Recovery Plan
For
Bluemask (=Jewel) Darter

(Etheostoma [Doration] sp.)

U.S. Fish and Wildlife
Southeast Region
Atlanta. Georgia

RECOVERY PLAN

for the

Bluemask (=Jewel) Darter (*Etheostoma (Doration)* sp.)

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Approved: _____
Acting Regional Director, U.S. Fish and Wildlife Service

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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1997. Recovery Plan for the Bluemask (=Jewel) Darter (*Etheostoma (Doration)* sp.). Atlanta, GA. 20 pp.

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EXECUTIVE SUMMARY

Current Status: The bluemask (=jewel) darter (*Etheostoma (Doration)* sp.) was listed as an endangered species on December 27, 1993. This small darter (2 inches long) is endemic to the Caney Fork River system (above the Great Falls Reservoir), Cumberland River basin, in central Tennessee. The species was historically known from five rivers and is still known from four of these rivers. One population inhabits about 23 stream miles. The other three populations inhabit less than 2.8 stream miles.

Habitat Requirements and Limiting Factors: The bluemask darter inhabits slow to moderate current over clean sand and fine gravel at depths of 4 to 20 inches; it typically occurs just downstream of riffles or along the margins of pools and runs. Its distribution has been reduced by impoundments, habitat alteration from gravel dredging, water withdrawal, and the general deterioration of water quality resulting from siltation and other pollutants contributed by coal mining, gravel mining, poor land-use practices, and waste discharges. These factors continue to impact the species and its habitat. The species' present limited distribution also makes it vulnerable to extirpation from stochastic events such as chemical spills.

Recovery Objective: Downlisting. Because much of the species' presumed historic habitat has been impounded or altered by other factors, it may not be possible to recover the species to the point of delisting.

Downlisting Criteria: The species will be considered for downlisting when three viable populations of the bluemask darter are established, studies of the fish's biological and ecological requirements are completed, there are substantial increases in the number and range of the species, and there are no foreseeable treats likely to impact the survival of the species over a significant portion of its range.

Actions Needed:

1. Use existing legislation/regulations to protect the species.
2. Determine threats and alleviate those that threaten the species' existence.
3. Determine the species' life history requirements.
4. Solicit the assistance of local landowners and initiate Partners for Wildlife projects to improve riparian habitat.
5. Develop and implement an information/education program.
6. Through augmentation or reintroduction, protect and establish viable populations.
7. Search for additional populations.

Cost ($000s):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Total
1997	5.0	10.0	10.0	25.0	15.0	20.0	0.0	**85.0**
1998	5.0	10.0	10.0	25.0	5.0	20.0	20.0	**95.0**
1999	5.0	10.0	10.0	25.0	5.0	20.0	0.0	**75.0**
2000	5.0	10.0	10.0	25.0	5.0	15.0	0.0	**70.0**
2001	5.0	0.0	0.0	0.0	0.0	15.0	0.0	**20.0**
2002	5.0	0.0	0.0	0.0	5.0	0.0	0.0	**10.0**
2003	5.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.0**
2004	5.0	0.0	0.0	0.0	5.0	0.0	0.0	**10.0**
2005	5.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.0**
2006	5.0	0.0	0.0	0.0	5.0	0.0	20.0	**30.0**
2007	5.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.0**
Total	**55.0**	**40.0**	**40.0**	**100.0**	**45.0**	**90.0**	**40.0**	**410.0**

Date of Downlisting: The year 2006, if all the recovery criteria are met.

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PART I

INTRODUCTION

The bluemask (=jewel) darter (*Etheostoma (Doration)* sp.) was listed as an endangered species on December 27, 1993 (U.S. Fish and Wildlife Service [Service] 1993). This darter is endemic to the Caney Fork River system (above the Great Falls Reservoir), Cumberland River basin, in central Tennessee. Based on historic records, the species was known from five rivers in the upper Caney Fork River system. The bluemask darter is now known from four of these rivers. Its distribution has been reduced by such factors as impoundments, habitat alteration, water withdrawal, and the general deterioration of water quality resulting from siltation and other pollutants contributed by coal mining, gravel mining, poor land-use practices, and waste discharges. These factors continue to impact the species and its habitat.

Taxonomic Status and Description

The bluemask darter (also referred to as the jewel darter) was first recognized as a distinct taxon by Howell (1968), who treated it as a subspecies of the speckled darter (*Etheostoma stigmaeum*) in the subgenus *Doration*. Layman (1991a and 1994) reevaluated the bluemask darter's taxonomic status. He recognized the form as a distinct species, coined the common name "bluemask darter" in reference to the species' distinctive breeding coloration, and prepared a taxonomic description as part of his unpublished dissertation (Layman 1994). Layman, the senior author of this recovery plan, has submited a manuscript formally describing the species to the journal *Copea*.

The following bluemask darter description is taken from Layman (1991b and 1994).

> The bluemask darter is a small, slender fish that reaches a maximum size of 48 millimeters (1.9 inches) standard length. Females and nonbreeding males are straw-yellow to tan. Along the sides there are 7-9 quadrate blotches formed by dark X-markings and faint blue pigment. Between the blotches and extending dorsally there are many small orange X-markings and spots. Dorsolaterally there are also many small brown markings. On the dorsum there are six dark brown saddles. The face and underside of the head are white to dusky, and there is blue pigment on the suborbital bar and operculum. The cheeks are fully scaled, and the lateral line is usually complete. The first dorsal fin contains a narrow dusky marginal band, a red-orange medial band, a dusky submedial band (males only), and a clear basal band. The second dorsal and caudal fins are mostly clear.
>
> Breeding males are generally dusky with 7-9 bright cobalt blue bars on the side of the body. Between the bars, orange spots coalesce to form conspicuous splotches. Bright cobalt blue continuously covers the face, underside of the head, and branchiostegal membranes. The first dorsal fin contains a narrow gray to black marginal band, a bright red-orange medial band, a wide black submedial band, and a mostly clear basal band with black pigment in the posterior portions of the membranes. The second dorsal, caudal, anal, and pelvic fins are dusky gray to black.
>
> The bluemask darter can be distinguished from *E. stigmaeum* and the blueside darter (*E. jessiáe*) by the following combination of characteristics: fully scaled cheeks; lateral line usually complete;

premaxillary frenum absent; breeding males with bright cobalt blue pigment continuously covering the lower face and underside of the head; breeding males with soft dorsal and anal fins with no orange spots on rays or blue pigment in membranes; and palatine teeth absent. The bluemask darter exhibits an allapatric distribution with respect to its close relatives *E. stigmaeum* and *E. jessiae*. Keys to the species of *Doration* are provided by Etnier and Starnes (1993) and Layman (1994).

Life History and Ecology

There is little published information on the life history and ecology of the bluemask darter (Layman *et al.* 1993, Etnier and Starnes 1993). Layman (1991b) collected the bluemask darter in slow to moderate current over clean sand and fine gravel at depths of 10 to 50 centimeters (cm) (4 to 20 inches), typically just downstream of riffles or along the margins of pools and runs. It inhabited the lower free-flowing reaches of streams on the Highland Rim (Layman 1991b), which are characterized by moderate gradient; waters of low to moderate productivity; and substrates of limestone or chert bedrock, coarse chert gravel, and sand (Starnes and Etnier 1986).

Mean stream width at three collection localities surveyed during August ranged from 14 to 28 meters (m) (46 to 92 feet), and mean depth ranged from 24 to 28 cm (9 to 11 inches) (Layman 1991b). Spawning males were collected from the Collins River in April over sand and gravel in moderately flowing runs (Layman 1991b). (The closely related *E. stigmaeum*, which shares an affinity for sand and gravel substrates, spawns in early spring by burying eggs in gravel [Winn 1958]). The upper reaches of all four streams that support the bluemask darter flow underground during summer, with little to no surface flow. This limits perennial habitat for the species to the lower stream reaches.

Distribution, Reasons for Decline, and Threats

The bluemask darter has been collected from, and is apparently endemic to, only the Caney Fork River system (above the Great Falls Reservoir), Cumberland River basin, in central Tennessee (Figure 1). Layman (1991b) reviewed historic collection records and reported that the species has been collected from five rivers in the Caney Fork River system--upper Caney Fork River, Collins River, Rocky River, Calfkiller River, and Cane Creek in Grundy, Warren, Van Buren, and White Counties. Historic fish collection records are sparse for this area. However, considering the extent of the fish's preferred habitat (slow to moderate current areas with sand and fine gravel substrates [Layman 1991b]), which was inundated by the Great Falls Reservoir in the 1910s, the species was once likely more widely distributed within this portion of the Caney Fork system than available records indicate. The belief that the species has undergone a range reduction is also supported by Starnes and Etnier (1980).

In 1990 and 1991, Layman (1991b) surveyed the Caney Fork River system above and below the Great Falls Reservoir using a 1/8-inch mesh seine (10 x 6 feet). The results of this survey and additional collections were reported by Layman *et al.* (1993). Layman found the bluemask darter restricted to isolated populations in short reaches of four rivers in the Caney Fork River system--Cane Creek, Van Buren County; Collins River, Warren and Grundy Counties; Rocky River, Van Buren County; and upper Caney Fork River, White County. Based on Layman (1991b) and Layman *et al.* (1993), the bluemask darter is estimated to inhabit about 700 feet (200 m) of Cane Creek; 23 miles (37 kilometers [km]) of the Collins River; 2.7 miles (4.3 km) of the Rocky River, including a

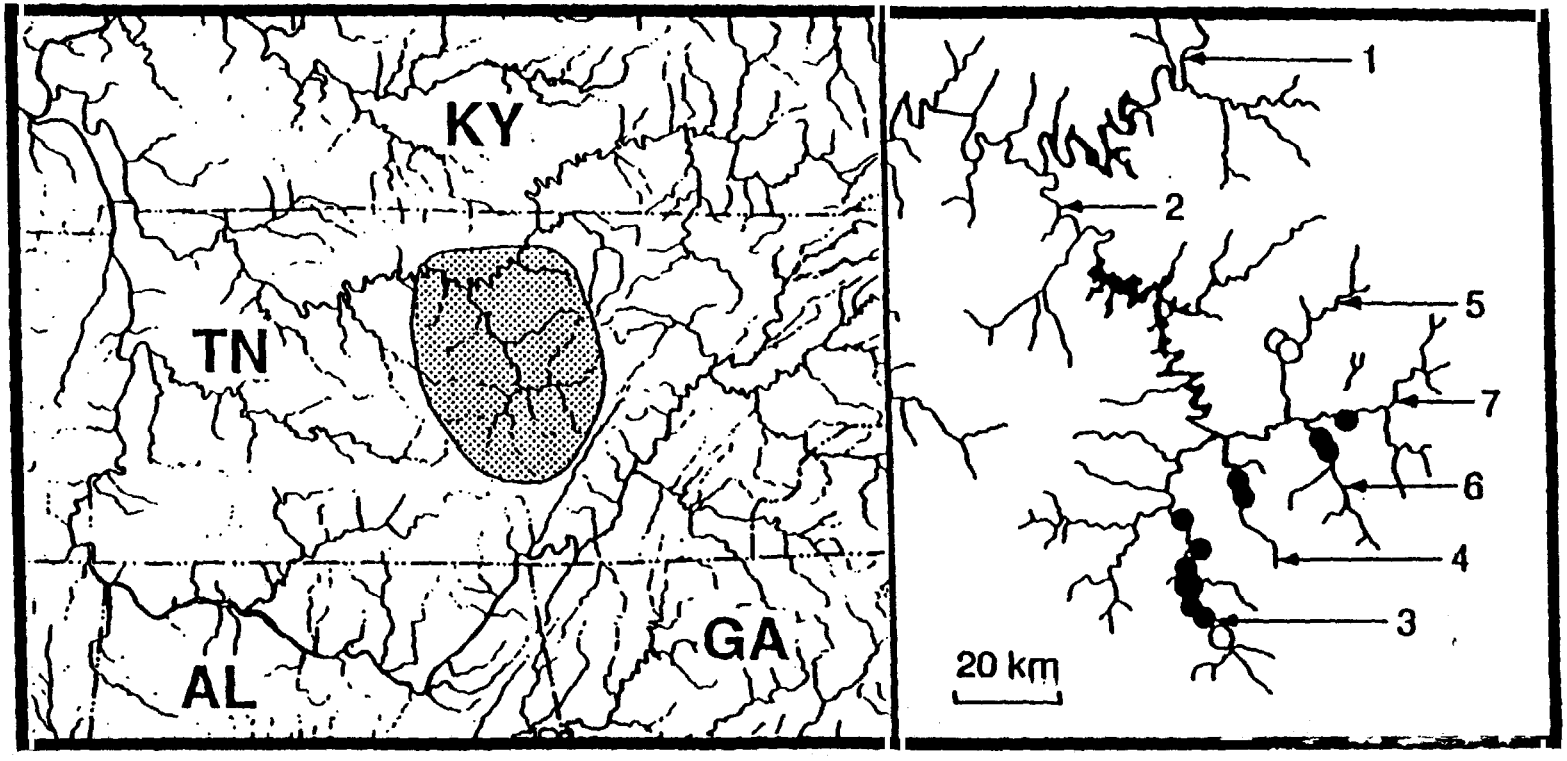

Figure 1. Known distribution of *Etheostoma* sp., bluemask darter (Layman 1994). Inset of Caney Fork River system shown on right. Solid circles represent current distribution. Open circles represent historic localities where the species no longer occurs. Streams are: 1 - Cumberland River, 2 - Caney Fork River, 3 - Collins River, 4 - Rocky River, 5 - Calfkiller River, 6 - Cane Creek, and 7 - Upper Caney Fork River.

1.1-mile (1.7-km) reach that alternates between impounded and free-flowing conditions as the Great Falls Reservoir water levels fluctuate; and 1.1 miles (1.7 km) of the upper Caney Fork River. The species may also seasonally occur in the 1.9-mile (3.0-km) reservoir fluctuation zone in the upper Caney Fork River and the 0.8-mile (1.3-km) fluctuation zone in Cane Creek (Layman *et al.* 1993)

The collection of juvenile bluemask darters by Layman (1991b) from the Collins River, Rocky River, and upper Caney Fork River and historic collections of the species from the Collins River, Rocky River, and Cane Creek, dating back to 1967, indicate that successful reproduction is occurring in all four extant populations. Presumably the impounded waters of the Great Falls Reservoir act as a filter, if not a complete barrier, to the movement of bluemask darters between these isolated populations.

The species was historically taken from two sites in the Calfkiller River, White County. However, Layman (1991b) made collections at both these historic collection sites and four other Calfkiller River sites, but no specimens were found. It is believed that the species is extirpated from this river. (Water quality degradation due to wastewater effluents from Sparta, several small impoundments of the main channel, and siltation associated with the impoundments probably eliminated the species from the Calfkiller River.) Neither was the fish found in collections made in other Caney Fork tributaries--Barrens Fork River, Falling Water River, Charles Creek, Laurel Creek, Hickory Creek, Town Creek, and Mountain Creek (Layman 1991b). No historic records exist for the fish in these waters.

The bluemask darter was most widely distributed and abundant in the Collins River, where it was collected at five localities in a 23-mile (37-km) reach of river between Shellsford, in Warren County, and the Tennessee Highway 56 bridge, 0.75 mile (1.2 km) east of Mt. Olive, in Grundy County (Layman 1991b). The upstream limit of the perennial flow on the Collins River is at the confluence of a large spring (Big Spring) located 1.7 air miles (2.7 km) southeast of Mt. Olive. The total length of the perennial habitat available to the bluemask darter in the Collins River is estimated to be about 25 river miles (40 km).

In the Collins River, Layman (1991b) found suitable bluemask darter habitat to be highly localized. The lower Collins River was dominated by long pools with bedrock and rubble substrates. Sand and fine gravel were sparse, and bluemask darters were uncommon. Bluemask darters were most abundant in the upper half of the perennial reach of the Collins River, where riffles occurred more frequently and sand and gravel were more widely distributed. More than 30 specimens were collected at the mouth of Scott Creek (1.3 air miles [2.1 km] southeast of Irving College) on each of two occasions in the spring of 1990 and the spring of 1991 (Layman 1991b).

Layman (1991b) reported that the Collins River was dry in July and August 1991 at the Tennessee Highway 56 bridge (1 air mile [0.6 km] south-southeast of Tarlton, Grundy County), a locality where 23 bluemask darters had been collected in April 1967. This bridge is located about 2 river miles (3 km) upstream of Big Spring, and gravel-dredging activities had extensively disturbed the substrates in this reach.

Layman (1991b) found the perennial flow in the Rocky River was limited to the lower 4.0 river miles (6.5 km) of unimpounded waters. The bluemask darter was collected at only three localities, covering the lower 2.7 river miles (4.3 km) (Layman *et al.* 1993).

The species was most abundant in a 0.3-mile (0.5-km) reach located immediately upstream of the impounded waters of the Great Falls Reservoir and in the upper portion of the 1.1-mile (1.7-km) reservoir fluctuation zone (a narrow channel). The upstream limit of the perennial flow in the Rocky River was located about 1.0 air mile (0.6 km) south of Riverview, in Van Buren County, where a spring entered along a rocky bluff. Beginning immediately upstream of this point, the streambed was completely dry and had been leveled and compacted by active gravel-dredging operations.

Layman (1991b) collected the bluemask darter from only about the lower 0.1 mile (0.2 km) of the free-flowing portion of Cane Creek, just upstream of the Great Falls Reservoir. Eight specimens were collected there on two occasions in the spring of 1990. Sand and gravel substrates were present in this reach but were very limited. A collection made about 1 mile (0.6 km) upstream was unsuccessful due to the almost complete lack of preferred sand and gravel substrates. The remainder of the creek is dominated by cobble and small boulders. Perennial flow in the stream is limited to about the lower 4.0 creek miles (6.4 km). The bluemask darter is apparently restricted to less than the lower mile of Cane Creek and is extremely rare, but the fish may also occur in the reservoir fluctuation zone extending at least another 0.8 mile (1.3 km) downstream.

The bluemask darter was collected at two localities in the Caney Fork River in the lower 1.1 river miles (1.8 km) above the Great Falls Reservoir (Layman 1991b, Layman *et al.* 1993). Twelve specimens were collected in relatively high flow along the margin of the stream over cobble and sparse gravel at a site 1.6 air miles (2.6 km) east-southeast of Dodson, White County, during April 1991. On a return trip to the site in August 1991, Layman (1991b) found the channel was completely dry, with the exception of widely scattered pools with substrates of large round boulders. However, he found 14 bluemask darters over silty sand, detritus, and occasional small cobble in a large spring-fed isolated pool a short distance upstream of the site (water temperature 24° to 26°C [75° to 78°F]). Layman *et al.* (1993) surmised that large pools like this, which were widely scattered, and the 1.9-mile (3.0-km) reservoir fluctuation zone may be critical in sustaining this population through low flow periods. Because the perennial flow appears to be limited to the lower 1.1 river miles (1.8 km) or less and because summer hold-over pools are widely scattered, at best, this bluemask darter population must be extremely small and thus vulnerable to perturbations. This latter statement could also apply to the populations in Cane Creek and the Rocky River.

The bluemask darter's distribution has been reduced by such factors as impoundments; habitat alteration from gravel dredging; water withdrawal; and the general deterioration of water and substrate quality resulting from siltation and other pollutants contributed by gravel mining, poor land-use practices, water withdrawal, waste discharges, and coal mining (coal mining-related impacts do not occur in the Collins River). These factors continue to impact the species and its habitat. Also, the species' preferred habitat (sand and fine gravel substrates) is scarce in many inhabited reaches.

All four bluemask darter populations are vulnerable to streambed modifications occurring as a result of gravel-dredging operations in their upper reaches. Sand and gravel substrates have been removed, eliminating potentially suitable habitat for bluemask darters during higher flows, including spawning habitat. These reaches, while often dry

during the summer, may contain isolated spring-fed pools that are critical to the survival of bluemask darters during low flow periods. The destruction of hydrologic controls, creating summer hold-over pools, could dramatically reduce or eliminate bluemask darter populations.

Because the existing bluemask darter populations inhabit only short stream reaches, they are vulnerable to extirpation from stochastic events, such as accidental toxic chemical spills. The valley along the Collins River is used extensively for commercial plant nurseries; this increases the chances of a toxic agricultural chemical spill and the buildup of contaminants in the stream sediment that could impact this population. Additionally, all existing bluemask darter populations are now isolated by the Great Falls Reservoir. Because the Cane Creek and upper Caney Fork River populations are extremely small and the Great Falls Reservoir presumably restricts gene flow among populations, the long-term genetic viability of all the populations is questionable. Bluemask darter allozyme studies by Layman (1994), using the Collins River population and a mean sample size of 12.3 fish per locus, found 14.3 percent of the loci to be polymorphic and found an average of 1.1 alleles per locus. This genetic variability is relatively low compared to what Layman (1994) observed in 17 other populations of the species of *Doration*.

PART II

RECOVERY

A. Recovery Objectives

The ultimate goal of this recovery plan is to restore viable populations* of the bluemask darter (*Etheostoma (Doration)* sp.) within a significant portion of its historic range, eliminate threats to its continued existence, and remove it from the Federal List of Endangered and Threatened Wildlife and Plants.

*Viable population - A reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. The number of individuals needed and the amount and quality of habitat required to meet this criterion will be determined for the species as one of the recovery tasks.

Criteria for downlisting to threatened status:

The bluemask darter will be considered for reclassification to threatened status when the likelihood of its becoming extinct in the foreseeable future has been eliminated by achieving the following criteria:

1. Through protection and enhancement of the existing populations, the species continues to exist in four rivers and viable populations* exist in at least three of these rivers.

2. Studies of the fish's biological and ecological requirements have been completed and the implementation of management strategies developed from these studies have been successful in substantially increasing the number and/or range of the bluemask darter in three rivers or additional collections or reintroduction efforts extend the darter's present known range to a fifth river (e.g., Barren Fork or Mountain Creek).

3. No foreseeable threats exist that would likely impact the survival of the species over a significant portion of its range.

Criteria for removing the species from Endangered Species Act protection:

The bluemask darter will be considered for removal from Endangered Species Act protection when the likelihood of its becoming endangered in the foreseeable future has been eliminated by achieving the following criteria:

1. Through the protection and enhancement of existing populations and successful establishment of reintroduced populations or discovery of additional populations, five distinct viable populations exist.

2. Studies of the fish's biological and ecological requirements have been completed and the implementation of management strategies developed from these studies have been successful in substantially increasing the number and/or range of the

bluemask darter in four rivers (other than the Collins River) or additional collections or reintroduction efforts extend the species' present known range to a total of at least six rivers.

3. No foreseeable threats exist that would likely impact the survival of the species over a significant portion of its range.

Note: *It may not be possible to accomplish recovery for this species. The species was historically known from only five rivers. One of these populations is extirpated, and with the exception of the Collins River, where it is found over about 23 river miles (37 km), the populations are restricted to very short river reaches (less than 2.7 river miles [4.3 km]). Thus, unless other historic habitat can be located and repopulated, the Calfkiller River can be improved to the point where a population can be reestablished, or currently unknown populations are found, it will be difficult to protect and expand the existing populations to the point where recovery can be achieved.*

B. Narrative Outline

Note:: The bluemask darter coexists with the Cumberland pigtoe mussel throughout much of its range, and many of the recovery tasks identified in the Cumberland Pigtoe Mussel Recovery Plan (Service 1992) are also listed below for the bluemask darter. Thus, the recovery of both species is linked and should be conducted in concert.

1. **Preserve present population and presently used habitat.** Because only four populations exist, it is essential that they be protected.

   1.1 **Continue to use existing legislation and regulations (Federal Endangered Species Act, Federal and State surface mining laws, wetland and water quality regulations, stream alteration regulations, Federal Energy Regulatory Commission licensing, etc.) to protect the fish and its habitat.** Prior to and during implementation of this recovery plan, it is critical to the species' survival that Federal and State agencies continue to protect the four existing populations with those existing laws and regulations that address habitat protection and conservation.

   1.2 **Solicit help in protecting the species and its essential habitat through the development of cooperation and partnerships (local watershed projects) with Federal and State agencies, local governments, nurserymen, farming groups, coal mining interests, conservation organizations, and local landowners and individuals.** Section 7 consultation under the Endangered Species Act and Fish and Wildlife Coordination Act activities can assist in the protection of the species when Federal programs are involved, but implementation of these programs alone cannot recover the bluemask darter. The assistance of Federal and State agencies and local governments will be essential. However, more importantly, the support of the local farming community and mining interests, as well as local individuals and landowners, will be essential in order to meet these recovery goals. Without a partnership with the people who live and work in these watersheds and who have an influence on habitat quality, recovery efforts will be doomed.

      1.2.1 **Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support.**

      1.2.2 **Meet with farming, plant nursery, timber, and coal mining interests and try to elicit their support in implementing protective actions.** The support of these groups is essential. They should be informed of current Best Management Practices that could be implemented to minimize the impact of their activities on the fish, and they should be encouraged to promote safe mixing, application, storage, and disposal of pesticides and herbicides and to comply with current water withdrawal restrictions.

1.2.3 **Develop cooperative ventures with private landowners to restore riparian habitat through programs like Partners for Wildlife.** The Service, in cooperation with willing landowners, has begun to implement programs to restore riparian habitat, fence cattle from stream reaches, develop alternative water supplies for cattle, and control agricultural run-off in other streams in the Southeastern United States. These programs, which are designed to benefit both the landowner and the resource, should be pursued with willing landowners to help minimize soil erosion and enhance bluemask darter habitat.

1.2.4 **Develop an educational program using such items as slide/tape programs, brochures, etc.** Present this material to government entities, schools, farming groups, civic groups, youth groups, church organizations, etc. Educational material outlining the recovery goals, with emphasis on the other benefits of maintaining and upgrading habitat quality, will be extremely useful for informing the public of recovery actions.

1.3 Determine threats to the species, conduct research necessary for the species' management and recovery, and implement management where needed.

1.3.1 **Conduct life history research on the species to include such factors as reproduction, food habits, age and growth, and mortality.** Layman (1991b) and Layman *et al.* (1993) provide some information on the bluemask darter's life history. However, much additional life history information will be needed to implement recovery. Whenever possible, studies should be accomplished without sacrificing any bluemask darters. Whenever possible, this research should be conducted in the Collins River, where the population is large enough to sustain some sacrifice of specimens for laboratory study.

1.3.2 **Characterize the species' habitat (relevant physical, biological, and chemical components) for all life history stages.** The bluemask darter has been able to withstand some degree of habitat degradation. However, some of its habitat has been so severely altered that the species was extirpated from one stream, and other population segments are reduced in size and vigor. Knowledge of the species' specific microhabitat requirements and ecological associations are needed to focus management and recovery efforts on the specific problems within the species' habitat.

1.3.3 **Determine present and foreseeable threats to the species.** Siltation from some farming, gravel dredging, coal mining, and logging practices and toxic run-off from coal mining activities, and possibly from farming, may have contributed, and may continue to contribute, to substrate and water quality degradation. In addition, water level fluctuations in the Great Falls Reservoir and excessive water withdrawal from some stream reaches are adversely impacting the species. The mechanisms by which the species and its habitat are impacted by these factors are not entirely understood, and the extent to which the species

can withstand these impacts and utilize those river reaches that alternate between impounded and free-flowing conditions is not known. Also, we need to know more about the environmental factors that impact the species (such as water withdrawals and in-stream gravel dredging).

1.3.4 **Based on the biological data and threat analyses, investigate the need for management, including habitat improvement.** Implement management, if needed, to secure a viable population. Specific components of the species' habitat may be lacking, limiting the species' potential expansion (e.g., sand and gravel substrates), or certain activities in the watershed may be adversely impacting the species. Habitat improvement programs may be needed to increase spawning success. Structures may be needed to provide cover and summer pool habitat and to stabilize the stream bank and streambed. Cooperative projects with landowners to provide alternative water sources may be needed to help minimize the impacts of water withdrawal projects. Cooperative efforts with willing landowners will be needed to overcome some of the threats identified in Task 1.3.3.

1.3.5 **Determine the number of individuals required to maintain a long-term viable population.** Inbreeding depression can be a major obstacle to the recovery of the species, especially if the remaining population size is small and/or it has gone through some type of genetic bottleneck. The actual number of individuals in a population is not necessarily a good indication of a population's genetic viability; rather, the "effective population" size is important. The effective population size is the size of an "ideal" population in which genetic drift takes place at the same rate as in the actual population (Chambers 1983). Franklin (1980) suggested that the inbreeding coefficient should be limited to no more than 1 percent per generation, a figure which implies that the short-term, maintenance effective-population-size should be no fewer than 50 individuals (Frankel and Soulé 1981, Franklin 1980, Soulé 1980). Because the effective population size is typically only one-third to one-forth the actual population size (being affected by sex ratio, overlapping generations, generally nonrandom distribution of offspring, and nonrandom mating) (Soulé 1980), a population of 150 to 200 individuals is needed for short-term population maintenance. Soulé (1980) further suggests that for long-term viability, an effective population of 500 individuals is necessary, translating into a population size of 1,500 to 2,000 individuals. The effective population size of the bluemask darter population needs to be determined in order to calculate whether this population is capable of long-term self-maintenance or whether a breeding program should be initiated. Some of these factors can be addressed under Task 1.3.3, while others will be addressed as needed. Allozyme studies should also be considered in order to assess genetic variability in the remaining populations, particularly in Cane Creek and the upper Caney Fork River.

2. **Search for additional populations and/or habitat suitable for reintroduction efforts.** The Caney Fork River system has been surveyed recently (Layman *et al.* 1993, Layman 1991b). However, it is possible that some small bluemask darter populations were missed. Further study may reveal additional populations and suitable unoccupied habitat for transplants.

3. **Determine the feasibility of reestablishing the bluemask darter into historic habitat and reintroduce where feasible.** The exact historic range of the bluemask darter is unknown. However, based on historic collection records, the species has been taken from only five rivers/creeks (Layman *et al.* 1993, Layman 1991b). The species is extirpated from the Calfkiller River, and because of significant habitat deterioration (impoundments, siltation, and water quality degradation), it may not be possible to reintroduce the fish into this system. However, further study is needed to determine if water quality and physical habitat may now be suitable for reintroductions. Other streams may exist within the species' probable historic range that may be suitable for reintroduction (i.e., the Barrens Fork River or lower reaches of Charles Creek or Mountain Creek in the Collins River system). If such streams exist, they should be assessed to determine the likelihood that they might have been historic habitat and to determine their potential for reintroduction success. Based on this review and discussions with appropriate State, Federal, and local government entities and scientists familiar with the species and zoogeography, a determination should be made as to whether reintroduction efforts are appropriate. Also, the need to augment existing populations through introductions should be considered.

   3.1 **Develop successful techniques for reestablishing populations.** If it is determined that reintroduction is an appropriate management tool and sufficient stock of the bluemask darter is not available to allow for the removal of enough adults to reestablish populations or expand the species' range in existing habitat, consider developing artificial propagation techniques for the species.

   3.2 **If appropriate and necessary, reintroduce the species into its historic range and evaluate success.** Using the techniques developed in Task 3.1, reintroduce the bluemask darter into historic habitat and into other areas to help expand the range of existing populations. Monitor the progress of the transplants.

   3.3 **Implement the same protective measures for reintroduced populations as outlined for established population segments.**

4. **Develop and implement a program to monitor population levels and habitat conditions of currently existing population segments as well as any newly discovered, introduced, or expanded population segments.** During and after recovery actions are implemented, the status of the species and its habitat must be monitored to assess any progress toward recovery. This should be conducted on a biennial schedule.

5. **Annually assess the overall success of the recovery program and recommend action (changes in recovery objectives, delist, continue to protect, implement new measures, other studies, etc.).** The recovery plan must be evaluated periodically to determine if it is on track and to recommend future actions. As more is learned about the species, the recovery objectives may need to be modified.

C. Literature Cited

Chambers, S. M. 1983. Genetic principles for managers. Pp. 44-45. *In*: C. S. Schonewald-Cox, S. M. Chambers, B. MacBryde, and W. Thomas (eds.). 1983. Genetics and Conservation - A reference for managing wild animal and plant populations. The Benjamin/Cummings Publ. Co., Inc., New York, NY. 722 pp.

Etnier, D. A., and W. C. Starnes. 1993. The fishes of Tennessee. University of Tennessee Press, Knoxville, TN. 681 pp.

Frankel, O. H., and M. E. Soulé. 1981. Conservation and Evolution. Cambridge Univ. Press. England.

Franklin, R. I. 1980. Evolutionary change in small populations. Pp. 135-149. *In*: Conservation biology, an evolutionary-ecological perspective. Michael E. Soulé and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA. Pp. 135-149.

Howell, W. M. 1968. Taxonomy and distribution of the percid fish, *Etheostoma stigmaeum* (Jordan), with the validation and redescription of *Etheostoma davisoni* Hay. Unpubl. Ph.D. dissertation, University of Alabama, Tuscaloosa. 113 pp.

Layman, S. R. 1994. Phylogenetic systematics and biogeography of the subgenus *Doration* (Percidae: *Etheostoma*). Unpubl. Ph.D. dissertation, University of Alabama, Tuscaloosa. 299 pp.

------. 1991a. The bluemask darter, *Etheostoma* (*Doration*) sp., a new species from the Caney Fork River system, Tennessee. Unpubl. abstract, 71st Annual Meeting, American Society of Ichthyologists and Herpetologists, New York.

------. 1991b. Status survey for the dirty darter (*Etheostoma olivaceum*) and the jewel darter (*Etheostoma* (*Doration*) sp.) in the Caney Fork and Cumberland Rivers, Tennessee. Final report submitted to the U.S. Fish and Wildlife Service, Asheville, NC. 35 pp.

Layman, S. R., A. M. Simons, and R. M. Wood. 1993. Status of the dirty darter (*Etheostoma olivaceum*) and bluemask darter (*Etheostoma* (*Doration*) sp.) with notes on the fishes of the Caney Fork River system, Tennessee. J. Tenn. Acad. of Sci. 68(2):65-70.

Soulé, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Ch. 8, pp. 151-169. *In*: Conservation biology, an evolutionary perspective. Michael E. Soulé and Bruce A. Wilcox (eds.). Published by Sinauer Assoc., Inc., Sunderland, MA.

Starnes, W. C., and D. A. Etnier. 1986. Drainage evolution and fish biogeography of the Tennessee and Cumberland River drainage realms, pp. 325-361. *In*: C. H. Hocutt and E. O. Wiley (eds.). The zoogeography of North American freshwater fishes. John Wiley and Sons, New York, NY.

------. 1980. Fishes, pp. B1-B134. *In*: D. C. Eager and R. M. Hatcher (eds.). Tennessee's rare wildlife, Volume I: the vertebrates. Tennessee Wildlife Resources Agency and Tennessee Heritage Program, Nashville, TN.

U.S. Fish and Wildlife Service. 1993. Endangered and threatened Wildlife and Plants; determination of the bluemask darter (*Etheostoma* (*Doration*) sp.) to be an endangered species. *Federal Register* 58(58):68480-68486.

------. 1992. Cumberland Pigtoe Mussel Recovery Plan. Atlanta, GA. 20 pp.

Winn, H. E. 1958. Observations on the reproductive habits of darters (Pisces-Percidae). Amer. Midl. Nat. 59:190-212.

PART III

IMPLEMENTATION SCHEDULE

Priorities in column 1 of the following Implementation Schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. Priority 2 - An action that must be taken to prevent a significant decline in species population and habitat quality or some other significant negative impact short of extinction.

3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

ES - Ecological Services Division, U.S. Fish and Wildlife Service.
FA - Other Federal Agencies - Includes the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, and U.S. Natural Resources Conservation Service.
FWS - U.S. Fish and Wildlife Service.
LE - Law Enforcement Division, U.S. Fish and Wildlife Service.
R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service.
SCA - State Conservation Agencies - Includes the Tennessee Wildlife Resources Agency and the Tennessee Department of Environment and Conservation.
TNC - The Nature Conservancy

BLUEMASK DARTER IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates ($000s)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.1	Continue to utilize existing legislation and regulations to protect species and its habitat.	Continuous	R4/ES and LE	FA, SCA	5.0	5.0	5.0	
1	1.2.1, 1.2.2	Solicit help in the protection and conservation of the species and its habitat.	Continuous	R4/ES	FA, SCA, TNC	5.0	5.0	5.0	
1	1.2.3	Develop programs like "Partners for Wildlife" with willing landowners to protect and improve habitat quality.	3 years	R4/ES	FA, SCA, TNC	20.0	20.0	20.0	
1	1.2.4	Develop information and education program and present.	1 year (then continuous)	R4/ES	FA, SCA, TNC	15.0	5.0	5.0	
1	1.3.1, 1.3.2, 1.3.3	Conduct research necessary for species' management and recovery; i.e., habitat requirements, biology, and threat analysis.	3 years	R4/ES	FA, SCA, TNC	20.0	20.0	20.0	
1	1.3.4	Based on biological and threat analyses, investigate need for management and implement where needed.	3 years	R4/ES	FA, SCA, TNC	5.0	5.0	5.0	

BLUEMASK DARTER IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates ($000s)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.3.5	Determine number of individuals required to maintain viable population.	1 year	R4/ES	FA, SCA, TNC	---	---	20.0	
2	2	Search for additional populations and suitable habitat.	1 year	R4/ES	FA, SCA, TNC	---	20.0	---	
2	3	Develop techniques, select sites, reintroduce the species back into historic habitat, and evaluate and protect any populations established.	3 years	R4/ES	FA, SCA, TNC	20.0	20.0	20.0	
2	4	Develop and implement a monitoring program.	Biennial	R4/ES	FA, SCA, TNC	2.0	---	2.0	
3	5	Annually assess recovery program and modify program and plan where required.	Continuous	R4/ES	FA, SCA, TNC	0.5	0.5	0.5	

PART IV

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