Bluemask Darter
(Etheostoma akatulo)

5-Year Review:
Summary and Evaluation

(USFWS photo: R. Biggins)

U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services Field Office
Cookeville, Tennessee

5-YEAR REVIEW

Bluemask Darter/*Etheostoma akatulo*

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied upon the best available information pertaining to historic and current distribution, life history, and habitat of this species. Our sources include the final rule listing this species under the Endangered Species Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by U.S. Fish and Wildlife Service (Service), State, Tennessee Valley Authority (TVA) and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. A *Federal Register* notice announcing the review and requesting information was published on July 6, 2009 (74 FR 31972). Comments received and suggestions from peer reviewers were evaluated and incorporated as appropriate (see Appendix A). No part of this review was contracted to an outside party. This review was completed by the Service's lead Recovery Biologist in the Cookeville Field Office, Tennessee. This fish, at the time of listing and its recovery plan, was recognized as bluemask (=jewel) darter (*Etheostoma (Doration*) sp.). Since that time, it has been more formally described and accepted as *Etheostoma akatulo* and in this review the Service is recognizing this established name (see the taxonomy section C.1.c. for further detail).

B. Reviewers

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

Lead Field Office – Cookeville, Tennessee, Ecological Services Field Office, Todd Shaw, 931-528-6481

C. Background

1. Federal Register Notice citation announcing initiation of this review: July 6, 2009, 74 FR 31972.

2. Species status: Stable. There is no information on new or increasing threats. Collections since 1990 indicate that "isolated populations" of bluemask darters currently exist within approximately 1 mile of Cane Creek (Van Buren County), 23 miles of the Collins River (Warren and Grundy counties), 3.5 miles of the Rocky River (Van Buren County), approximately 1 mile of lower Laurel Creek, a tributary to the Rocky River (Van Buren County), and approximately 1.8 miles of the upper Caney Fork River (White County). Bluemask darters occurring within Laurel Creek are considered part of the Rocky River population which utilize habitat in lower Laurel Creek during certain flow conditions. The

TVA initiated a program to monitor the species in 2008, which provides a baseline for measuring future trends. TVA has confirmed species presence at locations in the Collins, upper Caney Fork, and Rocky Rivers, as well as Cane Creek. Historically, the bluemask darter was also collected in the Calfkiller River (White County), but is now believed to be extirpated from that system. Based on recent survey data collected by TVA, the overall status of the bluemask darter appears to have remained stable. However, there is some concern that the Caney Fork River population may be decreasing due to low numbers of individuals found during 2011 and 2012 surveys at sites where the species had been previously encountered (14 individuals were collected during a 2011 survey, and three were collected during a 2012 survey); additional surveys are necessary to determine whether the Caney Fork River population is actually in decline.

3. Recovery achieved: 1 (1=0-25% species recovery objectives achieved)

4. Listing history:

Original Listing

FR notice:	58 FR 68480
Date listed:	December 27, 1993
Entity listed:	species
Classification:	endangered

5. Associated rulemakings: Not applicable

6. Review History: Recovery Data Call: 2013, 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, and 1998

Final Recovery Plan: July 25, 1997

7. Species' Recovery Priority Number at start of review (48 FR 43098): 5 (low recovery potential; if historic habitat [Calfkiller River] cannot be repopulated and a new population reestablished, it will be difficult to achieve existing recovery criteria)

8. Recovery Plan

Name of Plan: Recovery Plan for the Bluemask (=Jewel) Darter (Etheostoma (Doration) sp.)
Date issued: July 25, 1997

II. REVIEW ANALYSIS

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

1. **Is the species under review listed as a DPS?** No

2. **Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No

B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes

2. **Adequacy of recovery criteria.**

   a. **Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?** No

   b. **Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?** Yes

3. **List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information**.

   While the species' recovery plan includes criteria for both downlisting and delisting, the recovery objective stated in the Executive Summary is downlisting to threatened status, rather than eventual delisting. The reason given is that 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.

   Reclassification of bluemask darter to threatened status would be considered 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.**

      *At the time the recovery plan was written, the bluemask darter was known to occur in four systems, including the Caney Fork River, Cane Creek, the Rocky River and the Collins River. The species is still present in these four systems. However, a recent population structure and genetic diversity study determined that three genetically distinct populations occur in these four systems (Robinson et al. 2012); because no genetic differention was

detected between the Caney Fork River population and Cane Creek (a Caney Fork River tributary), they were determined to be a single population.

** 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 of quality habitat required to meet this criterion will be determined for the species as one of the recovery tasks.

This criterion has not been met. Since 1990, bluemask darters have been collected or observed in three streams or rivers, including the Caney Fork River/Cane Creek (one population), Rocky River/Laurel Creek (considered one population) and Collins River. According to Robinson et al. (2012), bluemask darters in these three systems appear to represent the only three genetically distinct populations. Each of these populations has relatively little genetic diversity, overall. Genetic diversity is greatest in samples collected from the Collins River, which supports the largest population of bluemask darters. We believe that the Collins River represents a viable population but do not have data sufficient to establish that the others are viable. Refer to section II.C.1.a. and II.C.1.d.for further discussion on population status and spatial distribution.

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).

*At the time the recovery plan was written, the bluemask darter was known to occur in four systems, including the Caney Fork River, Cane Creek, the Rocky River and the Collins River. The species is still present in these four systems. However, a recent population structure and genetic diversity study determined that three genetically distinct populations occur in these four systems (Robinson et al. 2012); because no genetic differention was detected between the Caney Fork River population and Cane Creek (a Caney Fork River tributary), they were determined to be a single population.

This criterion has been partially met. Simmons et al. (2008) studied age-class structure and variability of the Rocky River and Collins River populations of the bluemask darter from 2001 through 2003. Simmons and Layzer (2004) studied spawning behavior and spawning microhabitat in the Collins River bluemask darter population in 2002. Layzer and Brady (2003) studied bluemask darter microhabitat usage from June through September 2000. Refer to section II.C.1.a. and II.C.1.e. for further discussion on species biology and habitat. The number and/or range of bluemask darters have not been substantially increased in three rivers, nor has the species' present known range been extended to another river drainage.

Management strategies are being developed via an adaptive management process, which was established as a result of a section 7 consultation between the Service and TVA. This process will outline the ecological needs of the species; specify biological goals and objectives for the species; identify metrics to monitor progress toward specified goals, the sampling designs for measuring those metrics, and the period over which monitoring will be conducted; and describe the management strategies to achieve the desired biological goals and objectives.

We have developed a conservation strategy for the bluemask darter and update and modify it as needed. The Service completed a population structure and genetic diversity study. The Service, TVA and CFI are currently developing a bluemask darter translocation and propagation plan to reintroduce the species into the Calfkiller River; this document should be completed by January 2014. Tennessee Tech. University – USGS Cooperative Fisheries Unit, is currently coordinating with TVA to determine bluemask darter population dynamics and modeling needs. Mark/recapture, intensive sampling or a coarser approach determining utilization based upon recruitment rates could be tools used to assess population dynamics. Modeling could involve examining persistence rates, recruitment rates and dispersal. Conservation Fisheries, Inc. has currently agreed to move forward with conducting a tag retention study prior to any mark/recapture work in the field. One of the challenges is whether small enough tags are currently available to determine individual dispersal. TVA is also determining inundation of bluemask darter spawning habitat in the Caney Fork River/Cane Creek, resulting from Great Falls Reservoir, and attempting to determine what extent inundation has impacted suitable bluemask darter spawning habitat in those systems. This work began in 2013 and shall continue into 2014. TVA will determine whether modifications can be implemented at

Great Falls Dams to alleviate inundation effects based on the data being collected.

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

This criterion has not been met. Refer to section II.C.2. for further discussion on threats to this species.

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.

This criterion has not been met.

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.

This criterion has not been met.

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

This criterion has not been met.

C. Updated Information and Current Species Status

1. Biology and Habitat

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

Historic and current records indicate that the bluemask darter is endemic to the Caney Fork River drainage in central Tennessee. Historically, individuals have been collected from the Caney Fork River, Collins River, Rocky River, Calfkiller River, and Cane Creek in Grundy, Warren, Van Buren, and White counties. Collections since 1990 from the following areas indicate that bluemask darters currently exist as three genetically isolated populations: (1) approximately 1.8 miles of the upper Caney Fork River (White County) and 1 mile of Cane Creek (Van Buren County), (2) approximately 23 miles of the Collins River (Warren and Grundy counties), and (3) approximately 3.5 miles of the Rocky River and 1 mile of lower Laurel Creek (Van Buren County) (Layman et al. 1993; Simmons 2003; Simmons 2004; Tennessee Valley Authority 2009; J. W. Simmons, pers. comm. 2009; Robinson et al. 2012). Bluemask darters have been consistently collected in all of these stream reaches. As might be expected, the total number of individuals collected in these reaches since 1990 is somewhat proportional with the length of stream occupied, ranging from 57 and 74 (Laurel Creek and Cane Creek, respectively) to 1,459 and 3,499 (Rocky River and Collins River, respectively).

Simmons (2004) observed no bluemask darter during surveys of two reaches of the Calfkiller River for bluemask darters, a 2.9 mile reach downstream of Sparta and a reach upstream of Sparta. In 2009, TVA searched for bluemask darters in the Calfkiller River (lower 5.3 miles and river miles 21.1-34.5); no bluemask darters were observed within any of the reaches surveyed. TVA conducted fish Index Biological Integrity (IBI) surveys of lower and upper reaches of the Calfkiller River during spring of 2010 (Tennessee Valley Authority 2011). No bluemask darters were collected during these surveys. Bluemask darters have not been collected from the Calfkiller River drainage since 1968. The species is considered to be extirpated from this system.

Although long term monitoring data are not yet available to establish trends, the status of the species is considered to be stable. TVA conducted surveys to evaluate recruitment, age-class structure and overall status of the individual populations of the bluemask darter on the Caney Fork River/Cane Creek, Collins River, and Rocky River/Laurel Creek during 2008 (Tennessee Valley Authority 2009) and on the Caney Fork River in 2009 and 2012 (Tennessee Valley Authority 2010; J.W. Simmons, pers. comm. 2013a), and a general fish community IBI survey on the Collins River in 2010 (Tennessee Valley Authority 2011). The Service and TVA conducted surveys on the Caney Fork River/Cane Creek, Collins River and Rocky River in 2011 to obtain tissue from bluemask darters to describe population genetic diversity, structure and demographic history of the bluemask darter (Tennessee Valley Authority 2012; Robinson et al. 2012). The majority of sites recently surveyed were areas previously sampled by Simmons (2004). These established monitoring stations will

continue to be surveyed and data evaluated annually by TVA to determine if there are changes in population trends and total abundance.

No bluemask darters were found in lower Laurel Creek, a tributary to the Rocky River, during the April 24, 2008 survey; individuals had previously been collected in this stream reach during May and June 2002. However, the areas sampled had been impounded several days prior to the 2008 survey and substrate was covered with silt and fines. Habitat conditions during the 2002 survey period were much better. This area has not been resurveyed since 2008.

Two new sites on the Caney Fork River, supporting bluemask darters, were discovered when conducting the 2009 survey, however, these occurrences were within reaches previously identified within the recovery plan. Although no individuals were collected in the lower or upper reaches of the Calfkiller River in 2004, 2009 and 2010, suitable habitat for the bluemask darter was identified during surveys of the upper Calfkiller River in 2009. Low numbers of individuals found in the Caney Fork River in 2011 and 2012 surveys (14 individuals in 2011 and three in 2012), indicate that this population may be decreasing; however, subsequent surveys will assist in determining if the Caney Fork River population is in decline or if apparent reductions in the population are natural fluctuations.

Simmons et al. (2008) studied age-class structure and variability of the Rocky River and Collins River populations of the bluemask darter. They identified four age classes of bluemask darters with the species generally reaching at least 39 months of age and few, if any, individuals living until age four. Growth of bluemask darters was greatest during their first year of life. Growth rates differed significantly between males and females. Males were typically larger than females of the same age after the first growing season, and the majority of older fish were age-three males. However, females comprised a greater proportion of both populations than did males.

Simmons and Layzer (2004) studied bluemask darter spawning behavior and spawning microhabitat in the Collins River in 2002. They discovered that bluemask darters typically inhabit pools with clean sandy substrates during the majority of the year. During the spawning season, adult males occur in shallow runs at the head of riffles over substrate dominated by gravel. Spawning females move into this swift water to spawn and then move back to pool areas after spawning events. During 2002, bluemask darters were observed spawning from May 29 to July 1 at water temperatures of 16° to 23° C (61° to 73° F). Simmons (2004) found that some bluemask darters are sexually mature at one year of age, but most spawning adult bluemask darters are older individuals. Eggs are deposited

and buried in pockets of sand. Newly hatched larvae are pelagic, becoming demersal as they reach approximately one half of an inch in length.

Simmons and Layzer (2004) found that spawning microhabitat differed among lone females, lone males, and spawning pairs (Table 1).

Table 1. Mean (+/- SE) use of microhabitat variables by bluemask darters in Collins River [taken from Simmons and Layzer (2004)].

	Water depth (cm)	*Bottom velocity (cm/s)*	*Water column velocity (cm/s)*
Spawning pairs (63)	21.4 ±0.4	18.9±0.4	28.9±0.5
Lone males (45)	24.3±0.9	16.0±1.0	23.1±1.3
Lone females (37)	28.1±1.0	8.7±1.1	13.9±1.6

Spawning pairs and lone males used areas with greater velocity and shallower depths than lone females; spawning pairs and lone males used areas with substrates dominated by gravel/pebble while lone females were typically found over sand-dominated substrate. Spawning pairs used a narrower range of depths and velocities, compared to those available. Lone males used a wider range of microhabitats than spawning pairs, but used habitats at shallower depths and with swifter velocities than lone females. Lone females used the full range of water velocities observed, but tended to inhabit deeper-than-average areas.

Layzer and Brady (2003) studied bluemask darter microhabitat usage in 2000. They found 94% of bluemask darters observed in the Caney Fork River, Collins River and Cane Creek were using habitats with a mean water column velocity < 5 cm/s (0.16 ft/s) and 99 % were using habitats with near bottom velocity < 5cm/s (0.16 ft/s). They estimated that 93% of fish were found over sand-dominated substrate, with 63 % observed over all-sand substrate. They further found that 83% were found at depths ranging from 36 to 72 cm (14.2-28.3 in), though snorkeling visibility limited effective sampling to depth of approximately 90 cm (35 in). Using SCUBA gear, they found one bluemask darter at a depth of 170 cm (67 in) in a pool of approximately 183 cm (72.5 in) in depth.

The bluemask darter appears to generally feed on the larvae of aquatic insects and other small aquatic invertebrates (Service 1997; Etnier and Starnes 1993). J. W. Simmons, pers. comm. 2012, indicated that from field observations he believes they feed on chironomid larvae present in sand substrate, similar to O'Neil's (1980) determination that the diet of the

closely related speckled darter (*Etheostoma stigmaeum*) was dominated by chironomid larvae.

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

It was initially thought that impoundment of the Caney Fork River by Great Falls Dam in the early 1900s may have effectively isolated the four remaining known populations of the bluemask darter. However, results from a recent population structure and genetic diversity study (Robinson et al. 2012) suggest that lack of diversity in this species is not because of the construction of Great Falls Dam, but most likely due to historically small effective population sizes.

Smith (2005) studied the population genetics of bluemask darters using microsatellites to determine the level of gene flow among these seemingly isolated populations and determine the amount of inbreeding within populations. Microsatellite DNA was collected from a total of 129 fish in the Collins (40), Rocky (40), and Caney Fork (40) rivers and Cane Creek (9) and successfully amplified for three microsatellite loci. Within population heterozygosity appeared to be low for all populations, based on multiple analyses. All populations indicated some level of subpopulation (i.e., drainage) isolation; however, statistical tests for examining how genetic structure is partitioned among individuals and subpopulations with respect to total genetic variation indicated greater influence from inbreeding within subpopulations than due to isolation among them.

Smith (2005) acknowledged that limited geographic scope of sampling could have influenced observed low levels of heterozygosity, if populations were locally fragmented/isolated within a stream. Such fine-scale population structure would be consistent with results reported from a study on microendemism in Eastern Highland Rim endemic barcheek darters (*Percidae Etheostomatinae*) (Hollingsworth Jr. and Near 2008). This could be due largely to natural processes if gene flow has been restricted by limited dispersal of adults.

Genetic analyses by Smith (2005) revealed little genic or genotypic differentiation between bluemask darters in the Caney Fork River and Cane Creek; results from that study indicated that Cane Creek fishes could be migrants from the Caney Fork River population, and that a separate population might not exist in Cane Creek. Robinson et al. (2012) confirmed that Cane Creek occupants are part of the Caney Fork River population via Bayesian population assignment and pairwise population differentiation measures; both measures identified a lack of differentiation between bluemask darter populations inhabiting Cane Creek and the Caney Fork River. This observation reduces the number of distinct breeding populations of this species from four (Cane Creek and Caney

Fork River, Collins River and Rocky River) to three (Caney Fork River, Collins River and Rocky River). They further determined that none of these populations had high levels of genetic diversity and that lack of diversity in this species is most likely due to historically small effective population sizes, rather than a recent population bottleneck or a historic population decline and recommended that future conservation efforts should seek to maximize available habitat while simultaneously limiting the influences of anthropogenic stressors in the system.

Robinson et al. (2012) determined population structure and genetic diversity in the bluemask darter. They sampled bluemask darters in the Caney Fork, Collins and Rocky rivers and Cane Creek. Population genetic diversity and structure were assessed at ten microsatellite loci. All populations exhibited low levels of genetic variation, with expected heterozygosity ranging from 0.2 to 0.35. As expected, genetic divergence among the sampled tributaries was substantial. However, in contrast to previous studies on darters (Krabbenhoft et al. 2008), they found no evidence of structure within individual tributaries. This assessment produced three clear groups, corresponding to the Collins River, Caney Fork River/Cane Creek, and the Rocky River. These results together suggest that the populations inhabiting the Caney Fork River and Cane Creek are not genetically distinct. These two drainages are geographically proximate and the populations inhabiting both are found in the lower reaches of the tributaries, near the backwaters of Great Falls Reservoir. The lack of genetic differentiation between these areas raises the possibility that migrants are exchanged between populations inhabiting separate tributaries. Their analysis supports this suggestion; several individuals sampled in the Lower Caney Fork show large genetic contributions from the Rocky River and vice versa.

c. Taxonomic classification or changes in nomenclature:

Layman and Mayden (2009) described the bluemask darter, a species of the darter subgenus *Doration* (Percidae:*Etheostoma*) endemic to the upper Caney Fork River system and gave it the name *Etheostoma akatulo*. The epithet *akatulo* is derived from the Cherokee word for mask (King 1975). The species was recognized as bluemask (= jewel) darter (*Etheostoma (Doration*) sp.), but had not been formally described, at the time of listing and at the time the Recovery Plan was written in 1997. The Service is recognizing the use of this accepted name in this review, but would have to release a more formal notice to be able to reflect this change under 50 CFR 17.11.

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

With the exception of Laurel Creek, which is considered part of the Rocky River population, no additional occurrences of the bluemask darter have been discovered since the recovery plan was written. All other individuals have been collected within reaches previously identified in the recovery plan in the upper Caney Fork River, Collins River, Rocky River, and Cane Creek since 1990.

According to J. W. Simmons, pers. comm. 2009, the question of dispersal is of particular interest in bluemask darters because of the presumed fragmentation of habitats caused by the impoundment of the Upper Caney Fork and its tributary streams to create Great Falls Reservoir. Several individuals sampled in the lower Caney Fork have shown large genetic contributions from the Rocky River and the reverse, individuals found in the Rocky River population have shown genetic contributions from the lower Caney Fork population, indicating that migrants are exchanged between populations inhabiting separate tributaries (Robinson et al. 2012).

e. Habitat:

In 2005, TVA initiated formal consultation with the Service regarding routine operation and maintenance of TVA's water control structures. The Service concluded in 2006 that the bluemask darter may "likely be adversely affected" by the operations of Great Falls Dam, the uppermost dam on the Caney Fork, due to its effects on stream reaches within the current known range of the species. One result of this consultation was that TVA agreed to not only monitor population levels, but also habitat conditions of existing bluemask darter population segments. Such efforts would incorporate any newly discovered, introduced, or expanded population segments.

In addition, TVA agreed to examine the feasibility of reestablishing the bluemask darter into its historic habitat. This involves determining whether suitable habitat conditions exist in the Calfkiller River to support an introduced population of bluemask darters, examining the potential removal or modification of passage impediments (lowhead dams) to expand natural dispersal for an introduced population, and conducting water quality and fish IBI sampling to assist in determining why this species no longer occurs in the Calfkiller River.

In 2009, TVA searched for suitable habitat to allow for potential reintroduction of bluemask darters into the Calfkiller River. TVA assessed the lower portion of the Calfkiller River (approximately 5.3 miles) from the mouth of the river upstream to the County House Road Bridge (White County Road 575) for suitable bluemask darter habitat. No suitable habitat was identified within this stream reach. TVA also evaluated potential habitat from England Cove Road (near the

White/Putnam County line at approximately River Mile [RM] 34.5), downstream to the upper end of an old mill dam impoundment at approximately RM 21.1 on the upper Calfkiller River. They discovered that suitable physical habitat exists throughout many reaches in the upper Calfkiller River.

Simmons (2004) found abundant suitable habitat (both spawning and summer) in a reach of the Calfkiller River, upstream of Sparta. He also sampled a reach downstream of Sparta, approximately 4.7-km (2.9 miles) in length, between Hwy 70 South and the confluence with the Caney Fork River, within the Great Falls Reservoir fluctuation zone. He focused on areas where habitat consisted of large sandbars and sandy margins and determined that the area was similar to the fluctuation zone in the Rocky River. He recommended that reintroduction efforts on the upper Calfkiller River should be considered as a recovery strategy.

Layman (1991) considered the Calfkiller River as a potential site for reintroduction of bluemask darters based on good water quality. He specifically indicated the reach downstream of Tennessee Highway 111 in Sparta. This 6-mile reach ranges from 20-40 meters (approximately 65-130 ft) in width, and potentially suitable sand and gravel substrates are common, particularly in the vicinity of Demps Road Bridge.

Recent benthic surveys and water quality sampling in the Calfkiller River indicate that conditions are favorable for reintroduction of the bluemask darter into the river. TVA observed diverse benthic taxa at four stations on the Calfkiller River in 2010 (Tennessee Valley Authority 2011). According to Saylor (pers. comm. 2011), the presence of little black caddisflies (*Glossosomatidae* sp.), encountered during the 2010 TVA benthic surveys on the Calfkiller River, indicates pristine water quality conditions at least during spring months when benthic monitoring occurred because this family of insects generally will not tolerate anthropogenic effects. Saylor (pers. comm. 2011) further stated that their presence during spring months may indicate that the unknown stressor, which resulted in extirpation of the bluemask darter from the Calfkiller system, may be temporal, rather than constant (year-round) if it is still present or occurring. Chemical sampling conducted in the Calfkiller River has found water quality conditions to generally be good with the exception of slightly elevated nitrate- nitrite and total phosphorous levels downstream of the City of Sparta's Wastewater Treatment Facility (B. Chance, pers. comm. 2011). According to Saylor (pers. comm. 2011) and Tennessee Valley Authority (2011), TVA's 2010 general fish community IBI survey of the Calfkiller River confirmed extirpation of the bluemask darter from the Calfkiller River and determined that the sawfin shiner (undescribed *Notropis* sp.) and corrugated darter (previously known as the striped darter [*Etheostoma virgatum*]) appear to be missing or greatly

reduced in the Calfkiller River. Recent records of the corrugated darter from Mill Creek indicate that it persists in at least one tributary of the Calfkiller River (Mill Creek); however, its absence from the 2010 IBI samples is not understood and suggests that unknown adverse conditions may continue to prohibit its re-colonization of the Calfkiller River. Despite the presence of suitable habitat and favorable water quality and other ecosystem conditions, the absence of the sawfin shiner and corrugated darter in the Calfkiller River raise concerns that there could be possible implications regarding potential reintroduction of the bluemask darter into the Calfkiller drainage.

The Bluemask Darter Technical Working Group is an informal working group formed in 2012 in response to a Section 7 consultation between TVA and the Service regarding TVA's operation of Great Falls Dam that affects bluemask darter populations. The working group includes various types of relevant technical expertise, and includes representatives from the Service, TVA, Tennessee Wildlife Resources Agency (TWRA), Tennessee Department of Environment and Conservation (TDEC) and U.S. Geological Survey (USGS). The working group meets on a regular basis to discuss technical issues related to conservation and recovery of the bluemask darter. Based on input from this working group, the Service is currently developing a strategy to reintroduce the bluemask darter into the Calfkiller River as described under Recovery Measure 2 of the recovery plan.

2. Five-Factor Analysis

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

Operation of Great Falls Dam creates a barrier to movement of bluemask darters among the populations in the upper Caney Fork River, Cane Creek, Rocky River, and Collins River. It may also preclude movement of the fish into the Calfkiller River. Because the entire known range of the bluemask darter is being affected by operation of the dam and reservoir presence, this is considered the greatest threat to the continued existence and recovery of the species. Observation of individuals in the uppermost reach of the reservoir during winter drawdown indicates that the species may have a limited ability to adapt to habitat changes. The bluemask darter may continue to survive in these 3 reaches, but natural recovery is precluded by the presence of the reservoir; bluemask darters cannot move freely and establish additional populations in tributary streams such as the Calfkiller River.

Sedimentation from flow manipulations and impoundment effects is likely the second most significant threat to the bluemask darter. Substrates in

reaches inhabited by bluemask darters in reservoir fluctuation zones are commonly embedded by silt, deposited from flow fluctuations, due to ongoing dam operations. Bluemask darters appear to seek out and utilize areas comprised of predominantly clean, sandy substrate for spawning and utilize clean, sandy pools during a majority of the year (Simmons 2004). In an isolated instance, TVA biologists observed bluemask darters during a non-spawning period (October 2009) using areas covered with a layer of fine silt in the upper Caney Fork River. It was thought that these fish were using what habitat was available at that time, rather than their preferred clean sand substrate.

Sediment has been shown to abrade and/or suffocate bottom-dwelling algae and other organisms by clogging gills; reducing aquatic insect diversity and abundance; impairing fish feeding behavior by altering prey base and reducing visibility of prey; impairing reproduction due to burial of nests; and, ultimately, negatively impacting fish growth, survival and reproduction (Waters 1995). Wood and Armitage (1997) identified at least five impacts of sedimentation on fish, including (1) reduction of growth rate, disease tolerance, and gill function; (2) reduction of spawning habitat and egg, larvae, and juvenile development; (3) modification of migration patterns; (4) reduction of food availability through the blockage of primary production; and (5) reduction of foraging efficiency.

Some efforts have been undertaken for the purpose of reducing non-point sources of sediment in waters inhabited by bluemask darters. The Service's Tennessee Ecological Services Field Office has coordinated with private landowners to construct 19,500 feet of livestock exclusion fencing and four off-stream livestock water developments in the Rocky River drainage and 2,500 feet of livestock exclusion fencing and one off-stream livestock water development on the Calfkiller River under the Service's Partners for Fish and Wildlife Program. The TWRA is partnering with a private landowner on a bank stabilization project along several hundred feet of stream in the headwaters of the Collins River mainstem. These enhancements are expected to improve stream water quality and benefit the bluemask darter.

There is speculation that water quality impacts from the City of Monterey's Wastewater Treatment Plant (WWTP) may have contributed to the apparent eradication of bluemask darters from the Calfkiller River. The facility has been found in violation for nitrogen/nitrate totals in effluent (U.S. Environmental Protection Agency 2010) and for overflow on several occasions (Tennessee Department of Environment and Conservation 2010). Additional investigation will be required to determine if the facility has contributed to their absence of the bluemask darter in this system.

Additional potential and actual threats to the bluemask darter from Layman, Simons and Wood (1993), Simmons and Layzer (2004), Simmons (2004) include:

- pesticides, herbicides and fertilizers used by the plant nursery industry
- water withdrawals for irrigation of nurseries could reduce habitat or degrade water quality during low flows
- habitat alteration and destruction from gravel dredging; gravel dredging could increase siltation and water turbidity in downstream perennial reaches
- siltation and agricultural runoff in the Collins and Rocky Rivers
- acid drainage from historical coal mines in the Cumberland Plateau reaches of all four stream systems
- logging of upland areas resulting in decreased aquifer recharge, changes in the annual hydrograph, and overland runoff to streams
- water quality degradation and bank instability caused by livestock access, removal of riparian vegetation, and encroaching streamside development
- hydrologic alteration and habitat degradation in lower reaches of bluemask darter streams due to operation of Great Falls Reservoir.

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

Overutilization is not known to be a factor in the decline of this species.

c. Disease or predation:

Disease and predation are not known to be factors in the decline of this species.

d. Inadequacy of existing regulatory mechanisms:

The bluemask darter and its habitats are afforded limited protection from water quality degradation under the Clean Water Act of 1977 (33 U.S.C. 1251 et seq.) and the Tennessee Water Quality Control Act of 1977. These laws focus on point-source discharges, and many water quality problems for the bluemask darter are the result of non-point source discharges. Therefore, these laws and corresponding regulations have been partly inadequate to halt population declines and degradation of habitat for the bluemask darter.

In addition to the Federal listing, the bluemask darter is listed as Endangered by the State of Tennessee. Under the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974

(Tennessee Code Annotated §§70-8-101-112), "… it is unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife, or for any common or contract carrier knowingly to transport or receive for shipment nongame wildlife." Further, regulations included in the Tennessee Wildlife Resources Commission Proclamation 00-15 Endangered or Threatened Species state the following: except as provided for in Tennessee Code Annotated, Section 70-8-106 (d) and (e), it shall be unlawful for any person to take, harass, or destroy wildlife listed as threatened or endangered or otherwise to violate terms of Section 70-8-105 (c) or to destroy knowingly the habitat of such species without due consideration of alternatives for the welfare of the species listed in (1) of this proclamation, or (2) the United States list of Endangered fauna. Potential collectors of this species would be required to have a state collection permit.

Since listing, section 7 of the Act has required Federal agencies to consult with the Service when projects they fund, authorize, or carry out may affect the species. However, the lack of Federal authority over the many actions likely impacting bluemask darter habitat has become apparent. Many of the threats (including those identified at the time of listing, during recovery planning and since development of the Recovery Plan) involve activities that likely do not have a Federal nexus (such as water quality changes resulting from development, water withdrawals or indiscriminate logging) and, thus may not result in section 7 consultation. The take prohibitions of section 9 of the Act would apply to these types of activities and their effects on the bluemask darter.

Portions of the Caney Fork, Collins and Rocky rivers are listed as impaired by the State of Tennessee on the Final 303(d) List (Tennessee Department of Environment and Conservation 2008). Pollutants and causes identified on the list as occurring in these waterbodies include water chemistry imbalances (e.g., pH, low dissolved oxygen, iron, manganese and sulfates), siltation, and loss of riparian habitat and littoral vegetative cover. Pollutant sources on the list are identified as abandoned mining, industrial permitted runoff, stream and stream-side alterations, crop production, pasture grazing, unrestricted cattle access, highway/road/bridge construction, and upstream impoundment. State and Federal water quality laws have not been used to their full potential in preventing pollution from these various sources. Partnerships between agencies (Service, Natural Resources Conservation Service, USGS, TDEC Division of Community Assistance, TDEC Division of Water Supply, Tennessee Department of Agriculture), and landowners continue to be fostered in attempt to improve water quality conditions in these watersheds.

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

As indicated in the Recovery Plan (U.S. Fish and Wildlife Service 1997), existing bluemask darter populations inhabit only short stream reaches, rendering them vulnerable to extirpation from stochastic events, such as accidental toxic chemical spills. The Collins River Valley is used extensively for commercial plant nurseries, increasing the likelihood of a toxic agricultural chemical spill and contamination of stream substrate, which could impact that population of bluemask darters. Other sources of potential spills include accidents involving vehicles transporting chemicals over bridge crossings, or intentional releases into streams of chemicals used in agricultural or residential applications.

As also indicated in the Recovery Plan, all existing bluemask darter populations are isolated due to the presence of the Great Falls Reservoir. While Robinson et al. (2012) indicate the low genetic diversity exhibited by the species may not have been the result of the impoundment, it is presumed that the existence of the reservoir does somewhat restrict gene flow among all the populations. Thus, the long-term genetic viability of bluemask darter populations is questionable. Species that are restricted in range and population size are more likely to suffer loss of genetic diversity due to genetic drift, potentially increasing their susceptibility to inbreeding depression and decreasing their ability to adapt to environmental changes (Allendorf and Luikart 2007).

D. Synthesis

The bluemask darter was listed because of its restricted range and because a status survey conducted in 1990 and 1991 revealed that the species had been extirpated from one stream, the Calfkiller River, in which it historically occurred. Municipal wastewater effluent, construction of several small impoundments and associated sedimentation on the Calfkiller River may have contributed to the extirpation of the bluemask darter from that system. Impoundment of the Caney Fork River by Great Falls Dam may have effectively isolated the four remaining known populations.

The Recovery Plan (U.S. Fish and Wildlife Service 1997) contains a statement that recovery of the bluemask darter may not be possible because of its restricted historic and current range, and the short stream reaches from which it is currently known (with the exception of the Collins River). Since the recovery plan was written, no additional populations of the bluemask darter have been discovered in adjoining drainages. All individuals have been collected within the upper Caney Fork, Collins and Rocky rivers, and Laurel and Cane creeks since 1990. Unless new populations are discovered or habitat quality in the Calfkiller River is improved to the point at which the species can be reestablished, achieving existing recovery criteria will be problematic.

The entire known range of the bluemask darter continues to be affected by operation of Great Falls Dam and presence of the reservoir. Natural recovery will continue to be precluded due to recurring habitat alterations from impoundment and the presence of the reservoir. Bluemask darters will continue to be unable to migrate and establish additional populations in tributary streams such as the Calfkiller River. Sedimentation, various other water quality impacts and the potential for toxic chemical spills also remain threats to the bluemask darter.

Due to its limited distribution, inability to expand its existing range and continued threats, the bluemask darter continues to be in danger of extinction. Therefore, the status of the bluemask darter as endangered remains appropriate.

Assessment of habitat suitability in the Calfkiller River for potential bluemask darter reintroductions will continue. Evaluation of recent information pertaining to genetic diversity, structure and demographic history of the species (Robinson et al. 2012) will provide the basis for making decisions regarding a source population for reintroductions into the Calfkiller River (either transplants from an existing population and/or obtainment of individuals from an existing population for captive propagation). This evaluation will occur via an adaptive management process. Presently, much uncertainty exists regarding recovery of the species and the threat of extinction remains. Thus, the recovery priority number for the bluemask darter should remain 5, as the degree of threat remains high and the potential for recovery is low.

III. RESULTS

A. Recommended Classification:

__X__ No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Determine whether it is feasible to reestablish the bluemask darter into its historic habitat. Layman et al. (1993) and Simmons (2004) both reported observing habitats in reaches above and below the City of Sparta that they believed to be suitable for reintroducing bluemask darters. The extant fish fauna in the Calfkiller River includes all darter species found in similar habitats throughout the Upper Caney Fork system, with the exception of the bluemask darter and possibly the corrugated darter (*Etheostoma basilare*), which may also no longer be part of the fish community based on recent surveys (J. W. Simmons, pers. comm. 2008; J. W. Simmons, pers. comm. 2013b). A thorough assessment of the distribution and quality of habitats in the Calfkiller should be prepared and a geospatial database developed, providing location data, ranking possible introduction sites according to relative priority, and documenting threats observed within the watershed. Highest priority should be given to continuing to attempt locating suitable habitat

upstream of the City of Sparta, in order to minimize the potential for water quality threats originating upstream of any sites chosen for reintroduction.

- Investigate the potential for removal or notching of the following passage impediments on the Calfkiller River:
  - low-head dam located upstream of Hwy 70N that impounds the Calfkiller River downstream of the City of Sparta
  - check dam located in the vicinity of the City of Sparta's water intake
  - mill pond dam on the upper Calfkiller River

  Should attempts be made to establish a population in the Calfkiller River, removal of these dams would greatly improve potential for an introduced population to expand through natural dispersal processes.

- Identify the appropriate broodstock selection and management strategies for reintroductions into the Calfkiller River, should this recovery action be implemented

- Establish a captive propagation program, if it is determined that existing populations could not function as a source of individuals for reintroduction into the Calfkiller River. Prior to doing so, review existing population genetics data to determine whether they provide a sufficient basis for developing a broodstock management plan. If additional genetics studies are necessary, conduct them prior to initiating captive propagation efforts.

- Conduct life history studies in concert with any captive propagation efforts.

- Continue TVA's population and habitat monitoring. Evaluate data produced by this monitoring in conjunction with Simmons (2004) data from the monitoring stations to determine what level of change could be detected by these efforts. These efforts would incorporate any newly discovered, introduced or expanded population segments.

- Use existing state and federal regulations and develop partnerships (local watershed projects) with federal and state agencies, local governments, nurserymen, farming groups, coal mining interests, conservation organizations, and local landowners and individuals to protect the species and its essential habitat.

- Ensure that all collection data are represented by records in the databases maintained by TVA's Regional Natural Heritage Project and Tennessee Division of Natural Areas' – Natural Heritage program. These databases are used during environmental reviews to screen for the presence of threatened and endangered species, and it is critical that both programs are continually provided the most current data from studies, as well as from TVA's ongoing bluemask darter monitoring.

- Identify important non-point sources of sediment in the drainages occupied by bluemask darters to prioritize areas for working with private landowners to reduce such threats. Additionally, identify major landowners in the drainages occupied by bluemask darters

who should be targeted for cooperative conservation efforts to prevent future risk of erosion and sedimentation associated with anticipated land uses.

- Conduct water quality studies in the Calfkiller River and compare results to similar sampling results, obtained where known bluemask darter populations occur in the Collins River, to assist in determining why bluemask darters no longer occur in the Calfkiller. Continue to conduct fish IBI sampling in conjunction with water quality monitoring.

- Engage the City of Crossville in developing water supply alternatives that would meet projected future water needs for this community without requiring any new impoundments in the Upper Caney Fork system.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Etheostoma akatulo*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

X No change is needed

Review Conducted By: Ross Shaw, Tennessee Ecological Services Field Office

FIELD OFFICE APPROVAL:

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

Approve: Mary E Jennings Date: 12-20-13

REGIONAL OFFICE APPROVAL:

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

Approve: Date: 12-27-13

APPENDIX A: Summary of peer review for the 5-year review of the **Bluemask darter (*Etheostoma akatulo*)**

A. Peer Review Method:

An e-mail was sent to Jeff W. Simmons with Tennessee Valley Authority, Dr. Jim B. Layzer, with Tennessee Tech University, and Dr. Steven R. Layman, with Geosyntec consulting firm (formerly with CH2M Hill), on June 24, 2010, requesting their assistance in providing a peer review of the draft bluemask darter 5-year Review.

B. Peer Review Charge:

The following instructions and other information were included in the June 24. 2010 e-mail sent to peer reviewers:

The U.S. Fish and Wildlife Service (Service) is conducting a 5-year review of the appropriateness of the current listing of the bluemask darter (*Etheostoma akatuloe*) as an endangered species under provisions of the Endangered Species Act of 1973, as amended (Act). On July 6, 2009, we published a notice in the *Federal Register* announcing our intent to conduct this review on this species for which our office has the lead responsibility under section 4(c)(2)(A) of the Act. At that time, we requested any new information on the bluemask darter since the time of its listing in 1993. In order to support the Service's interest in making its decision based on the best available science, portions of the draft review need to be subjected to an appropriate level of peer review. Due to your expertise regarding this species, we request that you peer review the attached portion of the document. We must receive your review comments within 30 days of the date of this email (July 24) in order to consider them in our final review document.

The goals of peer review during this process are (1) to ensure that the best available biological data, scientifically accurate analyses of those data, and the reviews of recognized experts are used in the decision-making process; and (2) to indicate to the public, to other agencies, to conservation organizations, and to personnel with the Service that the best available data and scientific analyses were used in the decision making process.

The following materials are enclosed for use during your review:

Peer Review in Endangered Species Act Activities: This July1, 1994, *Federal Register* notice established a peer review process for all listing and recovery actions taken under the authorities of the Endangered Species Act.

The Biological Portion of the draft 5-year review – This is the draft material that we would like you to review.

The Literature cited section of the draft 5-year review – The list is enclosed.

We appreciate your assistance in ensuring that this review is based on the best available science. If you have any questions or if we can provide additional information, please contact Todd Shaw by telephone at 931/528-6481, ext. 215, or via email at ross_shaw@fws.gov.

C. Summary of Peer Review Comments/Report:

Dr. Layzer asked that we replace the citation, "Layzer, J.B. and T.R. Brady. 2002. Summer microhabitat of the bluemask darter *Etheostoma* (*Doration*) sp. Final report submitted to the U.S. Fish and Wildlife Service, Cookeville, Tennessee. 10 pp." with the following updated citation, "Layzer, J. B. and T. R. Brady. 2003. Summer microhabitat of the endangered bluemask darter *Etheostoma* (*Doration*) sp. Journal of the Tennessee Academy of Science 78:55-57".

Jeff Simmons requested that we indicate "Caney Fork", rather than "upper Caney Fork" in regards to historical collections under C. Updated Information and Current Species Status, 1. Biology and Habitat, a. Abundance, population trends, demographic features, or demographic trends on page 7. He also requested that we insert, "in reservoir fluctuation zones" in the second sentence of the second paragraph and "utilize clean, sandy pools during a majority of the year" in the third sentence of the second paragraph under 2. Five-Factor Analysis, a. Present or threatened destruction, modification or curtailment of its habitat or range, on page 15.

Jeff also provided the following comments:

(1) Cane Creek may not have a self-sustaining population because there probably is limited reproduction in Cane Creek, and the main issue with Cane Creek is that bluemask darter habitat is very limited.
(2) Even if bluemask darters could recolonize the lower reaches of the Calfkiller River, the mill dam below Sparta would be a barrier to upstream dispersal.
(3) The corrugated darter (*Etheostoma basilare*) is also very rare in the Calfkiller River. Its current distribution is much smaller in the Calfkiller than were recorded by museum records. It currently is isolated to Mill Creek in the mainstem Calfkiller. I did document this species in the mainstem Calfkiller near the White/Putnam county line in 2001; it has since been extripated from this reach.

No comments were received from Dr. Steven R. Layman.

D. Response to Peer Review:

We have incorporated Dr. Layzer and Jeff Simmons suggested comments throughout the review, with the exception of Jeff's comments regarding: (1) Cane Creek not having a self-sustaining population because a genetics study has been completed since he provided the comment, and it was determined that the Caney Fork River/Cane Creek are actually a single population; we have rewritten parts of the review to reflect this, and (2) the mill dam on the Calfkiller River downstream of Sparta being a barrier to upstream dispersal because while we recognize the Mill Dam is a passage impediment, his comment was in response to a more general statement in the review regarding overall indinuation of tributary streams; over 4 miles of the lower Calfkiller (downstream of the Mill Dam) are in the Great Falls Reservoir fluctuation zone, so there is really no point in including the comment.