Goldline Darter (*Percina aurolineata*)
5-Year Review:
Summary and Evaluation

Photo by Eric Spadgenske, USFWS.

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

5-YEAR REVIEW
Goldline Darter (*Percina aurolineata*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to 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 with a 60-day comment period (72 FR 42425). We conducted an internet search, reviewed all information in our files, and solicited information from knowledgeable individuals familiar with this species including those associated with academia and State conservation programs. Specific sources included the final rule listing this species under the Endangered Species Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by the U.S. Fish and Wildlife Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. The completed draft was sent to other associated Service offices and nine peer reviewers. Comments are incorporated, as appropriate, into this final document (see Appendix A).

B. Reviewers

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

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

Cooperating Field Offices – Georgia Ecological Services Field Office, Robin Goodloe, 706-613-9493; **Alabama Ecological Services Field Office,** 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: Slightly improved. Site specific data and minor improvements in habitat indicate some improvements in status over the last 5 years.

3. **Recovery achieved:** 1 (1= 0-25% species' recovery objectives achieved): Some site specific habitat improvements have occurred. There has been greater awareness of the importance of good water quality of specific reaches and awareness through implementation of TMDLs (Total Minimum Daily Load) for nutrients and pathogens.

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

5. **Review History:**
Recovery Plan: 2000
Recovery Data Call: Annually from 1998-2014

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: Recovery Plan for the Mobile River Basin Aquatic Ecosystem
Date issued: November 17, 2000

II. REVIEW ANALYSIS

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

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

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

B. Recovery Plan and Criteria

1. **Does the species have a final, approved recovery plan containing objective measurable criteria?** Yes. It is included in the *Recovery Plan for the Mobile River Basin Aquatic Ecosystem* (USFWS 2000).

2. **Adequacy of recovery criteria.**

a. **Do the recovery criteria reflect the best available information on the biology of the species and its habitat?** Yes.

b. **Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?** Yes, however, we are interested in conducting a population viability analysis (PVA) on the species to gain more information..

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:

The goldline darter will be considered for delisting when the following criteria are met:

Criteria 1: The known populations of the species (goldline darter) are shown to be stable or increasing for a period of at least 5 years.

Status: Criteria partially met.

Alabama

The goldline darter is known sporadically from 43 km (27 mi) of the Cahaba River and three of its' tributaries: 1.9 mi (3.1 km) of Shultz Creek; about 3mi (4.8 km) of Shades Creek (O'Neil, pers comm., 2014, 2008; Kuhajda, pers. comm., 2008; Kuhajda 2007); and, sporadically from 11 km (7 mi) of the Little Cahaba River, including Bulldog Bend. Currently, as indicated by recent sampling efforts (O'Neil, pers comm., 2014), the species may be expanding in portions of its range, such as the main Cahaba River channel and the upper portion of Shades Creek.

Goldline darters historically existed in approximately 78.9 km (49 mi) of the Cahaba River and almost 11.3 km (7 mi) of the Little Cahaba River (Boschung and Mayden 2004; USFWS 2000; Stiles 1990, 1978). Thus, there has been an overall reduction in the Cahaba River total range of about 35km (22 mi) when current and historical ranges are compared.

In Alabama, there are no definitive population viability analyses available (O'Neil, pers comm., 2008; Kuhajda, pers. comm., 2008; Kuhajda 2007).

Georgia

The goldline darter is known sporadically from 102.4 km (63.6 mi) of the upper Coosa River drainage in Georgia (Albanese, pers comm., 2014; Albanese *et al.* 2013; Powers 2008; Stiles 2004; Boschung and Mayden 2004; Freeman and Troth 1999; Mettee *et al*. 1996) including portions of the Cartecay (38.9 km; 24.2 mi),

Ellijay (26.5 km; 16.5 mi) and upper Coosawattee (18.1 km; 11.3 mi) rivers, and Mountaintown Creek (18.8 km; 11.7 mi) within Murray, Gordon, Pickens and Gilmer counties (Powers 2008, Freeman and Troth 1999). The species is no longer in Talking Rock Creek (28.9 km; 18.0 mi) and below Carters Dam/ the lower Coosawattee River (21.6 km; 13.4 mi) (derived from Albanese *et al*. 2013). Recently, Albanese *et al.* (2013) assessed the conservation status and habitat use in Georgia and found the species at a high proportion of sites upstream of Carters Lake. However, Albanese (pers comm. 2014) estimated the species had lost 50.5 km (31.4 mi) or 33% of its' total range in Georgia.

In both the Alabama and Georgia portions of the species' range, population parameters such as natality, mortality, sex and age ratios etc., have not been determined. The total usable and available habitat (river miles) to the species is unknown. The scarcity of the fish, the difficulty in capturing it, and lack of any long-term monitoring preclude a definitive analysis of the population's status, at this time (Boschung and Mayden 2004).

Criteria 2: There has been a demonstrated trend in water quality improvement in the reach of the Cahaba River occupied by this fish. (Note that in the recovery plan for the species, there is no mention of the Georgia populations).

Status: Criteria partially met.

Minor site specific habitat improvements and slight increases of goldline darter relative density numbers at the former Marvel Slab (a low head dam) and box car sites, may be attributed to water quality improvements and reconnecting fish passage to historical habitat (Kuhajda 2007), but it does not reflect overall increases in the species and viable populations.

The Cahaba River continues to have water quality impairments (ADEM 2006). Extensive urban development of the metropolitan Birmingham area has led to many point and non-point sources in the upper Cahaba River, including large municipal waste-water treatment plants, agriculture, golf courses, urban lawn care, housing developments and water extraction by water work supply stations (Onorato *et al.* 2000).

Sedimentation in stormwater runoff from urbanized areas and eutrophication from nutrient loading by municipal wastewater and non-point sources (ADEM 2013; USEPA Region 4 2000, 1979; ADEM 2006; Shepard, pers. comm., 2011; Shepard 1994) are causes to water quality degradation. Sedimentation is intensified by silviculture, livestock production, and recently by re-establishing coal mines and their infrastructure (Howard *et al.* 2002). Howard *et al*. (2002) found that

excessive sedimentation and nutrient enrichment are affecting the overall biology of the Cahaba River (Alabama River) watershed.

Specific biological data indicates that the health of the aquatic community structure upstream, within, and downstream of the goldline darter range varies from fair to poor based on species diversity, benthic community structure, and biological condition (ADEM 2006). Since the species deposits eggs in sand and gravel in an eddy zone below large rocks (Boschung and Mayden 2004), sediment deposition can be deleterious on the fish and benthic macroinvertebrate communities.

Criteria 3: Community developed watershed plans are implemented to protect and monitor water and habitat quality in all occupied watersheds.

Status: Criteria partially met.

Community action outreach groups strive to protect water quality and quantity through grass roots, non-profit conservation and other types of organizations. Organizations and institutions such as: Cahaba River Society (on going public monitoring and outreach of the watershed), Conasauga River Alliance (supports wise use of the Conasauga River system), Coosawattee Watershed Alliance (supports wise use of the Coosawattee River system) and others, have published various watershed and specific reach management and conservation plans (e.g., Friends of Shades Creek 2008, Coosawattee Watershed Alliance 2008, Alabama Clean Water Partnership 2007, McKinney 2006, Cahaba River Society 2005). Community action groups have worked along with State and Federal agencies, city and county governments, to help distribute information to the public and landowners, conduct inventories and surveys and attempt to regulate actions that adversely affect water quality and quantity. Although outreach of the management plans for protecting water quality and quantity have occurred and initiated, the overall trend within the goldline darters' current range has shown minimal quantitative improvement in water quality.

C. Updated Information and Current Species Status

1. Biology and Habitat

The goldline darter inhabits mainly fifth order streams (Freeman and Troth 1999), with width of 15 m to 60 m (49 ft. to 197 ft.) (Suttkus and Ramsey 1967), in moderate to swift currents from 11 cm/s (4.3 in/s) to 73 cm/s (28.7in/s), and in depths of 30 cm to 0.6m (11.8 in to 1.96 ft.) or greater.

Riffle and run substrates consists of sand, gravel and cobble and boulders (Freeman and Troth 1999), often in association with patches of sand,

riverweed (*Podostemum ceratophyllum*),water willow (*Justicia* sp.) (Boschung and Mayden 2004, Howell *et al*. 1982) and woody debris (Freeman and Troth 1999). Persistence of goldline darters in pebble and gravel habitats throughout the summer (i.e., post spawning) suggests that these habitats may also be important for foraging (Albanese *et al.* 2013*).* The lack of relationships with other habitat variables suggests that the species are likely to be detected across a range of depths, velocities and riverweed coverages occurring within riffle-run habitats (Albanese *et al.* 2013*).*

Rakes and Shute (2003) detailed aspects of the goldline darter's spawning behavior and egg deposition in captivity where the spawning season was from late February until early June, with the majority of spawning occurring for 6 weeks from mid-April through May. Boschung and Mayden (2004) reported spawning in the wild from early April to July. Rakes and Shute (2003) found that eggs were adhesive when recently spawned, attaching to sand and debris. Embryonic and early larval development was rapid, strongly phototrophic (respond to sunlight), and larvae tended to hold their body position in areas of gentle current with bodies tilted head upward at about 30 degree upward angle possibly to facilitate swimming and feeding.

Genetics

A 2013 mitochondrial and nuclear DNA study by Powers indicates that the two populations of goldline darters (Cahaba and Coosawattee river systems) are a single species and do not represent Evolutionary Significant Units due to the overall similarity of their genetics. This supports the hypothesis of Suttkus and Ramsey (1967) that goldline darters were once more broadly distributed across the Alabama River drainage with gene flow between populations and the current distribution is the result of extirpation in intervening waters. There is a unique allele for the RAG1 nuclear gene found exclusively in the Cahaba River at a frequency of 0.559 indicating that there was some genetic differentiation between these two populations over the 300 river kilometers that separate them and they should be treated as separate management units.

Within the Cahaba River system, genetics indicate that this is a single panmictic population (no mating restrictions in the population; all individuals are potential recombination partners) with limited or no restrictions to gene flow (Powers 2013).

2. Five-Factor Analysis

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

The species is found sporadically in approximately 102 km (63 mi) of river reach of which contains the Cahaba River, Little Cahaba River, and the Upper Coosa River watershed including the upper Coosawattee River, Ellijay River, Cartecay River, and Mountaintown Creek (Boschung and Mayden 2004, Albanese *et al.* 2013).

Alabama: Cahaba and Little Cahaba River
Water Quality/Quantity and Development

The current range of the goldline darter in Alabama includes portions of the mid-Cahaba River from just downstream of the confluence with Buck Creek (Davenport, Samford University, Birmingham, pers comm. 2008) downstream to the old Marvel slab bridge in Shelby, Bibb and extreme north Perry counties. Also, recently included is about 4.8 km (3 mi) of Shades Creek upstream from the confluence with the Cahaba River (Kuhajda 2007), along with most of the Little Cahaba River. The goldline darter is also found in portions of Schultz Creek (9.0 km, 5.6 mi) in Bibb County from the confluence of Schultz Creek with the Cahaba River upstream to the confluence with Hill Creek (Stiles 2000). Within the Little Cahaba River in Bibb County, the goldline darters are found from about 1.3 km (0.8 mi) of the confluence with the Cahaba River to about 13.7 km (8.5 mi) upstream at the confluence with Alligator Creek (Stiles 2000).

Studies in general show that increased urbanization generally leads to declining water quality in streams and fish assemblages (Onorato *et al*. 2000, Anderson *et al*. 1995, Waters 1995, Weaver and Garman 1994). In particular, Honavar (2003) observed a negative correlation between water quality (sedimentation) and percent relative abundance of crevice spawning minnows and darters in the Cahaba River system. Historically, point- and non-point source pollution have resulted in decreased water quality coinciding with extirpation of the blue shiner (*Cyprinella caerulea*) and other aquatic species from the Cahaba River (U.S. Environmental Protection Agency 2000,1979; Sheppard *et al*. 1994; Pierson and Krotzer 1987; O'Neil 1984; Howell *et al*. 1982; Ramsey 1982). Impairment of aquatic life in the Cahaba River has been related to nutrient over-enrichment compounded by sedimentation and extremes in prevailing hydrologic patterns as reflected in decreased diurnal dissolved oxygen fluctuations at Piper Bridge (the upper mid-range of the species). Conversely recent surveys in seven sites of the Locust Fork may indicate

improvement in the sampled river reach based on fair to excellent in total Index of Biological Integrity (IBI) scores (O'Neil, pers. comm., 2012).

The Cahaba River has been subject of intense scrutiny and enforcement activity due to sanitary sewer overload from 24 municipal and 16 private sewage treatment plants (Meyland *et al*.1998) and consequently during high flows has very high fecal *coli* form concentrations in certain river segments (Alabama Department of Environmental Management 2003). Changes in temperature and photoperiod appear to be the most important controlling factors in the regulation of reproductive cycles of fishes (Krotzer 1984). Excessive turbidity caused by silt, change temperature and photoperiod, and adversely effects reproduction by preventing courtship and territorial displays and survivorship of eggs (Mayden 1989, Krotzer 1984). Honavar (2003) observed a negative correlation between water quality (sedimentation) and percent relative abundance of crevice spawning minnows and darters in the Cahaba River system.

Georgia: Upper Coosa River
Water Quality/Quantity and Development

Albanese *et al* (2013) documented the current status of the species in Georgia. His models indicate a high probability of suitable habitat within the mainstem Coosawattee River and large tributaries upstream of Carters Lake.

However, increased urbanization in the upper Coosawattee River and on the floodplain of Talking Rock Creek has resulted in a loss of the riparian zone (Powers 2008). Loss of riparian habitat may have a strong influence on local instream habitat by either reducing nutrient inputs to the stream or increasing erosion because of decreasing steam bank stability (Waters 1995). Toxic leaks resulting from storm water runoff, such as gasoline and oil, are routinely documented flowing directly into the Coosawattee River upstream from the city of Ellijay (Freeman and Troth 1999). In general perflurinated chemicals (a family of fluorine-containing chemicals with unique properties to make materials stain and stick resistant; such as Teflon™ or Scotchgard®) within the Conasauga River system in Georgia are a threat to the fish diversity in the watershed (Konwick *et al*. 2008)**.** The greatest density of Environmental Protection Agency regulated sites are located in the Ellijay area and represent a greater potential for environmental degradation than exists in other areas.

The species is threatened in Georgia by habitat loss and population fragmentation associated with Carters Lake and water quality impacts associated with poor land use (Powers 2008). Development is an emerging

threat to the Coosawattee watershed where Gilmer County has had a 24% increase of population size between 2000 and 2009, and the Coosawattee River basin has had a corresponding 3.5% increase in constructed or built on land and a 2.4% decrease in forest cover (Natural Resource Spatial Analysis Lab 2012 in Albanese *et al.* 2013).

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 the case of this species, may produce several isolated goldline darter populations. Isolation makes the populations more susceptible to environmental changes, such as a decreased genetic diversity and reproduction.

Flow in the lower Coosawattee River is regulated by releases from Carter Dam, potentially affecting the species, which is considered extirpated from this reach.

b. Overutilization for commercial, recreational, scientific, or educational purposes: At the time of listing, overutilization was not deemed to be a likely threat to this fish. We do not have any new information indicating that overutilization is a threat to this fish. Specifically scientific collecting is not considered a threat; due to control of scientific collecting by the States of Alabama and Georgia through the issuance of collection permits

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

d. Inadequacy of existing regulatory mechanisms:

In the State of Alabama the species is protected by Code of Alabama §§ 220-2-.92: and 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.

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), and Georgia Water Quality Control Act (O.C.G.A. 12-5-20). Alabama and Georgia follow traditional common-law riparian doctrine which associates the right to use water with ownership of land abutting the water (Elliott 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 and Georgia are still inadequate.

In Alabama, the goldline darter is offered some protection in the Cahaba River National Wildlife Refuge. In Georgia, the Chattahoochee National Forest (Powers 2008) protects some headwaters along with the Rich Mountain Wildlife Management Area and by municipal and county planning (Etowah Habitat Conservation Plan Advisory Committee 2007, Coosa North Georgia Water Planning Council 2011).

In summary, regulatory mechanisms are in place to protect aquatic species, but multiple stream reaches within the occupied habitat of the goldline darter, 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:

The concern, at the time of listing, that the increased fragmentation of the goldline darter habitat and isolating of existing populations would continue to make the species more susceptible to environmental changes and decreased genetic diversity is still accurate. 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 have resulted in producing several isolated goldline

darter populations. Isolation makes the populations more susceptible to environmental changes resulting in decreased genetic diversity and reproduction.

However, in Alabama, the removal of the Marvel Slab on the Cahaba River in 2004 (Kuhajda 2007) established connectivity to the populations of goldline darters in the Cahaba River. Increases of goldline darters were noted after the Marvel Slab was removed on the Cahaba River in 2004. Two new riffle habitats for the goldline darter were created (Kuhajda 2007), confirming the positive response of restored riffle habitat upon removal of barriers.

In Georgia, Carters Lake, a 1,295 ha (3,200 acre) impoundment fragments and blocks fish passage of the species at the junction of the Blue Ridge and the Ridge and Valley physiographic provinces. An additional dam and fish passage obstruction, occurs downstream of Carters lake dam and fragments Talking Rock Creek from the Ridge and Valley portion of the Coosawattee River (Albanese *et al.* 2013). Goldline darters may be more sensitive to isolation (e.g., perched culverts, dams) than species comprised of demographically independent populations (Albanese *et al* 2013)

D. Synthesis

Improvements to the goldline darter condition since listing include: 1) in Alabama, protection in the Cahaba River National Wildlife Refuge and in Georgia, protection of headwater streams and mainstem reaches by the Rich Mountain Wildlife Management Area, and municipal and county planning (Coosa North Georgia Water Planning Council 2011, Etowah Habitat Conservation Plan Advisory Committee 2007); 2) site specific improvements of connectivity and fish passage within the Cahaba River at the Marvel Slab and box car culverts in Shades Creek; 3) marginal water quality improvements and TMDL designations in the Cahaba River, Little Cahaba River, Shades and Schultz creeks in Alabama, and the Cartecay, Ellijay and Coosawattee rivers, and Mountaintown Creek in Georgia; and 4) some increase in relative abundance of the species at site specific reaches within the Cahaba River system.

The goldline darter in Georgia has lost 50.5 km (31.4 mi) or 33% of its' total range We do not have adequate status survey information and population viability estimates necessary to determine population status. The species limited site specific distribution and small population creates vulnerability to random natural or human induced events that negatively impact water quality and water quantity. We also have accelerated development in the range of this fish which creates habitat modification threats for this fish.

Protection and enhancement of water quality and water quantity is necessary for the species' survival in both watersheds. We do not have long-term monitoring information on both populations, to demonstrate success in completely meeting the recovery criteria in the recovery plan. Therefore, the goldline darter continues to meet the definition of threatened species under the Act.

III. RESULTS

A. Recommended Classification:

No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Focus monitoring on the areas of high habitat suitability identified in Georgia and extending this model to the Cahaba River population.

2. Initiate long-term monitoring and PVA of the species that includes age/sex information, natality and mortality, larval and juvenile fish life stages.

3. Continue surveys of the Cahaba River and upper Coosa River basins with suitable habitat that may have the chance of containing goldline darters. Use new technology in surveying specifically environmental DNA survey methods.

4. Work to obtain protection for riverine and tributary buffering on privately owned lands specifically by forming relationships with landowners and working with conservation groups, state, county and town governments.

5. Establish best management and conservation practices to improve water quality and water quantity issues by reducing stormwater runoff, sediment and eutrophication. Protect through cooperative agreement, conservation easement, fee title purchase or other means to guarantee safeguards to the water quality, especially turbidity, water quantity, geomorphology, hydrology and other aspects of the habitat and natural history of the species.

6. Work to enforce existing regulations and land management laws should be enforced along with implementation of existing conservation and water quality and water quantity plans.

7. Continue developing techniques for propagation and husbandry of the species.

8. Revise and expand the recovery plan as a stand-alone document to reflect new information like the Georgia populations and refine criteria.

V. REFERENCES

Alabama Department of Environmental Management. 2013. Final. Total maximum daily loads (TMDLs) for the Cahaba River Watershed. Pathogens (*E. coli*). Water Quality Branch. Montgomery, AL. 50 pp.

Alabama Department of Environmental Management. 2006. Final. Total maximum daily loads (TMDLs) for the Cahaba River Watershed. Water Quality Branch. Montgomery, AL. 95 pp.

Alabama Department of Environmental Management. 2003. Total maximum daily loads (TMDLs) for the Cahaba River Watershed. Water Quality Branch. Montgomery, Al. 58 pp.

Alabama Clean Water Partnership. 2007. Reporting period Nov. 14, 2006 thru March 31, 2007. Cahaba River basin clean water partnership. Report submitted by Kellie Johnston. 25 pp.

Albanese, B., T. Litts, N. Camp, and D. Weiler. 2013. Using occupancy and species distribution models to assess the conservation status and habitat use of the Goldline Darter (*Percina aurolineata*) in Georgia, USA. Ecology of Freshwater Fishes. 2013. 13 pp.

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.

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.

Cahaba River Society. 2005. Upper Cahaba Plan. http://www.cahabariversociety.org/crsfact.htm

Coosa North Georgia Water Planning Council. 2011. Coosa north Georgia's water development and conservation plan. Atlanta, GA: Georgia Department of Natural Resources. Available online at: http://www.coosanorthgeorgia.org/. Accessed 23August, 2013.

Coosawattee Watershed Alliance. 2008. http://www.coosawatteewatershedalliance.org/

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

Etowah Habitat Conservation Plan Advisory Committee. 2007. Draft Etowah aquatic habitat conservation plan. Athens, GA: University of Georgia River Basin Center. Available online at: http://www.etowahhcp.org. Accessed 25 August 2014.

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, GA. 84 pp.

Freeman, B.J. and B.C. Troth. 1999. Identification and mapping of critical habitats in the Etowah system. Section VI, Annual Report. Georgia Department of Natural Resources. 80 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.

Friends of Shades Creek. 2008. http://www.shadescreek.org/

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, H., B. Quinn, M. Flexer, 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 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.

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.

Krotzer, R.S. 1984. The ecological life history of the blue shiner, *Notropis caeruleus* (Jordan), from the Conasauga River, Georgia. M.S. Thesis, Samford Univ., Birmingham. 38 pp.

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.

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.

McKinney, S. 2006. Stormwater planning for the upper Cahaba watershed. International urban water systems-CE691, assignment #6. 12 pp. http://www.ecosystemvalue.org/DOCTORATE/ClassWork/CE691-InternationalUrbanWaterSystems/Assignment6/McKinneySteve-InternationalUrbanWaterSystemsCE691-Assignment6-2006-05-03.htm

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.

Meyland,S., M.Lalor, and R.Pitt. 1998. Monitoring and assessing the environmental and health risks of separate sanitary sewer overflows (SSOs). http://acwi.gov/monitoring/conference/98proceedings/Papers/14-MEYL.html

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.

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.

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. Geol. Suv. Al. 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.

Powers, S.L. 2013. Testing for genetic diversity within and among isolated populations of a threatened species in Georgia and Alabama, *Percina aurolineata*, Goldline

Darter (Percidae). Final report to Georgia Department of Natural Resources, Social Circle, GA. 14 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. 2003. Development of captive propagation techniques for the threatened Goldline Darter, *Percina aurolineata*. Final report to U.S. Fish and Wildlife Service. Daphne, Al. 12 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.

Sheppard, T.E., P.O'Neil, S.W. McGregor, and S.C. Harris. 1994. Report to the U.S. Fish and Wildlife Service, Jackson, MS. 426 pp.

Stiles, R. A. 2004. Goldline Darter, *Percina aurolineata* Suttkus and Ramsey. Pp.196 in R.E. Mirarchi, J.T. Garner, M. F. Mettee, P.E. O'Neil, eds. Alabama wildlife. Volume 2. Imperiled aquatic mollusks and fishes. The University of Alabama Press, Tuscaloosa, AL.

Stiles, R.A. 2000. A preliminary report on the current distribution of the Goldline Darter, *Percina aurolineata* , in the Cahaba River System of Alabama. Report to the U.S. Fish and Wildlife Service. Jackson. 11pp.

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.

Suttkus, R. D. and J. S. Ramsey. 1967. *Percina aurolineata*, a new percid fish from the Alabama River system and a discussion of ecology, distribution, and hybridization of Darters of the subgenus *Hadropterus*. Tulane Studies in Zoology 13: 129-145.

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. 2000. Mobile Basin Aquatic Ecosystem Recovery Plan. Atlanta, GA. 128 pp.

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

Waters, T.F. 1995. Sediment in Streams, Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. Bethesda, MA. 251 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.

Personal communication:

Dr. Brett Albanese, Georgia Department of Natural Resources, Social Circle, GA. Estimation of goldine darter range in Georgia. 2014.

Dr. Larry Davenport, Samford University, Birmingham, AL. July 23, 2008. Memo to Jackson Field Office of fish collections in and around Buck Creek and Cahaba River confluence, 2006.

Dr. Bernie Kuhajda, University of Alabama. Tuscaloosa, AL. July 21, 2008. Memo to Jackson Field Office of collections from Cahaba River at, above, and below the Marvel Slab 2005-07, and Shades Creek 2006-08.

Dr. Pat O'Neil, Alabama Geological Survey, Tuscaloosa, AL. August, 2014. Field spreadsheet, email.

Dr. Pat O'Neil, Alabama Geological Survey, Tuscaloosa, AL. telephone convers. 2012. IBI Scores

Dr. Pat O'Neil, Alabama Geological Survey, Tuscaloosa, AL. July 21, 2008. Memo to Jackson Field Office of collections from Shades Creek 1994 and 2008.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Goldline Darter (*Percina aurolineata*)

Current Classification: Threatened.

Recommendation resulting from the 5-Year Review:

__X__ **No change needed**

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

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Cary Wright Date 12/1/14

REGIONAL OFFICE APPROVAL:

for

Lead Regional Director, Fish and Wildlife Service

Approve Aaron Valdez Date 5-12-15

Appendix A. Summary of peer review for the 5-year review of the goldline darter (*Percina aurolineata*)

A. Peer Review Method: Peer review was requested from nine knowledgeable individuals: Dr. Brett Albanese (Georgia Dept. of Natural Resources), Dr. Byron Freeman (University of Georgia), Dr. Bernard Kuhajda, (Tennessee Aquarium), Dr. Pat O'Neil (Alabama Geological Survey), Steve Rider (Alabama Division of Wildlife and Freshwater Fisheries), Dr. Steven Powers (Reinhardt College), Patrick Rakes (Conservation Fisheries), Dr. Bob Stiles (Samford University), and Dr. Randy Haddock (Cahaba River Society). Responses were received from four of the nine peer reviewers.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments/Report: Peer reviewer responses were supportive of the information and conclusions presented in this review. It was brought to our attention that there were some reach distances occupied by the species that needed to be increased slightly. A specific reach was the Schultz Creek reach from the confluence of the Cahaba River up to the confluence with Hill Creek. Corrections were made as were some minor technical additions.

Powers provided new genetic information on the species. He found that the two populations of goldline darters (Cahaba and Coosawattee river systems) may be a single species and possibly do not represent Evolutionary Significant Units supporting the hypothesis of Suttkus and Ramsey (1967) that the species were once more broadly distributed across the Alabama River. There may be some genetic differentiation between these two populations over the 300 river kilometers that separate them. More work is needed to determine if the populations should be treated as separate management units.

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 Shultz Creek.

Guidance for Peer Reviewers of Five-Year Status Reviews
U.S. Fish and Wildlife Service, Mississippi Ecological Services Field Office

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.

2. Identify, review, and provide other relevant data apparently not used by the Service.

3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.

4. Provide written comments on:
    - Validity of any models, data, or analyses used or relied on in the review.
    - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
    - Oversights, omissions, and inconsistencies.
    - Reasonableness of judgments made from the scientific evidence.
    - Scientific uncertainties by ensuring that they are clearly identified and characterized and that potential implication of uncertainties for the technical conclusions drawn are clear.
    - Strengths and limitation of the overall product.

5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author.

Questions regarding this guidance or the peer review process should be referred to Daniel Drennen, Mississippi Ecological Services Field Office, at (601) 321-1127; e-mail: daniel_drennen@fws.gov.