001). The significance of the effects of these operations to the sharpnose shiner is not known. The current limited distribution of the sharpnose shiner within the Upper Brazos River Basin makes it vulnerable to catastrophic events occurring in this region. The shiner maintains populations within the harsh conditions of this area and can recover from droughts, provided the conditions of its habitat remain suitable. Catastrophic events such as the introduction of competitive species or prolonged drought would increase the likelihood of extinction.

The potential for introduction of competitive species is high due to the reports of such unintentional introductions by anglers and commercial bait fishermen. For example, the Red River shiner was apparently introduced into the range of the threatened Arkansas River shiner, and may seriously threaten its status. The Red River shiner is currently not known from the Brazos River, but the probability of introduction is high, since the Red River Basin is immediately to the north of the current population of sharpnose shiners. Currently, there is no evidence that introduced species within the Brazos River effectively compete with the sharpnose shiner.

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PETITION TO LIST

chucky madtom
(*Notorus* sp.)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 11/15/94:
CNOR 06/13/02: C

TAXONOMY

The chucky madtom is a *Noturus* catfish in the subgenus *Rabida* (the "mottled" or "saddled" madtoms) and part of the *Noturus elegans* species complex (Burr and Eisenhour 1994). The chucky madtom differs from typical *N. elegans* by having a more robust body, a different pigmentation pattern, a more posterior dorsal fin, and larger, more prominent cheek melanophores (Burr and Eisenhour 1994). Preliminary meristic, allozyme, and morphometric analyses have indicated that the chucky madtom is a distinct species (Burr and Eisenhour 1994). Brooks M. Burr (Southern Illinois University), James Grady (University of New Orleans), and David Eisenhour (Morehead State University) are currently completing a formal description of the chucky madtom as a distinct species (personal communication cited in U.S. Fish and Wildlife Service candidate assessment form).

Originally, museum specimens collected from the Roaring River (a Cumberland River drainage) and from the Paint Rock River system in Alabama (a Tennessee River tributary well downstream of the Nolichucky and Little Pigeon River sites) were identified and catalogued as *N. elegans* and thought to be chucky madtoms. However, closer analysis of morphology and meristic characters in these specimens has indicated that they are likely distinct from the Dunn Creek and Little Chucky Creek forms (two personal communications 2001 cited in U.S. Fish and Wildlife Service candidate assessment form). Therefore, the Little Chucky and Dunn Creek forms are the only forms that are recognized as chucky madtoms.

NATURAL HISTORY

This species is currently believed to be restricted to two riffle areas in Little Chucky Creek, a third order tributary of the Nolichucky River that drains a portion of the Ridge and Valley physiographic province in Tennessee (Lang and Mayden 2001). All of the specimens collected in the creek have been found in stream runs with slow to moderate current over pea gravel, cobble, or slab-rock substrates (Burr and Eisenhour 1994). Habitat of these types is sparse in Little Chucky Creek, and the stream affords little loose, rocky cover suitable for madtoms (Shute et al., 1997). It is notable that an intact riparian buffer occurs in the two riffles where chucky madtoms have been found (Shute et al., 1997). Intact riparian buffers may be required by the species. Studies to determine the life history and behavior of this species have not been conducted. Nothing is known about chucky madtom reproductive or foraging behavior, recruitment, life expectancy, food items, or mobility, although it is likely that this species exhibits similar behavior and has similar habitat requirements to other members of the *N. elegans* species complex.

POPULATION STATUS

The chucky madtom is a rare, undescribed catfish known from only 12 specimens collected from two Tennessee streams. A lone individual was collected in 1940 from Dunn Creek (a Little Pigeon River tributary) in Sevier County and 11 specimens have been encountered since 1991 in Little Chucky Creek (a Nolichucky River tributary) in Greene County. Only 1 specimen has been encountered since 1994 despite numerous surveys of both historic localities and several streams, similar in size and character to Little Chucky Creek, in the Nolichucky, Holston, and French Broad River watersheds (upper Tennessee River basin). The species is apparently very rare and geographically restricted.

The U.S. Fish and Wildlife Service classifies the chucky madtom as a candidate for Endangered Species Act protection with a listing priority number of 2.

LISTING CRITERIA

Historical range:	Dunn Creek (tributary of Little Pigeon River, Sevier County) and Little Chucky Creek (tributary of Nolichucky River, Greene County) and possibly other streams in the Ridge and Valley and Blue Ridge physiographic provinces in Tennessee.
Current range:	Little Chucky Creek.
Land ownership:	The Little Chucky Creek watershed is primarily owned by private entities with the exception of small government land holdings such as public school properties and county and state road right-of-ways. Approximately 5 percent of the Dunn Creek watershed is owned by the National Park

Service (i.e., portions of the Great Smoky Mountains National Park and Foothills Parkway), but the Dunn Creek watershed is also primarily in private ownership.

A. ***The present or threatened destruction, modification, or curtailment of its habitat or range.***

The current range of the chucky madtom is believed to be restricted to Little Chucky Creek in Greene County, Tennessee. Because this species was also collected, in 1940, from Dunn Creek, a stream that is in a different watershed and physiographic province than Little Chucky Creek, it is likely that the historic range of the chucky madtom encompassed a wider area in the Ridge and Valley and Blue Ridge physiographic provinces in Tennessee than is demonstrated by its current distribution. A survey for the chucky madtom in Dunn Creek in 1996 was not successful at locating the species (Shute et al. 1997), and approximately ten additional collections from the Dunn Creek site, during both daylight hours and at night, from the 1970s through 2001, also failed to produce chucky madtoms (personal communication 2001 cited in U.S. Fish and Wildlife Service candidate assessment form). The Dunn Creek population may be extirpated. The very small current range of the species leaves it vulnerable to stochastic events that may extirpate it from the only creek that it occupies (also see Factor E).

The chucky madtom is a bottom dwelling species. Bottom dwelling fish species are susceptible to sedimentation and other pollutants that degrade or eliminate habitat and food sources (Berkman and Rabeni 1987; Folkerts 1997; Richter et al., 1996; Waters 1995). Etnier and Jenkins (1980) suggested that madtoms, which are heavily dependent on chemoreception for survival, could be susceptible to anthropogenic disturbances, such as chemical and sediment inputs, because these alterations interfere with their ability to obtain food and otherwise monitor its environment.

The majority of the Little Chucky Creek watershed is privately owned and managed for beef cattle production, tobacco cultivation, and row crops, especially corn and soybeans (USDA 1958; personal observation 2001 cited in U.S. Fish and Wildlife Service candidate assessment form). Therefore, non-point source sediment and agrochemical inputs into Little Chucky Creek from local agricultural and other sources may adversely affect the chucky madtom by altering the physical characteristics of its habitat, thus potentially impeding its ability to feed, seek shelter from predators, and successfully reproduce. The Dunn Creek watershed shares some of these same agricultural pressures, and these will continue to threaten the species if it still occurs there. Additional threats within the Dunn Creek watershed also include residential development and associated new infrastructure (e.g., roads, utilities, etc.) that contribute sediment and other pollutants to the stream or alter riparian areas. The effects of these types of threats will likely increase as human populations in these watersheds increase in response to human demands for housing, transportation, and places of employment. In particular, the areas surrounding Dunn Creek are becoming developed for new residential and vacation homes due to its proximity to the Great Smoky Mountains National Park and other area attractions.

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

This species is known from only 12 collected specimens. Because of the chucky madtom's extreme rarity and restricted range, scientific or commercial collection of even a few individuals could be detrimental to the species.

C. ***Disease or predation.***

Various predators, including birds, snakes, and other fish, undoubtedly consume chucky madtoms. No predation studies have been performed on this species, but, because the chucky madtom is presumed to be extremely rare, even natural predation could adversely affect any extant population. Nothing is known about any diseases that may affect the species.

D. ***The inadequacy of existing regulatory mechanisms.***

The federally endangered Cumberland bean (*Villosa trabalis*) is still believed to exist in the western section of Little Chucky Creek, Greene County, Tennessee (personal communication 2002 cited in U.S. Fish and Wildlife Service candidate assessment form). Therefore, the chucky madtom might receive some incidental protection under the federal Endangered Species Act within sections of Little Chucky Creek that may contain the Cumberland bean. However, one of the known chucky madtom locations is located upstream of the sites thought to contain the Cumberland bean. Federal listing as an endangered species would provide additional protection for this species by (1) requiring federal endangered species permits to take or collect this species and (2) requiring federal agencies to consult with the U.S. Fish and Wildlife Service whenever projects they fund, authorize, or carry out may adversely affect the species. The chucky madtom was listed as Endangered by the State of Tennessee in September of 2000, which would require potential collectors of this species to have a state collection permit.

Current Conservation Efforts: The Service has four Partners for Fish and Wildlife projects underway along Little Chucky Creek. These projects involve riparian fencing, creation of alternate water sources and development of hardened stream access points for cattle, and bank stabilization. Additional Partners for Fish and Wildlife funding has been secured for new habitat restoration projects in the watershed during 2002. The U.S. Fish and Wildlife Service's Candidate Conservation Program has also provided funding for Conservation Fisheries, Inc., to perform an intensive survey for the chucky madtoms in Little Chucky Creek. Any live individuals encountered during the survey will be retained by Conservation Fisheries, Inc. in order to initiate a captive propagation program.

E. ***Other natural or manmade factors affecting its continued existence.***

The chucky madtom is apparently restricted to two riffle areas in Little Chucky Creek, Greene County, Tennessee, and is therefore extremely vulnerable to extirpation due to vandalism or random catastrophic events such as toxic chemical spills. Species that are restricted in range and population size are also susceptible to inbreeding depression and genetic bottlenecks (Avise and Hamrick 1996). It is likely that the only extant population of chucky madtoms is below the effective population size (Soulé 1980) required to maintain long-term genetic and population viability without substantial human intervention. Overall, the U.S. Fish and Wildlife Service believes that the potential demographic effects of inbreeding, limited species distribution, and low number of individuals pose the most significant threats to the chucky madtom.

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PETITION TO LIST

rush darter
(*Etheostoma phytophilum*)

AS A FEDERALLY ENDANGERED SPECIES

CANDIDATE HISTORY

CNOR 6/13/02: C

TAXONOMY

The rush darter (*Etheostoma phytophilum*), a medium-sized percid darter in the subgenus *Fuscatelum*, was described by Bart and Taylor in 1999.

NATURAL HISTORY

Morphology

The average size of the rush darter is 40 mm (2 in) standard length (30 to 58 mm, or 1 to 2 in) (Bart and Taylor 1999, Johnston and Kleiner 2001). Diagnostic characters of the subgenus *Fuscatelum* include the lack of bright colors on the body and fins and the presence of anal fin tubercles on breeding males (Page 1983). The rush darter is closely related to the goldstripe darter (*Etheostoma parvipinne*), a drab species with a thin golden stripe along the lateral line that is surrounded by heavily mottled or stippled sides (Shaw 1996). However, the distinct golden stripe characteristic of the goldstripe darter is not well developed in the rush darter (Bart and Taylor 1999). The brown pigment on the sides of the rush darter is usually not as intense as in the goldstripe darter. Other characteristics of the rush darter include 47 or fewer lateral line scales, 13 or fewer transverse (across the body) scales, and 22 or fewer caudal peduncle (end of body and beginning of caudal fin) scales (Bart and Taylor 1999).

Ecology

The life history of the rush darter is poorly known, but its life history characteristics are likely similar to the goldstripe darter. Spawning of the goldstripe darter occurs from mid- March through June in Alabama (Mettee et al. 1996) and from mid-April through May in Tennessee and Mississippi (Etnier and Starnes 1993). Preferred food items for the goldstripe darter include midges, mayflies, blackflies, beetles, and microcrustaceans (Mettee et al. 1996). The life span of the goldstripe darter is estimated to be 2 to 3 years. The rush darter does not appear to be active nocturnally (Stiles and Blanchard 2001).

Rush darters have been collected from a variety of habitats (Johnston and Kleiner 2001, Stiles and Blanchard 2001, Bart and Taylor 1999) including: (a) root masses of emergent vegetation along the margins of spring-fed streams in very shallow, clear, cool and flowing water and (b) from both small clumps and dense stands of bur reed (*Sparganium* sp.) and coontail (*Ceratophyllum* sp.) in streams with substrates of silt, sand, sand and silt, muck and sand or some gravel with sand, and bedrock. Rush darters appear to prefer relatively low gradient small streams, and some of the streams where they occur are not influenced by springs. Water depth at collection sites ranges from 3.0 cm to 0.5 m (0.1 ft to 1.6 ft) with moderate water velocity in riffles and no flow or low flow in pools. No rush darters have been found in higher gradient streams with bedrock substrates and sparse vegetation, and rush darters also have not been found in dense growths of watercress (*Nasturtium officinale*) along the sides and mid-channel of spring runs.

POPULATION STATUS

The rush darter is currently known to have one of the most restricted distributions of any vertebrate in Alabama (Johnston and Kleiner 2001). All rush darter populations are located above the Fall Line in the Tombigbee-Black Warrior drainage (Warren et al. 2000) in portions of the Appalachian Plateau and Valley and Ridge physiographic provinces. The closely related goldstripe darter only occurs below the Fall Line. Reports of goldstripe darters from the 1960s and 1970s in Winston and Jefferson Counties (Caldwell 1965, Barclay 1971, Dycus 1972, Dycus and Howell 1974, Mettee et al. 1989), which is above the Fall Line, were made prior to the description of the rush darter. Those specimens are now considered to be rush darters (personal communication 2002 cited in U.S. Fish and Wildlife Service candidate assessment form).

Rush darter populations are widely separated from each other, and individual rush darters are only sporadically collected within the range of the species. Historically, rush darters have been found in three distinct watersheds: Doe Branch, Wildcat Branch, and Mill Creek of the Clear Creek drainage in Winston County; an unnamed spring run of Beaver Creek and Penny Springs in the Turkey Creek drainage in Jefferson County; and Cove Spring of the Little Cove Creek drainage in Etowah County. Currently, only two of these three populations are extant, one in Wildcat Branch and Mill Creek in the Clear Creek drainage (Johnston and Kleiner 2001), and the second in the unnamed spring run to Beaver Creek and in Penny Springs in the Turkey Creek drainage (Stiles and Blanchard 2001). The Little Cove Creek drainage population was known from only a single specimen collected in Cove Spring in 1975 (Jandebeiur 1975, Bart and Taylor 1999). Additional collection attempts by Bart and Taylor (1999) and Stiles and Blanchard (2001) did not find rush darters in Cove Spring or Little Cove Creek, and the U.S. Fish and Wildlife Service considers this population to be extirpated (U.S. Fish and Wildlife Service candidate assessment form).

Where it occurs, the rush darter is apparently an uncommon species that is usually collected in low numbers (Bart and Taylor 1999). Since 1969, approximately 100 rush darters have been collected or captured and released within the species' range (U.S. Fish and Wildlife Service candidate assessment form, compiled from Bart and Taylor 1999, Johnston and Kleiner 2001, Stiles and Blanchard 2001). Within the Clear Creek drainage in Winston County, the most individuals captured in one collection was six from Mill Creek in August 2001 (Johnston and Kleiner 2001). Bart and Taylor (1999) reported collecting up to 11 individuals during a survey of Wildcat Branch between 1990 and 1993. However, only one individual was collected by Johnston and Kleiner (2001) in August 2001 at a road crossing of Wildcat Branch, and Stiles and Blanchard (2001) were unable to find rush darters in the same locality later that same month after several attempts. In Jefferson County, collections have also been sporadic, with four individuals recorded at the Penny Springs site (Stiles and Blanchard 2001), seven individuals at the unnamed spring run that is the type locality (Stiles and Blanchard 2001; personal observation 2001 cited in U.S. Fish and Wildlife Service candidate assessment form), and only one individual at a bridge crossing over the same unnamed spring run (type locality). No rush darters were collected at the bridge crossing over the spring run 1 week later (Stiles and Blanchard 2001; personal observation 2001 cited in U.S. Fish and Wildlife Service candidate assessment form).Altogether, the rush darter has been collected only from localized collection sites within approximately 14 km (9 miles) of streams in the Clear Creek, Little Cove Creek, and Turkey Creek drainages in Winston, Etowah, and Jefferson Counties, respectively. Currently, about 3 km (2 miles) of stream, or about 23 percent, of the rush darter's known historical range is not occupied, which may be due to non-point source pollution, especially sedimentation. Within the Clear Creek drainage, the rush darter has been collected in Wildcat Branch, Mill Creek, and Doe Creek, which consists of about 13 km (8 miles) of stream or about 94 percent of the species' total range. Recent surveys (Johnston and Kleiner 2001) have documented the apparent absence of the rush darter in Doe Creek, so, if the species is extirpated from Doe Creek, this reduces the species' known range within the Clear Creek drainage by about 3 km (2 miles) of stream or 21 percent. No rush darters have been collected in the Little Cove Creek drainage (Cove Spring run) since 1975. This extirpation constitutes a loss of only 0.05 km (0.02 miles) of occupied stream habitat, or a 1.6 percent reduction. However, this loss is significant in that it represents the extirpation of the species from Etowah County. In the Turkey Creek drainage, rush darters have been collected sporadically within Penny Springs and at the type locality for the species (Bart and Taylor 1999). This area contains about 0.5 km (0.3 miles) of occupied stream habitat, or approximately 4 percent of the rush darter's total range.

The U.S. Fish and Wildlife Service classifies the the rush darter as a candidate for Endangered Species Act protection with a listing priority number of 5.

LISTING CRITERIA

A. *The present or threatened destruction, modification, or curtailment of its habitat or range.*

Historical range: Above the Fall Line in the Tombigbee-Black Warrior drainage (Warren et al. 2000) in portions of the Appalachian Plateau and Valley and Ridge physiographic provinces (Alabama).

Current range: Wildcat Branch and Mill Creek (Clear Creek Drainage, Winston County, Alabama), constituting approximately 95% of the total current range; Penny Springs and the type locality, an unnamed spring run of Beaver Creek (Turkey Creek Drainage, Jefferson County, Alabama).

Land ownership: The species is believed to currently inhabit stream habitats that are approximately 86 percent privately-owned industrial, forestry, agricultural and urbanized lands. The State of Alabama owns and maintains the ditch along the highway at the type locality for water control, which equates to about 1 percent of the rush darter’s habitat. The USFS manages some rush darter habitat in the Bankhead National Forest, which is approximately 10 percent of the rush darter’s total habitat. In addition, the Black Warrior Land Trust owns the Penny and Tapawingo Springs area , which constitutes approximately 3 percent of the rush darter’s habitat.

The rush darter is vulnerable to non-point source pollution, urbanization, and changes in stream geomorphology due to its highly local distribution within parts of two unconnected stream drainages, as well as its apparent low population sizes. Non-point source pollution from land surface runoff can originate from virtually any land use activity and may include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, and petroleum products. These pollutants tend to increase concentrations of nutrients and toxins in the water and alter the chemistry of affected streams such that the habitat and food sources for species such as the rush darter are negatively impacted.

Construction and road maintenance activities associated with urban development typically involve earth moving activities that increase sediment loads into nearby streams, and other siltation sources, including timber harvesting, clearing of riparian vegetation, and mining and agricultural practices, allow exposed earth to enter streams during or after precipitation events. The rush darter’s range is in close proximity to metropolitan Birmingham, Alabama, an area in which all of these activities are occurring, so impacts from these activities on the rush darter and its habitat are very likely. Land use practices that affect sediment and water discharges into a stream can also change the erosion or sedimentation pattern of the stream, which can lead to the destruction or modification of in-stream habitat and riparian vegetation, stream bank collapse, and increased water turbidity and temperature. Excessive siltation can make the habitat of rush darters and associated benthic fish species unsuitable for feeding and reproduction by covering and eliminating available food sources and nest sites. Sediment has been shown to wear away and/or suffocate periphyton (organisms that live attached to objects underwater and provide food items for species such as the rush darter), disrupt aquatic insect communities, and negatively impact fish growth, physiology, behavior, reproduction and survivability (Waters 1995, Knight and Welch 2001). Sediment is the most abundant pollutant in the Mobile River Basin (Alabama Department of Environmental Management 1996).

Within the Clear Creek drainage, Johnston and Kleiner (2001) reported that during August 2001 land use in the Doe Branch and Mill Creek area appeared to be dominated by forests and that there were no obvious threats to water quality. However, U.S. Fish and Wildlife Service and U.S. Forest Service (USFS) personnel noted extensive siltation at the bridge over Doe Branch at County Road 329 on March 12, 2001, during a modest spring rain and also noted siltation at several other road crossings and at other tributaries in the immediate area. Johnston and Kleiner (2001) reported that recent clear cutting in the Wildcat Branch watershed may have increased sedimentation into the stream. Approximately 84 percent (i.e., 5 km or 3 miles) of Wildcat Branch is privately owned, and recent land exchanges within the Bankhead National Forest have taken about 0.9 km (0.6 miles) of stream west of Clear Creek out of USFS management and protection. Therefore, it is likely that additional, periodic sedimentation events will occur in the Clear Creek drainage that may impact rush darter populations and habitat.

Cove Spring is a water source for the West Etowah County Water Authority. Water that is pumped from the spring for human consumption is chlorinated on the site, and an overflow pipe from the building that protects the spring outfall provides a constant water source for the spring run. U.S. Fish and Wildlife Service personnel visually evaluated the habitat within Cove Spring and its spring run and found that it appeared suitable for rush darters. However, it is not known whether previous releases of chlorinated spring water from the overflow pipe might have contributed to the apparent loss of the species at this site. Additional investigation is needed to clarify whether chlorination caused the demise of the darters at this site. Blanco (2001) identified siltation from development projects as the greatest threat to the fauna of Turkey Creek. Blanchard et al. (1998) identified five specific non-point source siltation sites that have impacted the Turkey Creek watershed, including four sites affecting Beaver Creek, which is a major tributary to Turkey Creek. These sites included bridge, road, and sewer line construction sites and a wood pallet plant. In addition, U.S. Fish and Wildlife Service personnel noted in 1998 that Turkey Creek at the confluence Tapawingo and Penny Springs was sediment-laden and completely turbid after medium to heavy rainfalls.

Four major soil types occur within the Turkey Creek watershed and all are considered highly erodible due to the steep topography (personal communication 1998 cited in U.S. Fish and Wildlife Service candidate assessment form). Therefore, any activity that removes native vegetation on these soils can be expected to lead to increased sediment loads in Turkey Creek, and urbanization, in particular, has contributed significantly to siltation within the Turkey Creek watershed (U.S. Fish and Wildlife Service 2001), including the areas near Penny and Tapawingo Springs. Industrialization is extensive throughout the watershed, particularly near the type locality for the rush darter (Bart and Taylor 1999).

B. ***Overutilization for commercial, recreational, scientific, or educational purposes.***

In general, small species of fish such as the rush darter, which are not utilized for either sport or bait purposes, are ignored by the general public. Therefore, take of these species by the general public is unlikely to be a problem. Scientific collecting and take by private and institutional collectors are not presently identified as threats, and scientific collecting is controlled by the

State of Alabama through the issuance of collection permits.

C. ***Disease or predation.***

Predation upon the rush darter undoubtedly occurs; however, there is no evidence to suggest that disease or natural predators threaten this species. To the extent that disease or predation occurs, it becomes a more important consideration as the total population decreases in number.

D. ***The inadequacy of existing regulatory mechanisms.***

There is currently no requirement within the scope of other environmental laws to specifically consider the rush darter or ensure that a project will not jeopardize its continued existence. Under the State of Alabama regulations for water use classification, Fish and Wildlife, Rule 355-6-10-09(4), "No turbidity, other than natural causes, that cause substantial visible contrasts with natural appearance or interfere with any beneficial uses they serve; in no case shall turbidity exceed 50 NTU above background"(Sheppard et al.1994). However, there is insufficient information on the rush darter's ecology, life history, and sensitivity to contaminants to determine the effectiveness of this or other existing environmental laws and regulations. Also, there is little or no enforcement of sedimentation regulations by the state.

Current Conservation Efforts: The Alabama Highway Department is aware of the occurrence of the rush darter at the type locality and says it will consider it during roadside vegetation control (U.S. Fish and Wildlife Service candidate assessment form), but the significance of this consideration is unclear. In conjunction with the U.S. Fish and Wildlife Service, the Jefferson County Lands Division and the Black Warrior River Land Trust have purchased and rehabilitated the Tapawingo Springs and spring run site. The Black Warrior River Land Trust has also purchased Penny Springs, and the USFS is funding additional surveys for the rush darter on the Bankhead National Forest.

E. ***Other natural or manmade factors affecting its continued existence.***

Currently, there are only two extant populations of rush darters, and genetic diversity of these two populations has likely declined due to isolation of the populations in separate watersheds within the Tombigbee-Black Warrior River drainage. The long-term viability of a species depends on conservation of numerous local populations throughout its geographic range (Harris 1984). These features are essential for the species to recover and adapt to environmental change (Noss et al. 1994, Harris 1984). Their disjunct distribution makes rush darter populations vulnerable to extirpation from catastrophic events, such as toxic spills or changes in flow regimes. The endangered watercress darter (*E. nuchale*) was introduced by the U.S. Fish and Wildlife Service into Tapawingo Springs in 1988 in order to assist in the species recovery through the establishment of a new population (Moss 1995). Since that time, the watercress darter has reproduced repeatedly (U.S. Fish and Wildlife Service 1992), and, recently, a population of watercress darters was found in the Penny Springs site (Stiles and Blanchard 2001). Interspecific competition between the robust watercress darter and the rush darter may be negatively affecting the rush darter at this site, as has been suggested by Stiles (personal communication 2001 cited in U.S. Fish and Wildlife Service candidate assessment form).

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