Blue Shiner (*Cyprinella caerulea*)
5-Year Review:
Summary and Evaluation

Blue Shiner © Outdoor Alabama

U.S. Fish and Wildlife Service
Southeast Region
Mississippi Ecological Services Field Office
Jackson, Mississippi

5-YEAR REVIEW
Blue Shiner (*Cyprinella caerulea*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on available information about historic and current distributions, life histories, and habitats of this species. We announced initiation of this review and requested information in a published *Federal Register* notice (72 FR 42425). We reviewed information in our files and solicited information from all knowledgeable individuals including those associated with academia and state conservation programs. 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rule listing this species under the Endangered Species Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by the Service, U.S. Geological Survey, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. The completed draft was sent to 9 peer reviewers for their assessment. Comments are incorporated into this final document (see Appendix A).

B. Reviewers

Lead Region – Southeast Region: Susan Oetker, 404-679-7050

Lead Field Office –Mississippi Ecological Services: Daniel J. Drennen, 601-321-1127

Cooperating Field Offices –Georgia, Ecological Services: Robin Goodloe, 706-613-9493; Alabama, Ecological Services: Jeff Powell, 251-441-5858

C. Background

1. Federal Register Notice citation announcing initiation of this review: August 2, 2007 (72 FR 42425)

2. Species status: Stable. The species is limited to the Coosa River system of Mobile Bay drainage in Alabama, Georgia and Tennessee. In Alabama it is found in the Little River system including a population from Spring Creek, a small tributary to the Weis Lake portion of Little River. The species is still found in Choccolocco Creek (confluence with Jones Branch and Egoniaga Creek) and limited reaches of Weogufka Creek. In Georgia the species is found in the Conasauga River above the city of

Dalton, and in Holly, Rock, Jobs, and Minnewauga creeks. In Tennessee the species is in the lower Jacks River (Conasauga River system).

3. Recovery achieved: 1 (1= 0-25% species recovery objectives achieved). Limited improvement has occurred for the species over the last 5 years. The population found in Spring Creek (Alabama) is consistently threatened by agricultural and non-sustainable water management practices as is the species in the Conasauga River system (Georgia) downstream of the Federal lands.

4. Listing history
Original Listing
FR notice: 57 FR 14786
Date listed: April 22, 1992
Entity listed: species
Classification: threatened

5. Review History:
Final Recovery Plan: 1995
Recovery Data Call: Annually from 1998-2013

6. Species' Recovery Priority Number at start of review (48 FR 43098): 8
Degree of Threat: Moderate
Recovery Potential: High
Taxonomy: species

7. Recovery Plan:
Name of plan: Blue Shiner (*Cyprinella caerulea*) Recovery Plan
Date issued: August 30, 1995

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, but the criteria need revising. More specific definitions of the species' population

metrics, such as sex and age class, mortality and natality are needed to determine the species' status and demonstrate recovery of the populations and their viability.

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? Not entirely; more up-to-date information is needed to determine population viability, which would then be used in development of measurable recovery criteria.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Not entirely, the criteria need revising, specifically long-term population monitoring is needed to determine viability and demonstrate recovery of the species.

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.

Criterion: The Blue Shiner will be considered for delisting when populations within its current range (Choccolocco Creek, West Fork of the Little River, Weogufka Creek, Conasauga River (including the Holly Creek and Coosawattee River system) plus one additional population in the species' historical range (Cahaba River) demonstrate long-term viability.

Status: Criterion not met.

Blue Shiners are distributed within four major watersheds of the upper Coosa River system (Choccolocco Creek, West Fork of the Little River, Weogufka Creek, in Alabama; Conasauga River in Georgia and the lower Jacks River in Tennessee). Limited status surveys conducted from 1976 to 2013 indicate fluctuations in relative abundance (individuals per time or unit effort) of the species.

This recovery objective is vague and difficult to measure. However, long-term population monitoring to determine viability of the species is essential to assessing its recovery. A minimum viable population size (the lowest population number below which growth in the population is negative) is not defined, nor are metrics for a population viability analysis (PVA) (Ralls *et al.* 2002; Patterson and Murray 2008) such as age/sex ratios, age classes, collection numbers, mortality, and natality. Population size criteria (with confidence intervals) should be established to provide a

benchmark by which to measure population health. Additionally, population persistence is not defined, and stochastic factors (demographic, environmental and genetic) or deterministic factors (habitat loss based on land management and water quality and water quantity threats in relation to the populations) are not accounted for.

Alabama Range

The species is currently found sporadically in about 7.7 kilometers (km) (4.8 miles (mi)) of the West Fork of the Little River (Drennen pers. observ. 2000). Pierson (2004) speculated that Blue Shiner populations may be stable or increasing in those sites. Stiles and Blanchard in 2000 discovered Blue Shiners nearby in 3.3 km (2.1 mi) of Spring Creek, a tributary to Weiss Lake Stiles and Blanchard (pers. comm. 2000).

Pierson (1998) found populations of Blue Shiners in historically occupied sites in Choccolocco and Weogufka Creeks. White *et al.* (2012) confirmed the presence of the species at these sites. Pierson (2000) did not find any evidence of new populations of the species in 24 historical sites in tributaries of the Coosa River system in Alabama. The Blue Shiner was extirpated from the Cahaba River system and Big Wills Creek since 1971 and 1958, respectively (Boschung and Mayden 2004).

Georgia/Tennessee Range

Reaches of the Conasauga River contain the largest and most genetically diverse populations of the species (George *et al.* 2008, U. S. Fish and Wildlife Service (USFWS) 1995). In the Conasauga River mainstem, minor fluctuations of Blue Shiner relative abundances have been noted based on annual survey data between 1996 and 2006 (Freeman *et al*. 2009, 2007). In Tennessee the species is in the lower Jacks River (Conasauga River watershed).

Criterion: Delisting will be considered when all populations (at the time of listing) are adequately protected. A population of Blue Shiners will be considered adequately protected when protective measures (e.g., conservation agreements and or easements, Memorandums of Understanding, adoption of silviculture and agricultural best management practices, regulations and ordinances, etc.) have been implemented to protect essential habitat and ensure population viability. Protection should extend within the watershed, including both public and private lands, to the point where future adverse impacts to the stream systems would be unlikely.

Status: Criterion partially met

Protection in Alabama

In Alabama only about 33% of the Blue Shiners' range is within public ownership. The Little River Canyon Natural Preserve protects 38.6 river km (24 river mi) of the West Fork of the Little River (Shew, National Park Service, pers. comm. 2008) and 5.8 km (3.6 mi) of suitable Blue Shiner habitat. Desoto State Park protects an additional 1,416 hectares (ha) (3,500 acres) of the watershed. Protection of the watershed includes the use of buffer zones and other sustainable and geomorphic techniques during management prescriptions for silviculture, road building and fire management to protect water quality and quantity. Roughly, 22.9 km (14.3 mi) of Blue Shiner habitat are in public ownership within the Coosa River Management Area of the Weogufka watershed. About 0.45 km (0.28 mi) of suitable Blue Shiner habitat is publically owned within the Choccolocco Creek watershed.

In Choccolocco Creek the waters are classified for fish and wildlife, although polluted runoff affects water quality and biological integrity (O'Neil and Chandler 2005); and in Weogufka Creek, macroinvertebrate bioassessment data indicates that the overall system assessment is fair (ADEM 2005; Lower Coosa River Basin Management Plan, 2004, *www.cleanwaterpartnership.org/.../Lower%20Coosa%20River%20Basin*).

Additionally, protection for the watershed includes some Corps of Engineers mitigation banks and The Nature Conservancy (TNC) easements in key habitat areas. Technical support is provided to landowners and governmental agencies from the USFWS, U.S. Forest Service, TNC, U.S. Geological Survey, Natural Resource Conservation Service, and the Alabama Department of Natural Resources. Many organizations work with landowners, both public and private, to provide expertise in best management practices and develop conservation strategies for stream habitat in correlation with urbanization.

Protection in Georgia/Tennessee

Within the National Forests, much of the headwaters to the Conasauga and Jacks Rivers flow through the Chattahoochee National Forest in Georgia and the Cherokee National Forest in Tennessee. On these National Forest lands, 40 km (25 mi) of suitable Blue Shiner habitat are protected from logging, roads, and fire damage in Georgia; 20 km (12 mi) are protected in Tennessee. The protections of these watersheds are not homogenous; some impacts occur from agricultural practices on several large, private inholdings in the Chattahoochee National Forest, particularly in Georgia's Alaculsy Valley in the Conasauga River headwaters.

The Conasauga River headwaters originate in the Chattahoochee/ Cherokee National Forest (Blue Ridge topographic province) and flow into the Valley and Ridge province. Downstream of the National Forest the land use shifts from predominately forested towards agricultural uses. Suburban growth begins just downstream and marks the beginning of a general decline in aquatic diversity. In particular, abrupt fish diversity declines within the Valley and Ridge province indicate change in habitat suitability for sensitive fishes, including species like the Blue Shiner (Baker *et al*. 2013).

Protection for the watershed includes some Corps of Engineers' mitigation banks and TNC easements in key habitat areas. Technical support is provided to landowners and governmental agencies from the USFWS, U.S. Forest Service, TNC, U.S. Geological Survey, Natural Resource Conservation Service, University of Georgia, and the Georgia Department of Natural Resources. Many organizations work with landowners, both public and private, to provide expertise in best management practices and develop conservation strategies for stream habitat in correlation with urbanization.

C. Updated Information and Current Species Status

1. Range and Status

Current Range

In Alabama, the current range for the Blue Shiner is the lower reach of Weogufka Creek, the upper reach of Choccolocco Creek (White *et al*. 2012; Pierson 1998, 2000) (including portions of Shoal Creek, Egoniaga Creek , Jones Branch, an unnamed tributary of Choccolocco Creek, and Kings Gap Branch (Meade, Jacksonville State Univ., pers. comm. 2014; White *et al*. 2012; Howell and Linton 1996)), West Fork of the Little River (Mettee *et al*. 1996), and the lower reach of Spring Creek (Mike Cummings, landowner on Spring Creek, pers. comm. 2000-2014; Drennen, USFWS, pers. observ. 2000; Stiles, Samford Univ., pers. comm. 2008). The Blue Shiner is still considered extirpated in the Cahaba River (Jefferson and Bibb counties,) Wills Creek (DeKalb County), Patton Creek (Jefferson County), Little Cahaba River (Shelby and Bibb counties), and Shultz Creek (Bibb County).

In Georgia and Tennessee the species is found in the Conasauga River above Dalton; the lower Jacks River; and Holly, Rock, Jobs, and Minnewauga creeks (Rakes *et al.* 1996; Johnston 2000; Freeman *et al.* 2003; Freeman and Scott 2003; Rakes and Shute 2007; Powers 2008). The Blue Shiner is still considered extirpated

in the Coosawattee and Oostanaula river systems in Georgia (Powers 2008).

Habitat and Biology

Blue Shiners are typically found throughout the water column, feeding at the surface, in mid-water, and on the bottom, preferring relatively shallow slow moving water 0.05 to 0.67 meters (m) (2 to 26 inches (in.)) deep, with pools, eddies and backwaters frequently close to the shoreline (Pierson 1998; Johnston 2000; Drennen, USFWS, pers. observ. 2005; Meade, Jacksonville State University, pers. comm., 2014). However, they were observed under a bridge in the West Fork of the Little River at 1.5 m (4.9 feet (ft.)) deep (Drennen, USFWS, pers. observ. 2000) and greater than 2 m (6.6 ft.) in Choccolocco Creek (Meade, Jacksonville State University, pers. comm., 2014).

Blue Shiners do not range freely throughout a continuous system, although riffles and glide mesohabitats (intermediate gradients between the riffle and the pool) are not barriers to dispersal (Johnston 2000). The habitat for the species includes specific habitat patches that may be separated from each other at a distance up to 332 m (1086 ft.). Bottom substrates are usually silt and sand, gravel, or a sand/gravel mixture, and the water velocities are low (0.0 to 0.08 meters per second (m/s; 0.0 to 0.27 feet per second (ft. /s)) (Rakes, pers. comm., 2014; Johnston 2000). Water quality parameters at the West Fork of the Little River include: an average annual water temperature of 16 degrees Celsius (°C) (60 degrees Fahrenheit (°F)); high dissolved oxygen concentrations (7 to 10 parts per million (ppm)); and high water clarity (2 Jackson Turbidity Units (JTU) (Jackson Turbidity Unit is a measurement of the turbidity or lack of transparency of water; the higher the JTU the less clarity of the water) (U.S. Fish and Wildlife Service 1995; Top of Alabama Regional Council of Governments: Alabama Department of Environmental Management 2008, 2005). The species has also been noted in water with degraded water quality (*i.e.* Sumac and Holly creeks in Georgia) (Rakes pers. comm. 2014).

Freeman *et al.* (2007) found little if any decline of Blue Shiner populations from 1996 to 2006 in high water quality and shallow-water habitat in the Conasauga River mainstem east of Dalton, Georgia.

Blue Shiners are crevice-spawners. Females spray their eggs forcefully into crevices in logs or rocks and then abandon them

(Johnston and Page 1992; Conservation Fisheries, Inc. 2014) from late spring to mid-summer (Johnston and Shute 1996). In captivity, Rakes (pers. comm. 2014, 1998) describes spawning being induced by warming of water temperatures to 17 to 20°C (62.6 to 68°F). Egg incubation time is about 7 days at 20°C (68°F). Yolk-sac larvae are benthic (bottom dwelling) and mostly inactive for approximately 48 hours, after which they become pelagic (free floating) and tend to stay within a centimeter or two of the surface. Blue Shiner larvae at hatching and swim-up stage are about 6 millimeters (mm) (0.24 in) in total length and are unable to eat whole fresh-hatched brine shrimp (*Artemia nauplii*) for a day or so after swim-up, but apparently have sufficient stored yolk reserves to grow to a size at which they can feed on brine shrimp before starving (Pat Rakes, Conservation Fisheries, Inc., pers. comm. 2014). Little is known about the Blue Shiner larvae and juvenile fish daily cycles or activities (Andrew Henderson, Tennessee Valley Authority, pers. comm., 2014). The adult Blue Shiner diet is dominated by terrestrial insects (Krotzer 1984; Etnier and Starnes 1993) that have fallen into the water, indicating that they are a visual drift feeder.

Blue Shiners are often associated with submerged tree roots, and woody debris. Vegetation includes beds of water willow (*Justicia americana*) (U.S. Fish and Wildlife Service 1995).

Henderson (Tennessee Valley Authority, pers. comm., 2014) speculated that the Blue Shiner may be using different microhabitats to maintain connectivity between populations throughout the species range. Continuous water flow and water availability is critical in maintaining the microhabitat connections. The Spring Creek population of Blue Shiners may have continued to survive due to its year round spring-fed flow. The habitat becomes impacted by sedimentation caused by cattle watering, agricultural disturbances and snagging of trees within the stream bed (Drennen pers. observ., 2002, Mike Cummings, landowner Spring Creek, pers. comm. 2002-2014). Because the stream has a continuous spring flow, it sweeps sediments from crevices that the species utilizes to deposit eggs. This stable spawning habitat results in consistent recruitment of various age classes resulting in a stable population structure.

2. Five-Factor Analysis

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

The range of the Blue Shiner within Alabama, Georgia and Tennessee has been reduced and fragmented by geomorphic and hydrologic changes such as reservoirs, bridges, pipelines and roads; aggregate extraction; major pollution events; an increase in turbidity caused by sedimentation; and general declining water quality attributed to non-sustainable urbanization and land use practices (Powers 2008).

Studies show that increased urbanization leads to declining water quality in streams and fish assemblages (Onorato *et al*. 2000, Anderson *et al.* 1995, Weaver and Garman 1994) which in turn curtails the connectivity of fish habitat, resulting in isolated populations.

Water pollution, including eutrophication, low dissolved oxygen, and excessive turbidity, degrades water quality and threatens the species by increasing temperature and reducing the intensity of light entering the water column. This reduction of light intensity can disrupt photoperiod, fish courtship behavior, territorial displays, reproduction, and egg/larvae survivorship (Mayden 1989, Krotzer 1984). Non-point source pollution, in particular, may be correlated with impervious surfaces and storm water runoff. Pollutants may include sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, and petroleum products. These pollutant sources tend to increase concentrations of nutrients and toxins in the water and alter the chemistry of subsurface and surface waters such that the habitat and food sources for species like the Blue Shiner are negatively impacted. Construction and road maintenance activities associated with urban development typically involve earth-moving activities that increase sediment loads into nearby aquatic systems through storm water runoff during and after precipitation events. Excessive sediment and increased turbidity can degrade Blue Shiner habitat by covering and eliminating available food sources and crevice sites for nesting. Sediment disrupts aquatic insect communities and negatively impacts fish growth, physiology, behavior, reproduction and survivability (Waters 1995; Knight and Welch 2001). Sediment is the most common pollutant in the Mobile River Basin (Alabama Department of Environmental Management 1996).

Alabama Blue Shiner habitat and water quality

The threats to water quality and quantity in Alabama and Georgia are: chemical contaminants such as glyphosate, nitrate/ nitrite, soluble reactive phosphorus and cations such as sodium and calcium (Freeman *et al.* 2009); dissolved nutrient concentrations (Baker *et al.* 2013); geomorphology changes and biological indicator changes such as vegetation, invertebrates, and fish cohorts (Ramsey 1976; Stiles 1978; Howell *et al*.1982; Stiles and Ramsey 1986; Pierson *et al*. 1989; Stiles 1990; USFWS 1992; Freeman and Weyers 1999; Howard *et al*. 2002; O'Neil and Chandler 2005; Kuhajda 2007; Powers 2008), and maintaining adequate instream flows (Annear *et al.* 2004). Throughout the species' range, hardness and alkalinity are also parameters of concern (ADEM 2005). Larval Blue Shiners are very sensitive to excessive chlorides (Keller, Environmental Protection Agency, email report to Daniel Drennen, 2002) by disturbing osmoregulation, specifically in the gills and kidneys, leading to impaired respiration, renal function and ultimately survival, growth and reproduction.

Eutrophication and low dissolved oxygen levels likely resulted in the extirpation of the Blue Shiner and other aquatic species from the Cahaba River (Environmental Protection Agency 1979; Howell *et al*. 1982; Ramsey 1982; O'Neil 1984; Pierson and Krotzer 1987; Shepard *et al*. 1994; Blanchard *et al.* 1999; U.S. Environmental Protection Agency 2000). The Blue Shiner no longer occurs in the Cahaba River from a 100 km (60 mi) reach, possibly related to major pollution events in the 1970s (Stiles, pers. comm., 2008).

The Spring Creek population is threatened by a decline of water quality (Drennen pers. observ. 2008; Mike Cummings pers. comm. 2014) and water quantity from increased extraction of the water by the Waterloo Springs Water Authority (Tom Garrett, Alabama Department of Environmental Management, pers. comm. 2008; Drennen pers. observ. 2008). Drennen (pers. observ. 2008) observed chlorine damage to vegetation at Waterloo Springs effluent pipe in the headwaters of Spring Creek in Cherokee County, Alabama.

Surface waters in Choccolocco Creek watershed have been classified as Fish and Wildlife (O'Neil and Chandler 2005), where the best usage of the water is for aquatic life (Alabama Water Watch 2014; McIndoe, Code of Alabama.1975). Biological conditions varied in the watershed from poor to good. Elevated nitrates in the watershed were linked to wastewater discharges and agricultural areas (O'Neil and Chandler 2005). Polychlorinated biphenyls and mercury from a former military base, as well as

waste water from dry cleaning operations, may be the limiting factors to the species in the middle and upper Choccolocco Creek, along with high turbidity, high phosphates and nitrates, and temperatures at or below 25°C (77°F) (Meade, Jacksonville State University, pers. comm. 2014). A Blue Shiner-Tricolor Shiner hybrid found in Choccolocco Creek indicates that reproduction has been affected in this reach, perhaps from sedimentation and loss of riparian and associated woody debris (George *et al*. 2008).

Georgia/Tennessee Blue Shiner habitat and water quality:

The headwaters of the Conasauga River in the Chattahoochee National Forest are protected from many water quality threats. However, since 2003 turbidity appears to be increasing at Holly Creek in the Chattahoochee National Forest (Powers 2008). The long history of extensive agriculture, timber harvest, and recent urban sprawl within the lower Conasauga River watershed in Murray County, Georgia, near Dalton, Ellijay, and Cleveland, contributes to the degradation of Blue Shiner habitat.

Even though the Holly Creek watershed is partially protected within the Chattahoochee National Forest, Blue Shiners are not common (Powers 2008, Alexander *et al.* 2007).

Powers (2008) found that historical sites upstream in Rock Creek had no Blue Shiners. This decline may be related to the instream habitat being heavily degraded by recent development near Ellijay and Chatsworth and construction of residential dwellings (mostly cabins/cottages) along the upper reaches of Holly Creek (Powers 2008). The absence of Blue Shiners in nearly pristine small stream sites may suggest that the lower reaches of the largely degraded Conasauga tributaries do not support self-sustaining populations (Powers 2008) and no migration, expansion or recolonization efforts from here have occurred.

The Cohutta Wilderness Area in Georgia and the Jacks River Fields Campground (Cherokee National Forest) in Tennessee provide protection of the Jacks River population of Blue Shiners.

Perfluorinated chemicals within the Conasauga River system in Georgia are a threat to the fish diversity in the watershed (Konwick *et al.* 2008), although the likely source of perfluorinated chemicals in the river is downstream of known Blue Shiner habitat. Rakes (pers. comm. 2014) states that the species has an acute sensitivity to chlorine and copper (Keller, Environmental Protection Agency, email report to Daniel Drennen, 2002). Chlorine is used

extensively as a biocide to prevent fouling of industrial equipment and as a disinfectant for municipal sewage discharges and water treatment facilities (Hoffman *et al.* 2003). Copper is known to cause a spectrum of reproductive abnormalities following exposure (Hoffman *et al.* 2003). Certain fluorocarbons tend to bioaccumulate, since they are extremely stable and can be stored in the bodies of both humans and animals. Examples of fluorocarbons include perfluorooctanoic acid and perfluorooctane sulfonate, frequently present in water resistant textiles and sprays conferring water resistant properties to textiles. Data from animal studies of PFOA indicate that it can cause several types of tumors and neonatal death and may have toxic effects on the immune, liver, and endocrine systems (Stahl *et al.* 2011).

b. Overutilization for commercial, recreational, scientific, or educational purposes: There was concern, at the time of listing, that the removal of individuals (along with habitat destruction) would increase the adverse impacts on the species. Currently, there is very little scientific or other collecting; therefore, this is not considered to be a significant threat. Scientific collection permits are required by the States of Alabama, Georgia, and Tennessee. In general, small species of fish may be used as bait, and Blue Shiner may be occurring sporadically, but there is no information to support the use of Blue Shiner as a bait species overall.

c. Disease or predation: Predation undoubtedly occurs within all sites for the Blue Shiner. There is no evidence to suggest that disease or natural predators threaten the species.

d. Inadequacy of existing regulatory mechanisms: The Blue Shiner and its habitats are afforded some protection through Section 7 and 9 of the ESA (1974). In the State of Alabama the species is protected by Code of Alabama §§ 220-2-.92: in the State of Georgia by Conservation Use Act of 1991 as amended (O.C.G.A 48-5-7.4), Endangered Wildlife Act of 1973 (O.C.G.A. 27-3-130), and others; in the State of Tennessee by TN ST § 70-8-101 – 112.

The species is afforded some protection from water quality and habitat degradation under the Clean Water Act of 1972 (33 U.S.C. 1251 et seq.), the Alabama Water Pollution Control Act, as amended, 1975 (Code of Alabama, §§ 22-22-1 to 22-22-14); in Georgia by the Erosion and Sedimentation Act of 1975 (O.C.G.A. 12-7-1), Georgia Water Quality Control Act (O.C.G.A. 12-5-20); and in Tennessee by the Tennessee Water Quality Control Act 69-

3-101 *et seq*. Alabama, Georgia and Tennessee follow traditional common-law riparian doctrine which associates the right to use water with ownership of land abutting the water (Elliott 2012, Pointer 2012, Blount *et al.* 2002).

Because of inconsistency in implementation of Clean Water Act regulations and other best management practices, which are voluntary for some activities and mandatory for others, existing regulatory mechanisms in Alabama, Georgia and Tennessee are still inadequate.

In summary, regulatory mechanisms are in place to protect aquatic species, but multiple stream reaches within the occupied habitat of the Blue Shiner, coupled with the lack of specific information on the sensitivity of the species to common industrial and municipal pollutants, limits the application of these regulations. Therefore, existing regulatory mechanisms, as currently applied, are not fully protective of the species.

e. **Other natural or manmade factors affecting its continued existence**: Other factors that may be affecting the continued existence of Blue Shiner include genetic considerations and nonnative species.

Genetic considerations

The genetic diversity of this species may be declining due to fragmentation and separation of populations by both anthropomorphic and natural causes (George *et al.* 2008). Disconnected Blue Shiner populations are more susceptible to environmental changes, thereby resulting in an overall decrease of genetic diversity of the species as a whole. Continued loss of connectivity between isolated populations of Blue Shiners will likely limit recovery of the entire species due to attrition of genetic diversity (George *et al*. 2008)

The long-term viability of the Blue Shiner is based on conservation of numerous local populations throughout its geographic range (Harris 1984). These features are essential for the species to recover and adapt to environmental change (Noss and Cooperrider 1994, Harris 1984). This disjunctive distribution makes Blue Shiner populations vulnerable to extirpation from catastrophic events, such as toxic spills, or changes in flow regime.

Nonnative species

The introduced red shiner (*Cyprinella lutrensis*) may have the capacity to hybridize with the Blue Shiner in the Conasauga River (Burkhead and Huge 2002). Currently, the red shiner has only reached the Highway 76/52 Bridge, but hybridization between the two shiners will be of greater concern if red shiners continue to move upstream (Freeman *et al*. 2007). The red shiner, a mid-west bait bucket species, is considered a conservation threat to native fishes and has spread up river in the Coosa River in nearby Georgia waters. Herrington and Devries (2004) found that the species had not yet spread to contiguous waters into Alabama portions of the Coosa River. However, Stiles and Mills (pers. comm. 2008) found red shiners in Spring Creek (Cherokee County, Alabama) an important location for Blue Shiners. Red shiners aggressively colonize mainstem reaches and can hybridize with the native Blacktail Shiner (*Cyprinella venusta stigmatura)* (Burkhead and Huge 2002); they routinely hybridize with the Blue Shiner in the laboratory (Herrington 2004).

The Asiatic Weatherfish (*Misgurnus anguillicaudatus)* has been reported by Meade (Jacksonville State University, pers. comm., 2014) in the lower Choccolocco Creek and is predicted to be in the midreach of the creek within 10 years. It is unknown if the species will impact the Blue Shiner however Meade (Jacksonville State University, pers. comm. 2014) suggests that it may be possible.

Blue Shiner meta-populations (spatially separated populations of the same species which interact at some level) remain vulnerable to stochastic and anthropogenic threats. The low density and sporadic presence of Blue Shiners within the Holly Creek drainage in Georgia suggest that populations are likely small and highly localized (George *et al.* 2008).

D. Synthesis

Over the last 24 years, there have been a variety of studies on the Blue Shiner. These studies have provided information to partially address threats to the species; however, the understanding of threats to the species and the application of recovery measures from the Blue Shiner Recovery Plan (1995) to make the essential conservation and management decisions for the species are insufficient and have not achieved the recovery criteria. None of the threats relating to habitat destruction and degradation has been completely eliminated since the Blue Shiner was listed. Due to the lack of consistent monitoring studies at specific temporal intervals, there has been no population viability analysis (PVA) or statistically significant estimate of the

species' populations. Most threats to the Blue Shiner that are identified in the final listing rule (57 FR 14786) still remain, although there is protection of the species' habitat within the publically owned lands within the species' range. Federally listed species are evaluated to address any effects to them by forest management practices (Counts 2008 pers. comm.). With the ongoing deterioration of water quality, expansion of urbanization, fragmented distribution caused by bridges, culverts etc., combined with small populations of Blue Shiners; the individual numbers within the populations possibly are declining leaving the Blue Shiner vulnerable to stochastic and anthropogenic events. Studies to monitor known populations will need to continue for at least 10 years to give an adequate picture of population viability. Therefore, the recovery criteria have not been met and the Blue Shiner continues to meet the definition of a threatened species under the Act.

III. RESULTS

A. Recommended Classification:

No change is needed.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Delineate the species' range by a status survey of historically and currently known locations and other possible stream reaches that have not been sampled.

2. Initiate selected long-term monitoring of the species and its habitat at sites within the species range.

3. Initiate exploratory survey methods for new populations of the species with environmental DNA survey techniques.

4. Establish collection metrics for population variability analysis and minimum and maximum sustainable yield of the populations.

5. Revise recovery plan to reflect new information acquired since the recovery plan was written in 1995, and continue implementing pertinent recovery actions from the recovery plan along with determining criteria for population viability (PVA).

6. Initiate a Blue Shiner Recovery Group.

7. Work with state, county and town governments in establishing best management and conservation practices to improve water quality and water quantity issues through cooperative agreement, conservation easement, fee title purchase or other means to guarantee safeguards to the Blue Shiner and habitat. Support the States of Alabama, Georgia and Tennessee comprehensive conservation strategy efforts concerning their species of concern.

8. Assess threats within current and historical habitats and prioritize plan of action to decrease threats and update recovery action items as required (see no. 2)

9. Determine and maintain instream flows within the habitat of the species.

10. Continue partnering with stakeholders (e.g. Forest Service, landowners, non-governmental organizations) in protecting Blue Shiner habitat.

11. Restore degraded habitat especially with regard to storm water runoff and other non-point source pollution.

12. Develop protection and management plans for all watersheds sites as indicated by information acquired from habitat and population survey studies.

13. Restore the Cahaba River population using captive propagation and reintroduction from an appropriate nearby source population.

V. REFERENCES

ADEM, 2005. Weogufka Creek 2005 monitoring summary. Montgomery, Al. 2 pages.

Alabama Water Watch. 2014. http://www.alabamawaterwatch.org/resources/general_faqs.html/title/what-are-the-different-alabama-water-use-classifications-

Alexander, R., E. Boyer, R. Smith, g. Schwarz and R. Moore. 2007. The role of headwater streams in downstream water quality. Journal of the American water resources association. Vol. 43. No. 1. 41-59.

Anderson, A., A. C. Hubbs, K. O. Winemiller, and R. J. Edwards. 1995. Texas freshwater fish assemblages following three decades of environmental change. Southwest Nat. 40:314--321.

Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream flows for riverine resource stewardship; revised edition. Instream Flow Council, Cheyenne, WY. 267 pp

Baker, C., M. Hagler and B. Freeman. 2013. Determining current threats to protected and rare aquatic species of the Conasauga River system. Final report to the Georgia Department of Natural Resources. Univ. of Georgia. Athens. 122 pp.

Blount, G. and others. 2002. The role of water rights and Georgia Law in comprehensive water planning in Georgia. A white paper to the Joint Comprehensive water plan study committee by the Georgia chamber of commerce. March. 6 pp.

Boschung, H.T. and R. L. Mayden. 2004. Fishes of Alabama. Smithsonian Institution Press, Washington D.C. 736 pp.

Burkhead, N.M. and D. H. Huge. 2002. The case of the Red Shiner: What happens when a fish goes bad? U.S. Geological Survey. Florida Integrated Science Center, Gainsville, Fl. 6 pp. http://cars.er.usgs.gov.

Burkhead, N.M. and H.L.Jelks. 2001. Effects of suspended sediment on the reproductive success of the tri-color shiner, a crevice-spawning minnow. Transactions of the American Fisheries Society. Vol 130, Issue 5.959-968.

Conservation Fisheries Inc. 2014. http://conservationfisheries.org/index.php/species/all-species/cyprinella-caerulea-blue-shiner/

Elliott, Heather. 2012. Alabama's Water Crisis. Alabama Law Review. Vol.63:2:383.

Etnier, D.A. and W.C. Starnes. 1993. The Fishes in Tennessee. Univ. Tenn. Press. Knoxville, TN. 681 pp.

Freeman, B.J., M. Hagler, S. Wenger, N. Pontzer. 2009. Identification and mapping of critical habitats in the Conasauga River Corridor of Georgia and Tennessee. 2008 Annual Report. Georgia Museum of Natural History. Athens. 45 pp.

Freeman, B.J., M. Hagler, S. Wenger, G. Anderson and R. Katz. 2007. Identification and mapping of critical habitats in the Conasauga River Corridor of Georgia and Tennessee. 2006 Annual Report. Georgia Museum of Natural History. Athens. 84 pp.

Freeman, B.J. and M.C. Scott. 2003. Assessing the distribution of sensitive fish species in the upper Mobile River drainage in Georgia. Annual report for 2001-2002. Inst. Of Ecology and Ga. Mus. Of Nat. Hist. Athens. 26 pp.

Freeman, B.J. and H.S. Weyers. 1999. Life history and status of the goldline darter Percina aurolineata in the Coosawattee River System of Northern Georgia. Annual report. Inst. of Eco. Univ. of Ga. 77 pp.

George, A. and J. Caldieraro, K. Chartrand and R. Mayden.2008. Population genetics of the blue shiner, *Cyprinella caerulea*. Southeastern Naturalist. 7(4):637-650. 13 pp.

Harris, L. D. 1984. The Fragmented Forest. Univ.of Chicago Press. 211 pp.

Herrington, S.J. 2004. Ecology and impacts of nonindigenous red shiner in the Chattahoochee River drainage, Georgia. Doctoral Dissertaion. Auburn University, AL. 31 pp.

Herrington, S.J. and D.R. Devries. 2004. Status survey of the red shiner in the Coosa River drainage, Alabama. Final report to the AL. Dept. of Cons.and Nat. Res. 54 p.

Hoffman, D., B. Rattner, G. Burton and J. Cairns. 2003. Handbook of ecotoxicology. 2nd edition. Lewis Publishers. CRC Press. 1290 pp.

Honavar, J.V. 2003. Assessment of ichthyofaunal assemblages as indicators of sedimentation in the upper Cahaba River and its Tributaries. Thesis, Univ. of AL. Birmingham. 40 pp.

Howard, Hoke, B. Quinn, M. Flexner, and R. Raschke. 2002. Cahaba River: Biological and Water Quality Studies, Birmingham, Alabama. March/April, September and July 2002. U.S. EPA, Region 4, Science and Ecosystem Support Div. Atlanta. 120 pp. and appendices.

Howell, W.M. and S. Linton. 1996. The fishes of Dugger Mountain, Talledega National Forest, Alabama. Samford Univ., Birmingham, AL. 7 pp.

Howell, W.M., and R.A. Stiles, and J.S. Brown. 1982. Status survey of the Cahaba shiner (*Notropis sp*.) and the goldline darter (*Percina aurolineata*) in the Cahaba River from Trussville to Both Ford, Alabama. Report to the U.S. Fish and Wildlife service, Jackson, MS. 148 pp.

Johnston, C.E. 2000. Movement patterns of imperiled blue shiners (Pisces: Cyprinidae) among habitat patches. Ecology of Freshwater Fish. 9:170-176.

Johnston, C.E. and L.M. Page. 1992. The evolution of complex reproductive strategies in North American minnows (Cyprinidae). In: Mayden , R.L., ed. Systematics, historical ecology and North American freshwater fishes. Stanford: Stanford University Press, pp. 600-621.

Johnston, C.E. and J.R. Shute. 1996. Spawning behavior of the blue shiner (*Cyprinella caerulea*) and the holiday darter (*Etheostoma brevirostrum*), two rare fishes of the Conaauga River, Georgia and Tennessee. Southern research Station, Forest Hydrology Lab., Oxford, MS. 9 pp.

Konwick B.J., G.T. Tomy , N. Ismail, J.T. Peterson and R.J. Fauver. 2008. Concentrations and Patterns of Perfluoroalkyl Acids in Georgia, USA Surface Waters Near and Distant to a Major Use Source. Environmental Toxicology and Chemistry: 27, 10; 2011-2018.

Kuhajda, B. 2007. Federal fish and wildlife permit number TE129505-0 permitting the capture and release of *Notropis cahabae*, the Cahaba shiner, and *Percina aurolineata*, the goldline darter. Report submitted to the U.S. Fish and Wildlife Service. Atlanta. 8 pp.

Lower Coosa River Basin Management Plan. 2004. *www.clean**water**partnership.org/.../Lower%20Coosa%20River%20Basin)*

Mayden, R. L. 1989. Phylogenetic studies of North America minnows, with emphasis on the genus Cyprinella (Teleostei: Cypriniformes). Misc. publ. Mus. Nat. Hist. Univ. Kansas. No. 80. 189 pp.

Mettee, M.F., P.E. O'Neil and J.M. Pierson, 1996. Fishes of Alabama and the Mobile Basin. Oxmoor House, Birmingham, Alabama. 820 pp.

McIndoe, J. 1975. Code of Alabama. §§22-22-9, 22-22A-5, 22-22A-6, 22-22A-8. ADEM, Chapter 335-6-11. Water use classifications for interstate and intrastate waters, 11-1 through 11-51.

Noss, R. E. and A. Y. Cooperrider. 1994. Saving Nature's Legacy. Protecting and Restoring Biodiversity. Island Press. CA. pp. 416.

O'Neil , P.E. 1984. Historical surface water quality analysis of the Cahaba River Basin north of Centreville, Alabama. A report to the U.S. Fish and Wildlife Service. 86 pp.

O'Neil, P.E., and R.V. Chandler. 2005. Water quality and biological monitoring in the Choccolocco creek watershed, Alabama 1996-2001. Geological Survey of Alabama. Bulletin 177. Tuscaloosa, Alabama, USA.

O'Neil, P.E., T. E Shepard, and M.R. Cook. 2006 Habitat and biological assessment of the Terrapin Creek watershed and development of the Index of Biotic Integrity for the Coosa and Tallapoosa River systems. Geological Survey of Alabama. Open File Report 0601. Tuscaloosa, Alabama, USA.

Onorato, D., R. A. Angus, and K. R. Marion. 2000. Historical changes in the ichthyofaunal assemblages of the upper Cahaba River in Alabama associated with extensive urban development in the watershed. J. Freshwater Ecol. 15:47--63.

Patterson, B. and D. Murray. 2008. Flawed population viability analysis can result in misleading population assessment: a case study for wolves in Algonquin Park, Canada. Biological Conservation. 8 pp. Published by Elsevier Ltd.

Pierson, J.M. 1998. Status of the Blue Shiner (*Cyprinella caerulea)* in Alabama. Report to the U.S. Fish and Wildlife Service. Jackson, MS. 38 pp.

Pierson, J.M. 2000. Blue Shiner (*Cyprinella caerulea)* Survey 2000. Report to the U.S. Fish and Wildlife Service. Jackson, MS. 26 pp.

Pierson, J.M. 2004. Blue shiner *Cyprinella caerulea* (Jordan 1877) page 206 in R.E. Mirarchi, J.T. Garner, M.F. Mettee, P.E. O'Neil, eds. Alabama wildife. Volume 2. Imperiled aquatic mollusks and fishes. The University of Alabama Press, Tuscaloosa, AL.

Pierson, J.M., W.M. Howell, R.A. Stiles, M.F. Mettee, P.E. O'Neil, R.D. Sutkus, and J.S. Ramsey. 1989. Fishes of the Cahaba River System in Alabama. Ala. Geol. Suvvey Bull. 134: 1-183.

Pierson, J.M., and R.S. Krotzner. 1987. The distribution, relative abundance, and life history of the blue shiner, *Notropis caeruleus* (Jordan). Prepared for the Alabama Nongame Wildlife Coordinator. 105 pp.

Pointer, L. 2012. Tennessee water laws and regulations. Understanding Tennessee surface water and groundwater rights and regulations. Baker, Donelson, Bearman, Caldwell and Berkowitz, P.C. Tennessee Bar Association. Htto://www.tba.org/news/Tennessee-water-laws-regulations 27 pp.

Powers, S.L. 2008. Distribution and status of *Cyprinella caerulea* (Cyprinidae) and *Percina aurolineata* (Percidae) in the upper Coosa River drainage of North Georgia and Southeast Tennessee. Report to the U.S. Fish and Wildlife Service, Jackson, MS. 29 pp.

Rakes, P.L. and J.R. Shute. 2007. Fish surveys of selected streams of the Chattahoochee National Forest to monitor effects of Hurricane Ivan on imperiled species. Interim report to Chattahoochee National Forest. 17 pp.

Rakes, P.L. and J.R. Shute. 2001. Population monitoring of rare southeastern fishes in the Conasauga River: 2000. Final report prepared for the U.S. Forest Service, Cherokee National Forest.4 pp.

Rakes, P.L. and J.R. Shute. 1998. Development of propagation protocols for the blue shiner, Cyprinella caerulea. Report to the U. S. Fish and Wildlife Service, Mississippi Field Office, 2 pp.

Ralls, K., S. Beissinger, and J. Cochane. 2002. Guidelines for using population viability analysis in endangered-species management, pp. 521-550; *in* Population Viability Analysis, S. Beissinger and D. McCullough, Univ. of Chicago Press, 577 pp.

Rakes, P.L., P.W. Shute, and J.R. Shute. 1996. Distribution and habitat surveys and population monitoring of rare fishes in the upper Conasauga River system. Final report to the U.S. Forest Service. 11 pp.

Ramsey, J.S. 1982. Habitat and distribution of the Cahaba shiner and appraisal of methods for its capture. Report to the U.S. Fish and Wildlife Service, Atlanta, GA. 44 p.

Ramsey J.S. 1976. Freshwater fishes. Pp. 53-65. In: H. Boschung, (ed). Endangered and threatened plants and animals of Alabama. Ala. Mus. Nat. Hist., Univ. of Ala., Tuscaloosa, AL.

Ramsey J.S. and J.M. Pierson. 1986. Blue shiner, *Notropis caeruleus*. Pp. 12-13. In: R.H. Mount, (ed). Vertebrate animals of Alabama in need of special attention. Ala. Agr. Expt. Sta., Auburn Univ. 124 pp.

Stahl, T., D. Mattern and H. Brunn. Toxicology of perfluorinated compounds. Environmental Sciences Europe 2011, 23:38. Springer Open Journal doi:10.1186/2190-4715-23-38.

Stiles, R.A. 1990. A preliminary report on the current status of the goldline darter, *Percina aurolineata*, and the Cahaba shiner, *Notropis cahabae*, in the Little Cahaba and Cahaba Rivers of Alabama. Cahaba River Study Project. A report to the U.S. Fish and Wildlife Service. 28 pp.

Stiles, R.A. 1978. A report on the status of the goldline darter, *Percina aurolineata*, and the Cahaba shiner, *Notropis sp*., in the Cahaba River system of Alabama. Cahaba River Study Project. 6 pp.

Stiles, R.A. and J.S.Ramsey. 1986. Goldline darter, *Percina aurolineata* Suttkus and Ramsey. In R.H. Mount, ed., Vertebrate Wildlife of Alabama. Al Agri Exp Stat., Auburn, pages 8-9.

Top of Alabama Regional Council of Governments: Alabama Department of Environmental Management. 2008. Land-use study and protection program for the Little River watershed. 33 pp.

U.S. Environmental Protection Agency. 2000. Atlas of America's Polluted Waters. EPA report 840-B-00-002, 53 p.

U.S. Environmental Protection Agency. 1979. Final environmental impact statement for the Cahaba River wastewater facilities Jefferson, Shelby, and St. Clair Counties, Alabama. 95 pp.

U.S. Fish and Wildlife Service. 1995. Blue Shiner (*Cyprinella caerulea*) Recovery Plan. Jackson, MS. 20 pp.

U.S Fish and Wildlife Service. 1992. Cahaba Shiner (*Notropis cahabae*) Recovery Plan. Atlanta, GA., 11 pp.

U.S. Forest Service. 2003. Final Environmental Impact Statement. Chattahoochee-Oconee National Forests. 30 pp.

U.S. Forest Service. 2000. Conasauga River Alliance Business Plan. Southern Region. 23 pp.

Weaver, L. A., and G. C. Garman. 1994. Urbanization of a watershed and historical changes in stream fish assemblage. Trans. Am. Fisheries Soc. 123:162--172.

White, D., M. Meade and G. Scull. 2012. Ichthyofaunal survey of Choccolocco Creek watershed: with emphasis on conservation need species. Report to the Mississippi Field Office. Jacksonville State Univ. 40 pp.

Personal communication:

Henderson, Andrew. Tennessee Valley Authority. Email to Daniel Drennen. Blue shiner records. 2014.

Pat Rakes. Conservation Fisheries, Inc.. Memo to Daniel Drennen. 2014.

Pat Rakes, Conservation Fisheries, Inc. editorial comment, 2014

Mike Cummings, landowner Spring Creek, pers. comm. 2002-2014

Mark Meade, Jacksonville State University, email, April, 2014.

Tom Garrett, Alabama Department of Environmental Management, phone conversation, July 29, 2008.

Mary Shew, Little River Canyon Natural Preserve, phone conversation, July 29, 2008

Robert Stiles, Samford University, phone conversation, June 6, 2008.

Robert Stiles, Samford University and Dick Mills, World Discovery Safaris, July 15, 2008.

Keller, Environmental Protection Agency, email report to Daniel Drennen, April, 2002.

Robert Stiles and Paul Blanchard, Samford University, June, 2000.

Personal Observations:

Daniel J. Drennen, Field Observations, 2000, 2002, 2005, 2008.

U.S. FISH AND WILDLIFE SERVICE
5-year Review for the Blue shiner (*Cyprinella caerulea*)

Current Classification: Threatened
Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X No change is needed

Review Conducted By Daniel J. Drennen, Mississippi Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve: _____ **Date:** 9-16-14

REGIONAL OFFICE APPROVAL:

for
Lead Regional Director, Fish and Wildlife Service

Approve: _____ Date: 10-14-14

APPENDIX A: Summary of peer review for the 5-year review of Blue Shiner (Cyprinella caerulea)

A. **Peer Review Method:** We shared the draft 5-year review to peer reviewers via email/mail. These individuals are considered to be species experts.

Peer Reviewers:

Dr. Byron Freeman
Senior Public Service Associate
Odum School of Ecology
University of Georgia
Ecology Bldg.
Athens, GA 30602-2202

Andrew R. Henderson
Aquatic Endangered Species Biologist
Tennessee Valley Authority
400 Summit Hill Drive, WT 11C
Knoxville, TN 37902

Dr. Carol Johnston
Associate Professor
Fish Biodiversity Lab
Department of Fisheries
Auburn University
Auburn, AL 36849

Dr. Mark Meade
Jacksonville State University
Department of Biology 242 Martin Hall
700 Pelham Road
Jacksonville, AL 36265

Dr. Pat O'Neil
Geological Survey of Alabama
P.O. Box 869999
Tuscaloosa, AL 35486-6999

Patrick Rakes
Conservation Fisheries, Inc.
3424 Division Street
Knoxville, TN 37919-3261

Steve Rider
Alabama Division Wildlife and Freshwater Fisheries
64 N. Union Street, Suite 551
Montgomery, Alabama 36130
Mary Shew
Little River Canyon National Preserve
4322 Little River Trail NE, Suite 100,
Fort Payne, AL 35967

Dr. Bob Stiles
2221 Great Rock Road
Birmingham, Al 35216

B. **Peer Review Charge:** Peer reviewers were not given specific directions or forms to fill out for their review. We asked for their simple assistance in reviewing the science and data in this document.

C. **Summary of Peer Review Comments** – Dr. Freeman, Dr. Johnson, Dr. Stiles, Mr. Rider and Mrs. Shew did not respond back with comments on the review. We did receive comments and new literature cited documents from Dr. O'Neil, Dr. Meade, Mr. Rakes and Mr. Henderson.

D. **Response to Peer Review** – Peer reviewer edits were evaluated and incorporated into the revised document as appropriate. In addition, the results of one non-published species survey project were incorporated into this report including field data locality information for the species in Choccolocco Creek.

Appendix A. Summary of peer review for the 5-year review of the Blue Shiner (*Cyprinella caerulea*)

A. Peer Review Method: The Service conducted peer review. Nine peer reviewers were selected by the Service for their knowledge of and expertise with the Blue Shiner. Individual responses were received from four of the peer reviewers.

Peer Reviewers:

Mr. Andrew Henderson, Tennessee Valley Authority- provided editorial comments and information concerning the threat of Red Shiners on the status of the Blue Shiner.

Pat Rakes, Conservation Fisheries Inc.-provided editorial comments and additional information concerning husbandry of the species and additional comments on threats of the species.

Dr. Mark Meade, Jacksonville State University-provided unpublished information about his survey of the Blue Shiner in the Choccolocco Creek watershed along with potential threats including degrading water quality and the possibility of the Asiatic Weatherfish as an invasive species in the Blue Shiner range.

Dr. Pat O'Neil, Alabama Geological Survey- provided editorial comments and additional information along with clarification of range of the Blue Shiner in Alabama and threats to the species.

B. **Peer Review Charge:** See attached guidance.

C. **Summary of peer Review Comments:**

Overall, peer reviewer comments were supportive of the information and conclusions presented in this reviewed. Dr. Meade of Jacksonville State University provided unpublished field notes of collection data for the species and possible threats to the species in the Choccolocco Creek watershed. Also provided were some observations concerning the Asiatic Weatherfish and possibility that this invasive species will be a threat to the Blue Shiner. Mr. Henderson of the Tennessee Valley Authority provided a publication concerning the threat of Red Shiners on the status of Blue Shiners. Dr. O'Neil provided unpublished collection records and notes concerning the species range in Alabama.

D. **Response to Peer Review:** Comments and concerns received from peer reviewers were addressed and incorporated into this 5-year review as appropriate, grammatical errors were corrected, various sentences were revised for clarity, localities were clarified and citations updated. Additional information was included concerning location data within Choccolocco threat along with possible new or existing threats.