Five-Year Review: Summary and Evaluation

Etowah Darter
(***Etheostoma etowahae*** Wood and Mayden 1993)

Cherokee Darter
(***Etheostoma scotti*** Bauer, Etnier, and Burkhead 1995)

Amber Darter
(***Percina antesella*** Williams and Etnier 1977)

(Etowah darter; photo by The Nature Conservancy)

U.S. Fish and Wildlife Service
Southeast Region
Georgia Ecological Services Field Office
Athens, Georgia

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FIVE-YEAR REVIEW

Etowah Darter (*Etheostoma etowahae*)
Cherokee Darter (*Etheostoma scotti*)
Amber Darter (*Percina antesella*)

I. GENERAL INFORMATION

A. Methodology Used to Complete the Review

Staff from the Georgia Ecological Services Field Office, U.S. Fish and Wildlife Service (Service), prepared this five-year review based on the best available information about Etowah, Cherokee, and amber darter distributions, life histories, and habitat requirements. Evaluation of the three species' status was combined into a single document because they share similar habitats and face similar threats in the Etowah River basin.

Our reference point document for the amber darter review was the Service's *Mobile River Basin Aquatic Ecosystem Recovery Plan* (2000). Reference point documents for our review of the status of the Etowah and Cherokee darters were the publications that formally described the species (Wood and Mayden 1993, Bauer et al. 1995); the final rule listing the fishes under the Endangered Species Act of 1973, as amended (ESA); and the Service's *Mobile River Basin Aquatic Ecosystem Recovery Plan*.

A July 6, 2009, *Federal Register* notice (74 FR 31972) announcing these reviews offered the public a 60-day comment period. We also conducted a search of Internet and peer-reviewed scientific literature, reviewed unpublished reports and field observation notes in our files, held five Coosa and Conasauga Summits from 2000-2008 that allowed scientists working in the basin to disseminate new research and survey information, and solicited information from knowledgeable individuals in academia, State and Federal agencies, and other conservation groups. No new species surveys or data analyses were conducted expressly as part of this review; major sources of information in our evaluation included research and other studies conducted 2002-2010 in the Etowah River basin to develop a draft Habitat Conservation Plan (HCP), 1995-2010 in the Conasauga River basin to monitor impacts of an off-line reservoir, and 1996-present in both basins to meet Georgia Department of Natural Resources (GDNR) grant requirements.

B. Reviewers:

Lead Field Office: Georgia Ecological Services Field Office, Robin Goodloe and Michael Pixley (student intern); 706-613-9493

Cooperating Field Office(s): Peggy Shute, Tennessee Ecological Services Field Office, 931-528-7075; peggy_shute@fws.gov.

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

Peer Reviewers: A draft of this document was reviewed by aquatic scientists with expertise on Etowah, Cherokee, and amber darters and their habitats (Appendix B).

C. Background

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

2. **Species status**:

   Etowah darter: Stable. The major threat to this species, urban development, has been limited since the 2007- 2009 recession on housing and commercial development in the metro-Atlanta area.

   Cherokee darter: Decreasing. Construction/filling of the Hollis-Latham and Hickory Log Creek Reservoirs impacted two large populations of this fish. Road construction, utility installation, and other projects that tend to directly impact smaller tributaries where Cherokee darters occur have continued through the recession and its aftermath. However, overall Cherokee darter persistence appears stable at many sites. Freeman and Hagler (2012) sampled 20 sites in 2011 that historically harbored Cherokee darters to assess persistence: Cherokee darters were collected at each of the 20 locations in 2011. Although persistence appears high, Bauer et al. (1995) noted that numerous populations appeared to persist in low abundance.

   Amber darter: Decreasing in both the Etowah and Conasauga basins. Hagler and Freeman's (2014) analysis of 1998-2009 fish collection data at 10 Etowah mainstem shoals between the confluences of Amicalola and Sharp Mountain Creeks found a declining trend over time for amber darter numbers, although this decline may have slowed or reversed over the past five years, when urban development has been limited. The number of amber darters USGS and University of Georgia scientists collected 1996-2008 at seven fixed sites in the Conasauga mainstem downstream of TN Hwy 74 to Tibbs Bridge Road was highly variable annually, but showed a decreasing trend (Golder Associates 2010). Survey work completed 2011-2012 by Hagler and Freeman (2012) documented a continued downward trajectory for sites between TN Hwy 74 and Tibbs Bridge Road, although no evidence of decline was noted at three sites in the upper Conasauga's Cohutta Wilderness.

3. **Recovery achieved**:
   Etowah darter: 2 (26-50% recovery objectives achieved)
   Cherokee darter: 2 (26-50% recovery objectives achieved)
   Amber darter: 2 (26-50% recovery objectives achieved)

4. **Listing History:**

Etowah and Cherokee: darters	FR notice: 59 FR 65505; Date listed: December 20, 1994 Entity listed: both species Classification: Etowah darter – endangered; Cherokee darter – threatened
Amber darter:	FR notice: 50 FR 31597; Date listed: August 5, 1985 Entity listed: species Classification: endangered

5. **Review History:**
   Recovery Data Calls FY 2000-2013
   Coosa Summits 2000, 2001, 2003, 2006; Conasauga Summit 2008

Previous 5-Year Reviews: The Service conducted a five-year review for the amber darter in 1991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessments of the five factors or threats as they pertain to the individual species. The notice stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the fish's listing classification was found to be appropriate.

6. **Species' Recovery Priority Number at start of review (48 FR 43098)**:
   Etowah darter – 2 Cherokee darter - 2C Amber darter - 5

   A recovery priority number of 2 means that the species is highly threatened but also has a high potential for recovery; the C denotes species that are, or may be, in conflict with development projects or other forms of economic activity. A recovery priority number of 5 means the species is highly threatened with low potential for recovery.

7. **Recovery Plans**
   Etowah/Cherokee darters: Mobile River Basin Aquatic Ecosystem Recovery Plan, Date Issued: November 17, 2000

   Amber darter: Recovery Plan for Conasauga Logperch (*Percina jenkinsi*) Thompson and Amber Darter (*Percina antesella*) Williams and Etnier, Date Issued: June 20, 1986.

   The Mobile River Basin Aquatic Ecosystem Recovery Plan (2000) complemented the 1986 amber darter recovery plan. It provided an updated recovery outline, but no new recovery criteria, for the species.

II. REVIEW ANALYSIS

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

1. **Are these species under review listed as DPSs?** No

2. **Is there relevant new information that would lead you to consider listing these species as a DPS in accordance with the 1996 policy?**
   Etowah and amber darters: No
   Cherokee darter: Recent genetics research suggests the Service may need to reconsider classification, but further studies are needed.

B. Recovery Criteria:

1. **Do the species have final approved recovery plans with objective, measurable criteria?** Yes

2. **Adequacy of recovery criteria.**
   a. **Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat**? Yes.

b. Are all of the 5 listing factors relevant to the species addressed in the recovery criteria? All relevant listing factors are addressed in each species' recovery criteria. New data suggest that stressors not considered, or considered marginally, when each species was listed actually are highly important to species recovery. However, the recovery criteria, which are based on population stability and implementation of management plans or strategies to benefit the species, are appropriate means to assess recovery.

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:

Etowah and Cherokee darters: Delisting will be considered when 2 criteria are met:

- Known populations of the species are shown to be stable or increasing for at least five years.
- Plans are developed to protect and monitor water and habitat quality in all occupied streams.

The first criterion for the Etowah and Cherokee darter has not been met. No long-term basin-wide surveys for either species have been conducted to quantitatively evaluate stability of known populations for either species.

- **Etowah darter**: Analysis of 1998-2009 fish collection data at ten Etowah mainstem shoals between Amicalola and Sharp Mountain Creeks found no support for an increasing or decreasing trend in Etowah darter numbers (Hagler and Freeman 2014). The study noted that numbers of Etowah darters collected at each site were extremely low, and that results suggested the observed count of individuals in the previous year was not predictive of the count observed in the subsequent year. Hagler and Freeman's analysis (2014), in addition, focused on collections from only a portion of the Etowah darter's range, excluding the Etowah River headwaters and large tributaries where the species is most numerous.

  Studies conducted in the mid-2000's in support of a draft Etowah River Regional HCP determined that the best-supported model for Etowah darter occurrence in a given habitat patch included both current effective impervious cover (EIA) and historic land use predictor variables. Under the best-supported model, the probability that Etowah darters occurred in suitable habitat approached zero at levels of upstream development equivalent to 3%–4% EIA; EIA had greatest impact on species occurrence when it was located within a 1.0-1.5-km radius of the fishes' habitat. Based on this information, it is likely that, during the early 2000's, Etowah darter populations declined in portions of their range with widespread urban development.

  We anticipate Etowah darter populations have been at least stable following the 2007-2009 recession, since the amount of residential and commercial development that would increase impervious surface and stormwater runoff has been limited in or near Etowah darter habitat; that status is likely to change as the economy recovers and robust urban development in the basin resumes.

- **Cherokee darter**: Hundreds of Cherokee darter surveys have been conducted across the species' range since the fish was listed, but this mass of data has not been collated/analyzed to evaluate trends in status basinwide (nor is such trend analysis likely to occur or to produce robust results, given bias in the data introduced by multiple collectors, using a wide array of equipment and methodologies, and collecting under differing conditions of water depth, velocity, temperature, and turbidity in streams with different substrates and amounts of large woody debris).

  Unlike Etowah darters, studies in support of the draft Etowah River HCP found no relationship between Cherokee darter occurrence and EIA. Instead, Wenger et al. (2010) determined that size of the population was responsive in models to increasing EIA. Based on this, it is likely that during the early 2000's, Cherokee darter numbers declined throughout that portion of the species' range where rapid urban development resulted in fill, culverting, impoundment, open trench excavation, and other direct impacts to the smaller Etowah tributaries that Cherokee darters prefer, as well as indirect impacts to these systems associated with increased stormwater runoff, sedimentation, and clearing of riparian buffers. These impacts declined following the 2007-2009 recession, but still are occurring as local governments construct and expand needed infrastructure (roads, utility lines and pipes, landfills, et. al). However, studies Freeman and Hagler (2012) conducted at 20 locations in the basin suggest the species persists, despite stressors, at many sites where it historically had been collected.

The second recovery criterion for both species has been partially met. Local governments in the Etowah basin submitted a draft Etowah River HCP (www.etowahhcp.org) to the Service in 2007 that detailed measures to address threats associated with urbanization. The HCP was not finalized. A number of the counties in the basin, however, have adopted some HCP-recommended measures, including riparian buffer and stormwater detention requirements, and the Corps of Engineers now requires most projects authorized under Nationwide Permit to meet draft HCP-developed measures for new culverts and utilities to reduce potential for fish passage blockage. However, key components of the draft HCP that would have required more stringent post-construction stormwater runoff limits and sediment/erosion control have not been implemented. No plans or strategies have been developed to protect and monitor water/habitat quality in occupied watersheds.

Amber darter: Reclassification to threatened status will be considered when:

- Through protection of the existing Conasauga River population and by introductions or expansion of the species in the Etowah River, or discovery of an additional population, there exist viable populations in two rivers.
- Studies of the fish's biological and ecological requirements have been completed and management strategies have been developed and implemented to ensure the species no longer is likely to become extinct in the foreseeable future.

The first criterion was partially met when amber darters were found in the Etowah River. When the species was listed in 1985, amber darters were known to occur only in the Conasauga. A single amber darter was collected in the Etowah in 1980, but intensive searches in the early 1980's failed to locate additional individuals, and the listing document

concluded that an Etowah population, if it existed, was very small. Since 1990, amber darters have been found in the Etowah River mainstem and several larger tributaries.

Like the Etowah and Cherokee darter, urban development is a major stressor for amber darters in the Etowah River basin. Given the minimal ongoing construction in North Georgia since the 2007-2009 recession, the Etowah population of amber darter likely is stable but vulnerable to future land use changes.

The Conasauga population is not protected, although the Service currently is working with partners to conserve priority lands in the basin. USGS and University of Georgia scientists monitored fish populations in the Conasauga at seven fixed sites 1996-2008 (Golder Associates 2010). The number of amber darters collected each year was highly variable (Fig. 1), but researchers concluded there was a decreasing trend in the total number collected since 2000. Survey work completed 2011-2012 by Hagler and Freeman (2012) documented a continued downward trajectory at sites downstream of TN Hwy 74 to Tibbs Bridge Road, although no evidence of decline was noted at three snorkel sites in the upper Conasauga's Cohutta Wilderness.

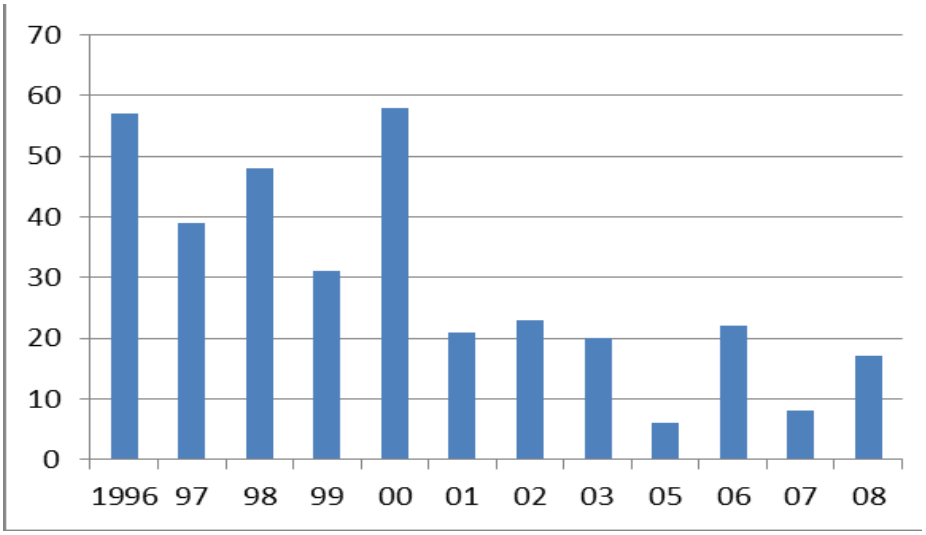

Figure 1. Number of amber darters collected at 7 fixed monitoring stations in the Consasuaga mainstem 1996-2008 (Golder Associates 2010).

The second recovery criterion has been partially met. Recently-completed studies of the fish's ecological needs in the Etowah River basin are listed in Appendix A and posted at http://www.etowahhcp.org. Current studies on amber darter stressors and population status in the Conasauga basin include assessment of:

- The Conasauga River's chemical profile to determine concentrations of contaminants, primary sources of these chemicals, season of discharge relative to target aquatic species' life histories, and trigger for discharge.
- Dissolved oxygen, temperature, conductivity, selected nutrients, and algal blooms.
- Agricultural best management practices to minimize loading of agricultural chemicals into stream systems.
- Population trends (to be conducted in 2014) at the seven fixed sites that previously were sampled from 1996-2008.

Management strategies for amber darters in the Etowah basin were developed in the draft Etowah River HCP and have been implemented as described above for Etowah and Cherokee darters. Management strategies to protect the fish in the Conasauga Basin have been developed with partners and stakeholders in the basin through a series of Coosa/Conasauga Summits from 2000-2008. New data suggests previously-unknown threats associated with use of Round-up Ready seed, heavy applications of chicken manure as fertilizer, and/or environmental estrogens, and the Service is working with partners to develop additional management strategies.

Ongoing Conservation Actions: The Service and partners are implementing the following conservation actions to reduce fragmentation and restore and protect Etowah, Cherokee, and amber darter habitat:

- Establishing a conservation area on the Conasauga River and major tributaries in Tennessee and Georgia.
- Protecting Paulding Forest and Sheffield Wildlife Management Area (WMA) on Raccoon Creek. GDNR and Paulding County purchased extensive land in the basin with a Service section 6 Recovery Land Acquisition Grant and other funds. The Nature Conservancy, Service, GDNR, and Paulding County currently are working acquire additional lands and to restore fish passage, riparian buffers, and stream stability on and off public lands in the basin.
- Conserving lands in the Smithwick Creek basin, adjoining GDNR's McGraw Ford WMA and a 5-mile reach of Smithwick restored/protected as partial mitigation for construction of the Hickory Log Creek Reservoir.
- Conserving lands in the Shoal Creek basin (Dawson County), upstream of the City of Atlanta's Dawson Forest.
- Working with The Nature Conservancy, private landowners, and others via the Service's Partners for Fish and Wildlife program to improve habitat and reduce stressors for rare aquatic species lands in the basin.
- Working with the Corps of Engineers to select mitigation properties that restore and conserve priority stream reaches in the Conasauga and Etowah (Table 1).

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Spatial distribution and trends/habitat conditions

Etowah darter: The Etowah darter is endemic to the Etowah River basin, Georgia (Fig. 2). The species, when listed, was known to occur only in the upper Etowah River mainstem above Lake Allatoona and in two tributaries, Long Swamp and Amicalola Creek. Sample collections and genetic analyses conducted since 2000 have extended the known range of the species in the Etowah mainstem upstream several kilometers and identified additional populations in three tributary systems: Shoal (Dawson County), Stamp, and Raccoon Creeks. The latter two tributaries are isolated from the upper Etowah basin populations by Lake Allatoona (Fig. 2). Etowah darters tend to be collected in substantial numbers only in a few localities, including the Etowah River headwaters, Shoal Creek (Dawson County), Amicalola Creek, Long Swamp Creek, and Raccoon Creek.

Table 1. Mitigation banks (MB) and large individual mitigation projects that restore and/or protect Etowah, Cherokee, and/or amber darter habitats.

Bank/Project	Stream Systems	Size	Actions
Alaculsy MB	Conasauga River	6.8 miles	Riparian restoration
Applewood MB	Etowah River	2.3 miles	Riparian restoration
Bannister Creek MB	Brewton and Bannister Creeks	2.5 miles	Riparian restoration Stream geomorphology
Cochran Creek MB	Cochran and Gab Creeks	3.2 miles	Riparian restoration Stream geomorphology
Etowah River MB	Etowah River	1 mile	Riparian restoration
Etowah River Preserve	Etowah River	1.6 miles	Riparian restoration Streambank stabilization
Etowah River Road MB	Palmer Creek and Etowah River		Riparian restoration Stream geomorphology
Hickory Log Creek	Hickory Log Creek	1.5 miles	Riparian preservation
Mill Creek	Mill Creek	1 mile	Riparian restoration
Prater Island DOT site	Conasauga River		
Shoal Creek site	Shoal Creek	3.9 miles	Riparian preservation
Smithwick Creek site	Smithwick Creek	5.2 miles	Riparian preservation/restoration Stream geomorphology
Yellow Creek MB	Etowah River	2.2 miles	Riparian restoration

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We do not know if Etowah darters occur in the Etowah River mainstem below Lake Allatoona. Genetic analysis of mitochondrial DNA showed haplotypes of both Etowah and greenbreast (*Etheostoma jordani*) darters in specimens collected from the lower mainstem, but the data were insufficient to determine if the two species currently occur together or if the two species overlapped and hybridized at some point in the past (Freeman et al. 2013). Nuclear DNA could resolve whether individuals that have *E. etowahae* mtDNA are pure or hybrids; fin clips have been collected for future analysis.

Fluvial specialist fish species, in general, are less likely to occur in the Etowah River downstream of Lake Allatoona compared to upstream reaches (Freeman et al. 2013; Fig. 3). Surveys conducted 2010 in the lower Etowah River, coupled with previous survey data, documented only a third of the small-bodied fish species known from the upper Etowah. This reduced species richness suggests that conditions in the lower, hydropower-regulated reach of the Etowah River fail to fully support reproduction, survival and/or growth for multiple small fishes, including the Etowah darter.

The two most recently-constructed reservoirs in the basin, Hickory Log and Hollis Latham, do not directly fragment Etowah darter habitat, although poor water quality during dam construction or pump-storage activities to maintain reservoir water levels may

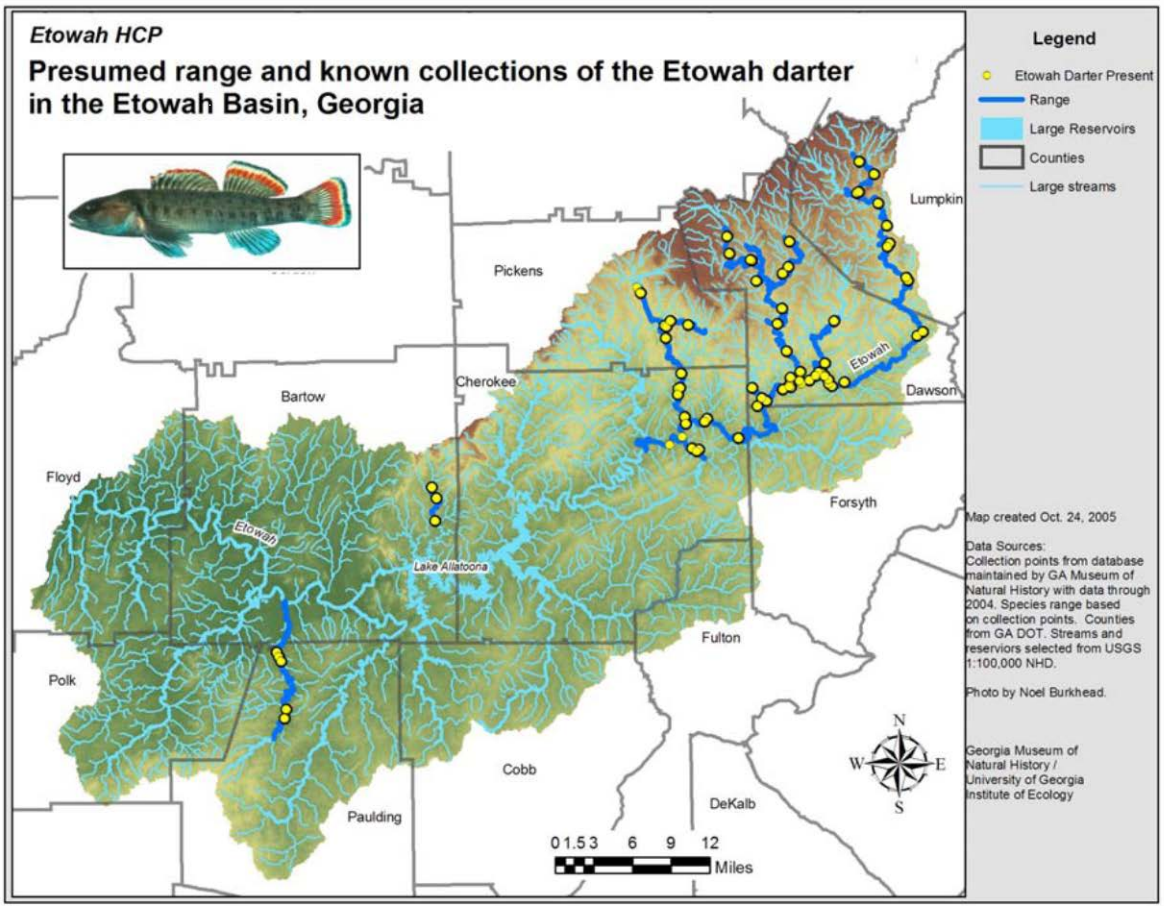


Figure 2. Presumed range of the Etowah darter, Etowah River basin, Georgia (www.etowahhcp.org).

reduce water quality/quantity in Etowah darter habitat and/or entrain/impinge these fishes and their eggs, larvae, and juveniles. The Etowah Water and Sewer Authority's new intake structure at its water treatment plant on the Etowah River also may have increased entrainment and impingement rates, but the Authority worked closely with the Service to design the intake to minimize impact on fish passage and mortality.

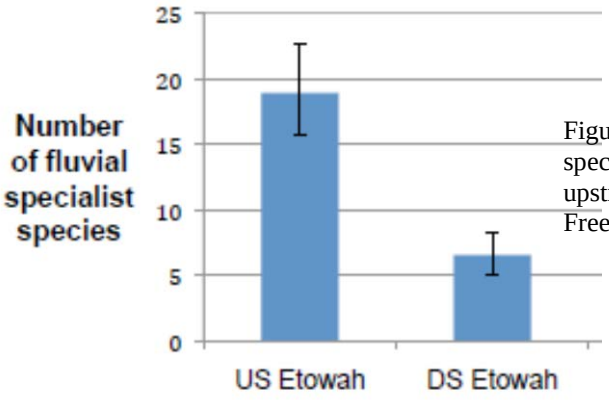


Figure 3. Estimated number of fluvial specialist fish species in shoal samples from the Etowah River upstream and downstream of Lake Allatoona (from Freeman et al. 2013).

Cherokee darter: The Cherokee darter is endemic to the Etowah River system, where it primarily is restricted to streams draining the Piedmont and Blue Ridge physiographic provinces (Fig. 4). The species, when it was described in 1995, was thought to occur in 26

tributary systems to the Etowah River (Table 2; from Bauer et al. 1995). These authors noted that the species was widespread, but that numerous populations appeared to persist in low abundance and that the species was close to meriting endangered status because of the imminent likelihood of additional population decline and localized extirpation.

In the 20 years since the species was described, Cherokee darters have been located in one large Etowah River tributary system (Pettit Creek), 2 moderate-sized tributaries (Richland and Ward Creeks), and 17 small tributaries (Table 2). The species also has been collected at a handful of locations in the Etowah River mainstem (C. Crow, B.J. Freeman, reported in annual Endangered Species Act Section 10 reports). Our knowledge about Cherokee darters in many tributaries is limited to a single collection, or, at best, a handful of collections spread over many years. With such limited data, we are unable to estimate population trends within many Etowah tributary systems, particularly since, in many cases, the survey that located the new Cherokee darter population was conducted as one of the requirements for urban development of adjacent uplands, and the tributary ultimately was degraded due to increased stormwater runoff, sediment transport, contaminants, and other stressors associated with increased impervious surface.

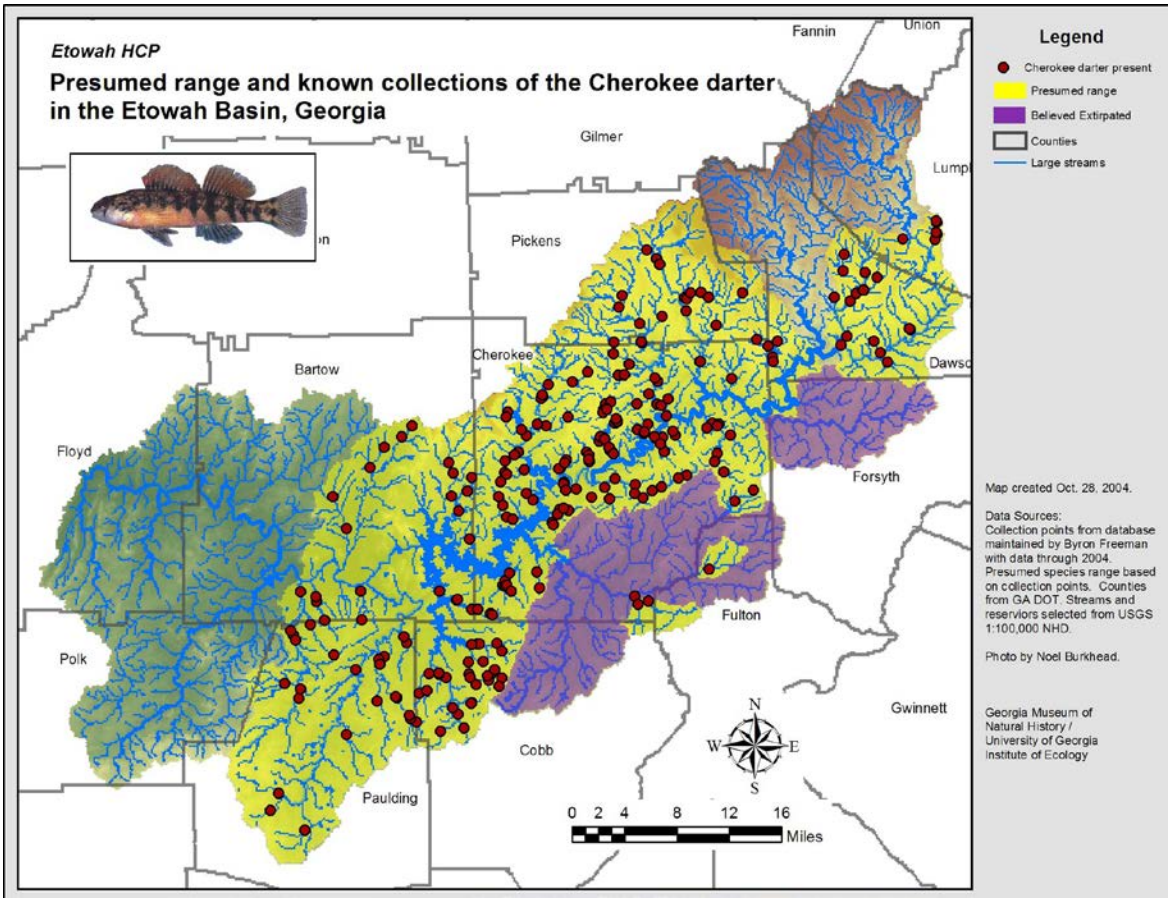


Figure 4. Presumed range of the Cherokee darter, Etowah River basin, Georgia (www.etowahhcp.org).

Cherokee darters appear to have been mostly extirpated from the Little River, Pumpkinvine Creek, and Settingdown Creek systems, except in isolated headwater streams. Known populations in Yellow Creek and Hickory Log Creek were fragmented by inundation of the Hollis Latham and Hickory Log Reservoirs, which began, respectively, in 1999 and 2007. Two

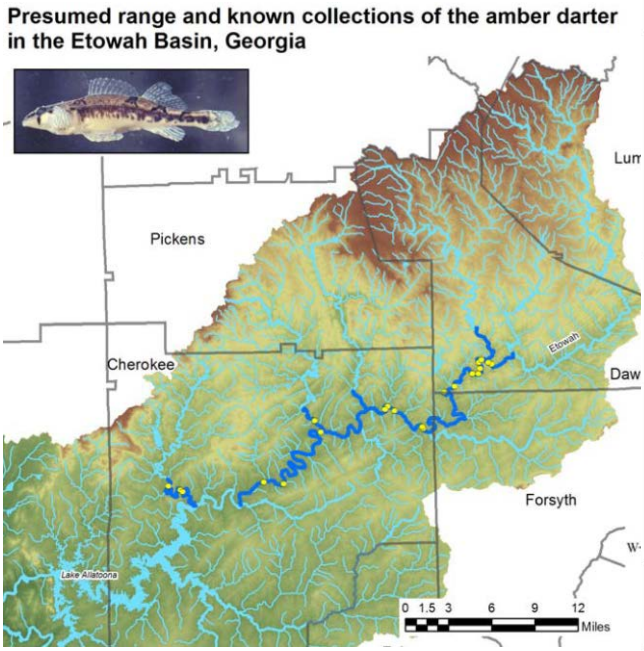
additional reservoirs in Cherokee darter habitat, on Russell and Richland Creeks in Dawson and Paulding County, respectively, currently are in the Clean Water Act permitting process by the Corps of Engineers.

One remnant Cherokee darter population was augmented in 2009. Cobb County-Marietta and the City of Canton funded a project to move Cherokee darters from Hickory Log Creek, before impoundment, to newly-restored reaches of Brewton and Bannister Creeks in Forsyth County. Monitoring suggests the translocation was not successful.

Amber darter: The amber darter is endemic to the Coosa River basin. When it was listed in 1985, the fish was known to occur only in a 33.5-mile reach of the Conasauga River mainstem, from the Tibbs Bridge crossing, Murray County, Georgia, upstream to the TN Hwy 74 crossing, Polk County, Tennessee. Surveys since the species was listed have extended the range several miles upstream of TN Hwy 74 (Fig. 5 right).

A single amber darter was collected in the Etowah River, Cherokee County, Georgia in 1980, but extensive surveys conducted prior to the species' listing failed to locate individuals, and the listing document concluded that a population in the Etowah River, if one existed, was very small. The amber darter was rediscovered in the Etowah River basin in 1990 (Fig. 5 left). Between 1990 and 1992, amber darters were found in the Etowah mainstem between Sharp Mountain and Amicalola Creeks and in the most downstream reaches of two large tributaries, Shoal Creek (Cherokee County) and Sharp Mountain Creek (Freeman and Freeman 1994). Subsequent surveys have expanded the known range in the mainstem only slightly downstream to the confluence with Canton Creek.

Fig. 5. Right: Known amber darter collections 2011-2012 in the Conasauga (yellow dots) compared to known locations (black dots) (Hagler and Freeman 2012). Left: Known amber darter locations (yellow dots) in the Etowah River basin, Georgia (www.etowahhcp.org).



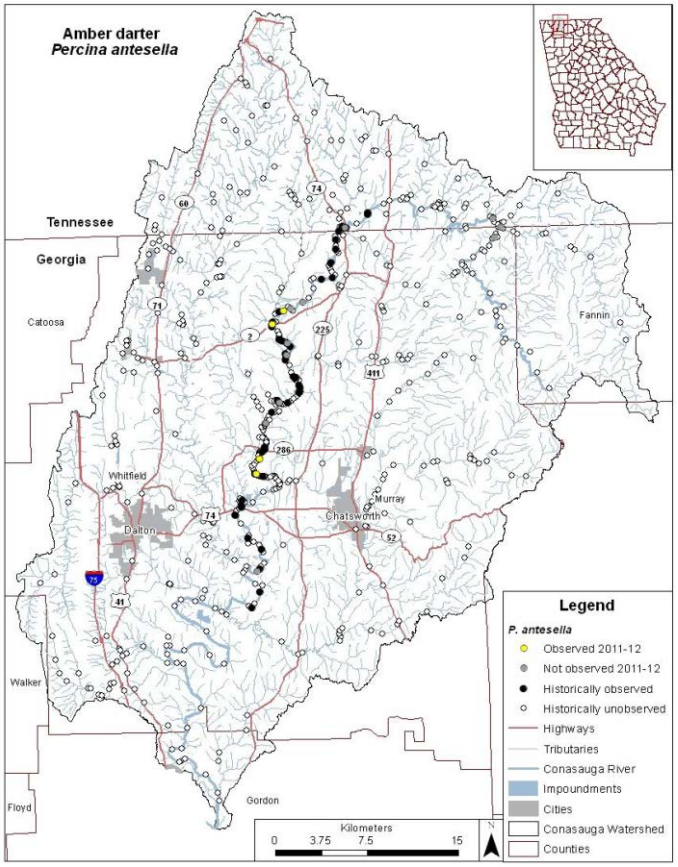


Table 2. Known Cherokee darter stream systems in 1995 (those know at listing marked with X; Bauer et al. 1995) vs. most recent collection data in GDNR Heritage and FWS GIS databases. Streams where much of the available habitat was/is slated for impoundment since 1995 are highlighted in grey. Streams where major restoration/preservation efforts have focused are highlighted in rose. Sufficient data on population trends within these watersheds are not available to assess changes in population health or habitat quality/availability over time.

Creek Name	County	Watershed Size (mi^2)	1995	Most Recent Collection	Notes
Allatoona	Cobb	25	X	2007	
Boggs Branch	Lumpkin	<1		2008	
Black Mill	Dawson	7	X	2002	
Brewton/ Bannister	Forsyth	4		2010	Translocated stock from Hickory Log Creek; large reaches preserved and restored as Bannister Mitigation Bank and other mitigation
Butler	Cobb	9	X	2008	
Calhoun	Lumpkin	3.5		2008	
Camp	Lumpkin	7	X	2003	
Canton	Cherokee	20	X	2010	
Clark	Bartow, Cherokee	8	X	2002	
Conn	Cherokee	9	X	2002	
Downing	Cherokee	3		2011	
Edward	Cherokee	3	X	2011	
Hickory Log	Cherokee	9	X	2012	Majority of stream impounded as Hickory Log Creek Reservoir
Illinois	Bartow, Cherokee	2		2000	
Jug	Cherokee	4	X	2001	
Kellogg/Owl	Cherokee	2.5	X	2004	
Little River	Cherokee, Cobb, Fulton	200	X (remnant)	2004	
Long Swamp	Cherokee, Pickens	75	X	2010	
Palmer	Dawson	5		2005	
Pettit/Nancy	Bartow	50		2010	
Proctor	Cobb	6.5	X	2008	
Proctor	Dawson	2.5		2005	
Puckett	Cherokee	2.5	X	2001	
Pumpkinvine	Bartow, Paulding	140	X (remnant)	2011	
Raccoon	Bartow, Paulding	55	X	2014	Extensive preservation and restoration (Paulding Forest, Sheffield WMA)
Richland	Bartow, Paulding	7		2005	Majority of stream proposed to be impounded
Riggin	Cherokee	3	X	2004	
Russell	Dawson	3.5		2005	Majority of stream proposed to be impounded
Ryle (Pyle)	Bartow, Paulding	3.5		2011	
Sharp Mountain	Cherokee, Pickens	75	X	2011	
Shoal	Cherokee	65	X	2011	
Shoal	Dawson	35	X	2010	Extensive preservation as mitigation for Hickory Log Reservoir and Dawson Forest
Smithwick	Cherokee	17	X	2013	Extensive preservation and restoration (McGraw Ford WMA and Hickory Log Reservoir mitigation)
Stamp	Bartow	15	X	2005	
Sweetwater	Cherokee	3.5	X	2011	
Tanyard	Bartow, Cobb	3		2010	
7 unnamed tributaries		1-3		1995-2006	
Ward (Word)	Bartow, Paulding	7		2006	
Yellow	Dawson, Cherokee, Pickens	15	X	1994	Majority of stream impounded as Hollis-Latham Reservoir

GDNR collected a single amber darter in 2010 on the Coosawattee River downstream of Carter's Lake (Freeman et al. 2013). Amber darters have not previously been captured in the Coosawattee, and we do not know if this watershed supports a population or if collection of this single fish was an anomaly. To the best of our knowledge at this time, the species' natural range only includes the Etowah and Conasauga River mainstems and a few Etowah tributaries.

b. New information on species biology and life history:

Etowah darter: The life history of the Etowah darter has not been determined, but a similar species, the greenbreast darter, is known to spawn in the spring in sand and gravel riffles. A greenbreast darter female selects the spawning site, buries herself with only her head and caudal fin exposed, and is mounted by the male. Females generally deposit 100 to 200 eggs in the substrate. Rakes and Shute (2005) noted that captively-bred Etowah darter eggs were about 0.1-inch in diameter with a relatively tough chorion (outer membrane) and were laid in small, loosely adhesive clumps buried under sand or in substrate interstices. The egg clumps tend to remain at the site where laid unless dislodged by flood or physical disturbance (Pat Rakes, Conservation Fisheries, Inc., pers. comm., 2006). At hatching, yolk-sac larvae are around 0.2-inches long; they swim in 2 or 3 days, when they are about 0.25-inches long and less than 0.02-inches wide. The pelagic larvae are attracted to light when they first swim up, drifting at or near the surface of the river. Distance downstream the larvae move with the current after hatching is influenced by discharge, flow velocity, amount of large woody debris that creates eddies, and other factors. Preferred habitat of the larvae after swim up is unknown, but observations of Etowah darters in captivity and information on other pelagic darter larvae suggest Etowah darter larvae inhabit relatively deep water (>1 ft) in gently flowing pools, often in an eddy below woody debris or a boulder. They maintain position in these places, swimming into the current, and feeding on drifting food particles/zooplankton.

In captivity, Etowah darter larvae transformed to the benthic juvenile stage at 2 weeks old, when they were about 0.4-inches long (Rakes and Shute 2005, Pat Rakes, Conservation Fisheries, Inc., pers. comm., 2006). As juveniles grow in size, they move upstream to suitable shoal habitat (Byron Freeman, University of Georgia, pers. comm., August 2006). Sexual maturity is usually reached after the first year of a typically three-year life span. The greenbreast, and probably the Etowah darter, consumes midge larvae, mayflies, water mites, caddisflies, and occasionally some mollusks (Mettee et al. 1996).

Cherokee darter: The Cherokee darter's spawning season extends from mid-March to mid-June (Storey et al. 2006). Cherokee darters deposit single eggs in small depressions or recesses on the surface of large gravel, small cobble and occasionally woody debris within runs, moderate to slow riffles and the tails of pools. The male pursues the female and attempts to fertilize each egg as it is deposited. Deposition sites are typically free of fine sediment or algal growth, but females have been observed cleaning prospective deposition points with their mouths (Storey et al. 2006). Cherokee darters presumably prey upon midge and black fly larvae and other small aquatic invertebrates.

Amber darter: Spawning of amber darters occurs from late fall to early spring (Mettee et al. 1996), probably in swift gravel shoals (Etnier and Starnes 1993). Spawning individuals have been observed burying themselves in gravel, and females are known to bury their eggs in these sediments during spawning (B. Freeman, UGA, and M. Freeman, USGS, pers. comm.).

Sexual maturity of some specimens occurs at slightly over one year's growth, and all are mature at two years. Maximum life span is 4 years (Etnier and Starnes 1993). Little is known about early growth and development, but post-hatching movement likely is similar to that described for Etowah darter larvae (Byron Freeman, UGA, pers. comm., August 2006). Larvae transform into benthic juveniles 15-30 days after hatching and begin to move upstream to suitable habitat. By spring, one year old darters have grown to 1.75 inches, and to over 2 inches at 2 years (Etnier and Starnes 1993).

Habitat use by the amber darter in the Conasauga River watershed was described by Freeman and Freeman (1994). Amber darters occurred in relatively low densities in stream riffles that generally supported large populations of other species of small benthic fish. Individuals usually were observed over cobble, gravel, or sand, and occasionally moved under small cobbles or river weed for short (<1 minute) periods. Amber darters were never observed in habitat characterized by slow current and extensive silt substrates. Freeman and Freeman (1994) suggested the following criteria for suitable amber darter habitat: depth > 7.9 in, substrate dominated by gravel or cobble, and a velocity near the substrate >0-51 cy/sec.

c. Abundance, population trends, and demographic features (also see the sections on species status on Page 2 and recovery criteria on Page 4):

Etowah River Basin: Our evaluation of demographic features for the three listed fishes in the Etowah River basin is based, to a large degree, on studies conducted as part of the draft Etowah River HCP process. These studies evaluated competing models to determine the relative importance of (a) impervious surface and other indicators of current land use, (b) historic land use (e.g., agriculture, impoundments), and (c) hydrogeomorphic characteristics like stream size, elevation, and geology in explaining the occurrence of five stream fishes in suitable habitat, including Etowah and Cherokee darters (Wenger et al. 2008). The best-supported models for the Etowah darter, tricolor shiner (*Cyprinella trichroistia*), speckled madtom (*Noturus leptacanthus*), and bronze darter (*Percina palmaris*) included both current effective impervious cover (EIA) and historic land use predictor variables (Fig. 6). Under the best-supported model, the probability that Etowah darters occurred in suitable habitat approached zero at levels of upstream development equivalent to 3%–4% EIA (Fig. 6c). For most of the fishes evaluated, EIA had greatest impact on species occurrence when it was located within a 1.0-1.5-km radius of the fishes' habitat. Wenger et al. (2008) did not model amber darter response to EIA due to the species' rarity and limited distribution, but the species is likely to respond similarly because it occupies similar habitat types to those modeled (Wenger et al. 2008).

No relationship was found between Cherokee darter occurrence and EIA. Instead, Wenger et al. (2010) found population size was responsive in models to increasing EIA.

Freeman and Hagler (2012) surveyed 20 locations in the Etowah River basin across the range of the Cherokee darter in fall 2011 to evaluate persistence of populations at these sites since the late 1990s, especially with regard to changing land uses in the upstream watersheds. Cherokee darters were collected at each of the 20 survey sites, and numbers appeared lower compared to older collections at the site. The study, however, provided only weak support for substantial loss of Cherokee darter populations due to increases in urbanization in the absence of other substantial factors (e.g., sedimentation and isolation by impoundments).

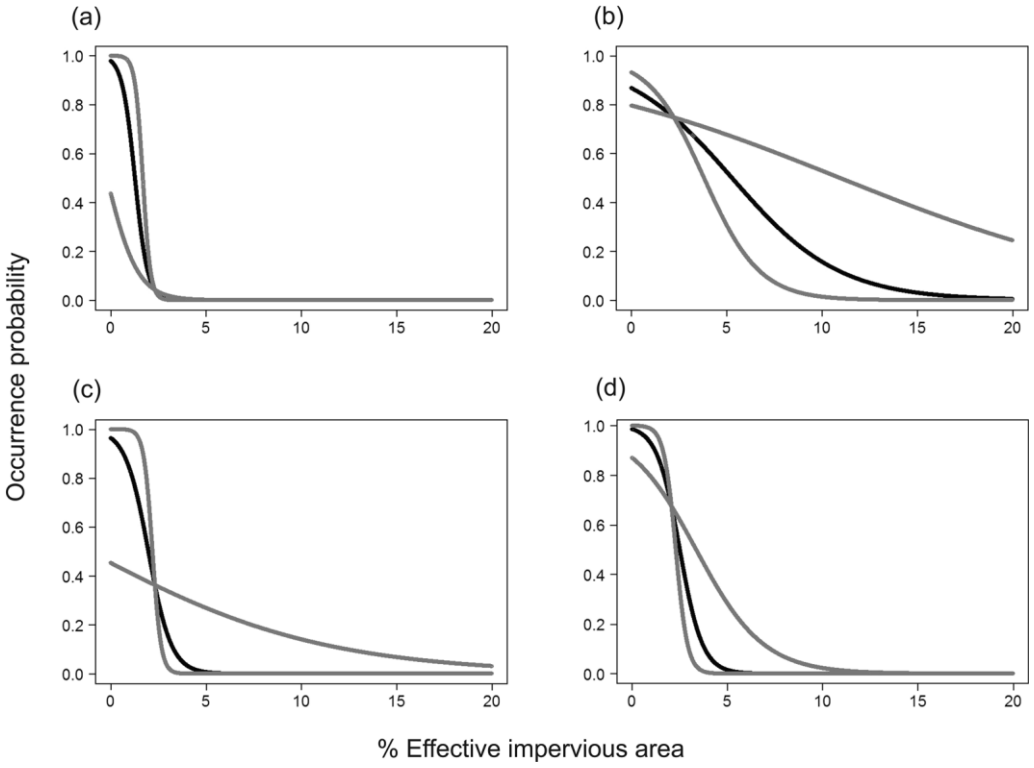


Fig. 6. Occurrence probability (*a*) *Cyprinella trichroistia*; (*b*) *Noturus leptacanthus*; (*c*) *Etheostoma etowahae*; (*d*) *Percina palmaris* in response to increasing impervious cover. The black line represents the response curve based on the mean parameter estimate for effective impervious area (EIA); other lines are response curves based on the 5% and 95% values for the EIA estimate (Figure from Wenger et al. 2008).

Urban development, with the exception of public works projects, has been limited in the Etowah basin over the past 5 years due to the effects of the 2007-2009 recession in the metro-Atlanta area (Fig. 7). However, some signs indicate housing and commercial development is

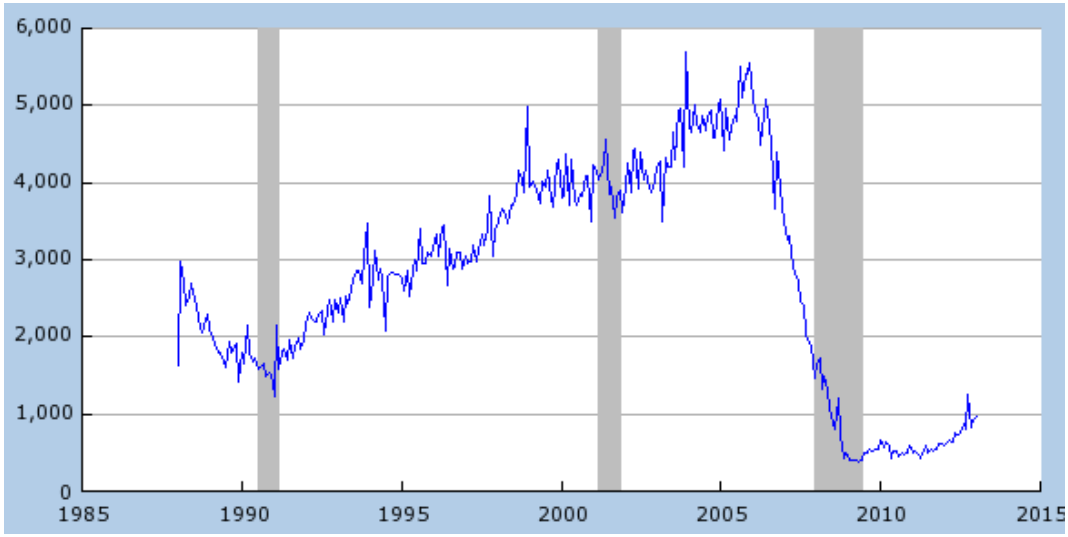


Fig. 7. Privately-owned housing starts authorized by building permits for Atlanta-Sandy Springs-Marietta, GA. (research.stlouisfed.org). Shaded areas are periods of economic recession.

rebounding -- new housing starts began to increase in the metro-Atlanta area in early 2012 – 8,288 new homes were permitted, a 53% increase compared to 2011, but significantly less than new starts recorded during the early 2000's boom. Many experts anticipate that urban development in the near future will be concentrated within the Interstate 285 beltway, with limited construction in suburban areas, including lands within the Etowah River basin. Others predict a return to urban sprawl, which would have greater long-term consequence to rare Etowah River fishes.

Amber Darters in the Conasauga River Basin: Results from repeated seine surveys conducted 1996-2008 at fixed sample sites in the Conasauga River documented a decline in the abundance and/or occurrence of a number of rare and sensitive fish species, including the amber darter (Fig. 8) (Golder Associates 2010). From 2011 to 2012, Hagler and Freeman (2012) conducted 19 snorkel and seine fish surveys at 15 locations along the Conasauga River, including many of the sites sampled 1996-2008. They observed most of the rare and imperiled fish species in the Conasauga River during the 2011-2012 surveys, but found little evidence to suggest an improvement in the declining trends of sensitive fish species in the mainstem downstream of TN Hwy 74 to Tibbs Bridge Road. Amber darters were found in low abundance (1 individual) at only 4 sites. The Coosa madtom (*Noturus sp. cf. N. munitus*) has not been encountered in the Conasauga River basin since 2000, and the Coosa chub (*Macrhybopsis sp. cf. M. aestivalis*), a species regularly encountered in the Conasauga through 2005, has only been encountered once each in 2006 and 2010 (Hagler and Freeman 2012).

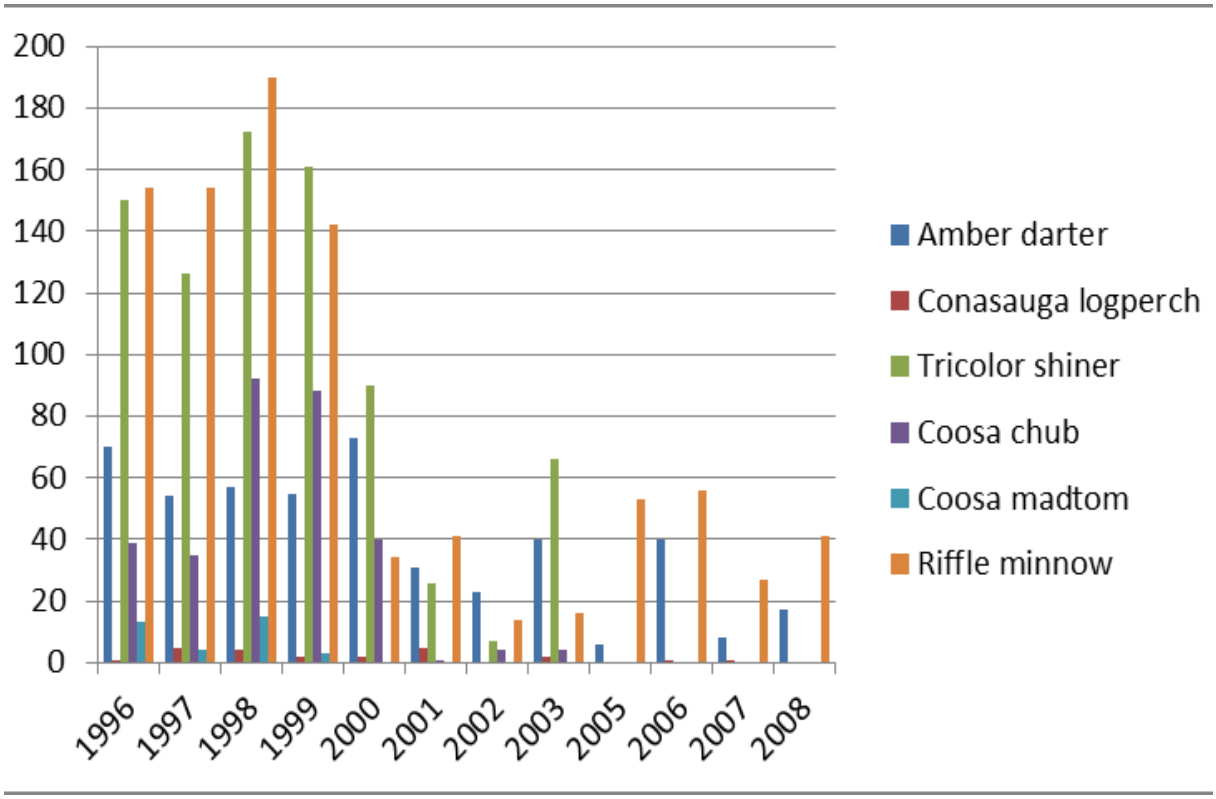


Figure 8. Total number of amber darters and other rare fishes collected at fixed sample locations in the Conasauga River 1996-2008.

d. Genetics

Etowah Darter: The Etowah darter was formally described out of the greenbreast darter species complex, along with two non-Etowah basin species, *E. chuckwachatte*, and *E. douglasi* (Wood and Mayden 1993). The Etowah darter shows little phylogenetic structure throughout its range (Ritchea 2008), suggesting that populations above and below Lake Allatoona should be managed as a single conservation unit. Mitochondrial DNA sequence data revealed a new population of Etowah darter in Raccoon Creek living in syntopy with the greenbreast darter. The mitochondrial DNA analysis also showed haplotypes of both Etowah and greenbreast (*Etheostoma jordani*) darters in specimens collected from the lower Etowah River mainstem, but the data were insufficient to determine if the two species currently occur together or if the two species overlapped and hybridized at some point in the past (Freeman et al. 2013). Funding is not available for nuclear DNA analysis that could clarify the relationship.

Cherokee Darter: Recent genetic analyses support recognition of three genetic Evolutionary Significant Units (ESUs) across the range of the Cherokee darter (Storey 2003) (Note: National Marine Fisheries Service uses the term ESU as a legal equivalent of the Fish and Wildlife Service's DPS; in this section, in keeping with our source material (Storey 2003), we use the ecological nonlegal definition, where an ESU is a population considered significantly distinct for conservation purposes).

The Lower Cherokee darter ESU (Fig. 9) includes Etowah tributaries below Allatoona Dam, as well as Stamp Creek and the tributaries entering Lake Allatoona within the Allatoona Creek arm of the reservoir. The Middle ESU includes populations from the Little River system and Sweetwater Creek (downstream extent) and tributaries upstream to Amicalola Creek. The Upper ESU includes populations within systems upstream from Amicalola Creek to the furthest upstream extent of the species.

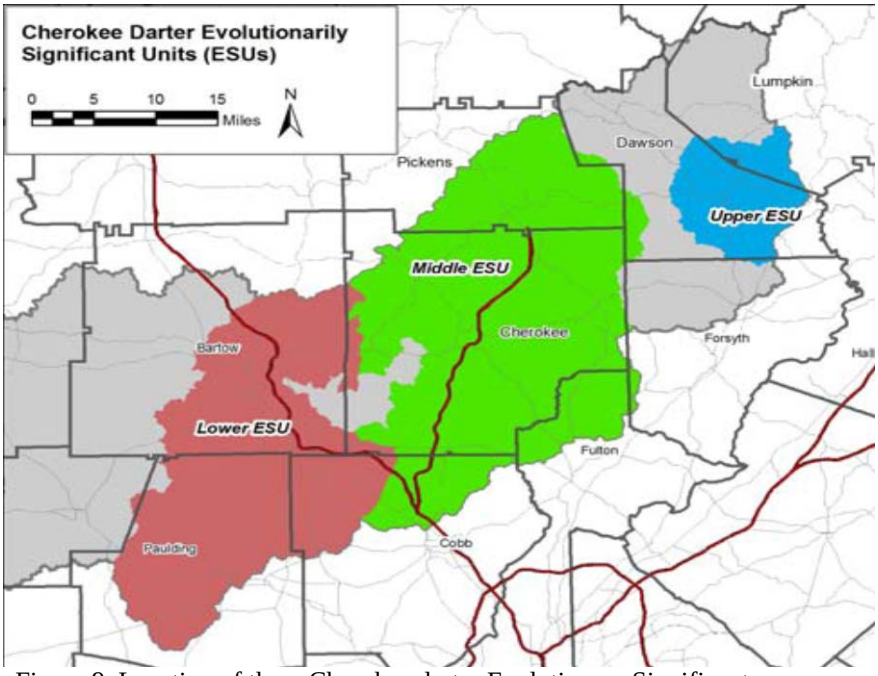


Figure 9. Location of three Cherokee darter Evolutionary Significant Units (Figure from draft Etowah HCP, www.etowahhcp.org).

Amber Darter: Freeman et al. (2012) analyzed amber darter genetic samples using mitochondrial DNA sequencing of two genes and six polymorphic microsatellite loci. Despite the relatively large geographic distance between amber darter populations in the Etowah and Conasauga River, no fixed differences in mitochondrial DNA were observed; however, the more rapidly-evolving nuclear microsatellite markers showed significant genetic differences between the two rivers, indicating either low levels of ongoing genetic exchange or a recent separation of the two populations. Levels of genetic diversity are considerably higher in the Conasauga population, and little genetic differentiation between shoals within either river was observed. These results indicate amber darters in the Etowah and Conasauga Rivers are somewhat genetically different but represent a single species.

e. Taxonomic classification or changes in nomenclature: None

2. Five-Factor Analysis

a. Present or threatened destruction or modification of habitat:

Threats described in the Etowah and Cherokee Darter listing rule: The Etowah and Cherokee darter listing document identifies the primary causes of habitat destruction, modification, or curtailment as:

- Impoundments that result in habitat loss, population extirpation, fragmentation, and changes in the thermal regime below dams that favors predatory fishes.
- Siltation associated with timber clearcutting, clearing of riparian vegetation, and construction, mining, and agricultural practices that allow dirt to enter streams.
- Increased development and land clearing that increases siltation from erosion, accelerates runoff, allows transport of pollutants into the Etowah River system, and requires additional road and landfill infrastructure.
- Bridges, railroad crossings, and other stream crossings that are potential sites for spills of toxic material due to vehicle accidents, deliberate dumping, and other means.
- Pollution from other point and nonpoint sources such as municipal and industrial waste discharges, agricultural runoff, poultry processing plants, and silvicultural activities.

None of these threats have been eliminated in the 20 years since the Etowah and Cherokee darter were listed, although the Service, USGS, UGA, GDNR, The Nature Conservancy, Upper Etowah River Alliance, Coosa River Basin Initiative, and numerous other partners have worked extensively with local governments, developers, and private landowners in the basin to reduce the impacts of urbanization and associated infrastructure on listed fishes and their habitat. Two large drinking water reservoirs (Hollis-Latham and Hickory Log Creek Reservoirs) were constructed in the late 1990's and early 2000's on priority Cherokee darter streams, and two other reservoirs currently are being evaluated by the Corps of Engineers, Savannah District, for authorization under Section 404 of the Clean Water Act (Richland Creek and Russell Creek Reservoirs).

Although threats described in the listing package have not been eliminated, they have been reduced. The two reservoirs proposed in the Etowah were sited following Corps/Service/EPA protocols and are located on lower priority streams, where impoundment will have less impact on aquatic communities, genetic exchange, and fish passage. Ordinances have been

passed by most local governments in the basin that require wider buffers than State mandated (50-100 foot) on streams adjacent to construction activities. Buffer requirements for forestry lands, although voluntary, are strongly encouraged. The State continues to refine the Georgia Erosion and Sedimentation Control Act and the Clean Water Act's National Pollution Discharge Elimination System (NPDES) permitting process to reduce erosion, sedimentation, and stormwater discharges from construction sites. Post-construction stormwater is regulated in some Etowah basin counties by the Metropolitan North Georgia Water Planning District's post-construction stormwater ordinance. These efforts have reduced the amount of runoff and turbidity allowed in streams downstream of construction sites, although implementation of protective measures often is inadequate, and enforcement for violations is inconsistent.

Several of the projects specifically described in the listing document as threats have been completed. The reservoir on Yellow Creek began construction in 1997, and now impounds 330 acres in Cherokee and Dawson Counties. The 577-acre Eagle Point Landfill on the Etowah River in Forsyth County opened in 2002, with a disposal footprint of 167 acres; the facility currently is being expanded. The rock quarry proposed on Stamp Creek in Bartow County has not been built, and the portion of the Northern Arc proposed in the Etowah basin (i.e., the I-75 to SR 371 connector described in the listing document), is not likely to be constructed due to urban development along the Arc's proposed route.

Threats described in the Amber darter listing rule: The amber darter listing rule stated the primary causes of habitat destruction, modification, or curtailment were:

- catastrophic events, either natural or human related
- increased silvicultural activity.
- road and bridge construction.
- stream channel modifications, including impoundments.
- changes in land use.
- other projects planned and implemented without consideration of the species' survival and habitat protection.
- the proposed Dalton Lake and Jacks River reservoir projects.

Several of these threats have been eliminated in the 29 years since the amber darter was listed. Two reservoir projects, Dalton Lake and the Jacks River project, have not and will not be built. Dalton Lake no longer was considered a viable water supply option when the final listing rule was published. The Jacks River project was authorized for study by Congress in 1945 but not for further planning. Dalton Utilities constructed a third reservoir, the River Road Reservoir, in uplands adjacent to the middle portion of the Conasauga River in the late 1990s, and began withdrawing and releasing water 1999-2000; project monitoring 995 to 2006 to comply with a Corps of Engineers' Section 404 permit determined that reservoir operation, at least during the first few years post-construction, did not significantly impact fish populations in shoals downstream of the reservoir, as compared to upstream reaches or baseline conditions (Golder Associates 2008). The Service has worked extensively with the U.S. Army Corps of Engineers, Savannah District, to craft stream crossing requirements that minimize the impact of culverts on fish passage and stream stability and to develop regional conditions that require Corps authorization (and therefore Service review) of all dredge and fill projects that impact any length of perennial stream.

Current Threats -- Etowah Basin: Extensive research conducted on threats to Etowah River fish during development of the draft Etowah River HCP (www.etowahhcp.org) identified 6 stressors to benthic fishes in the Etowah basin: sedimentation, hydrologic alteration, extensive riparian buffer loss, contaminants (heavy metals, pesticides, etc.), movement barriers, and channelization/piping of streams – the most significant source of these stressors was identified as stormwater runoff from impervious surfaces. Other sources of these stressors include construction, channel erosion, road and utility stream crossings, dams/impoundments, point-source discharges, water withdrawals, agriculture, forestry, and historic land use (Wenger and Freeman 2007).

The Etowah River basin, which lies on the north edge of the Atlanta metropolitan area, has experienced rapid growth over the last decade (Fig. 10). Most of the six primary stressors and their sources are related to this rapid urban development. The recession has slowed land clearing activities and may have altered future development patterns in the basin (e.g., delayed urban sprawl, less dense development in the more distant counties from Atlanta). However, threats associated with urbanization are likely to once again increase in magnitude as the economy improves, and it is unlikely that forestry, agriculture, or other threats typical of rural environments will ever again be primary stressors. The following information on fish stressors in the Etowah basin is closely paraphrased from Wenger and Freeman (2007).

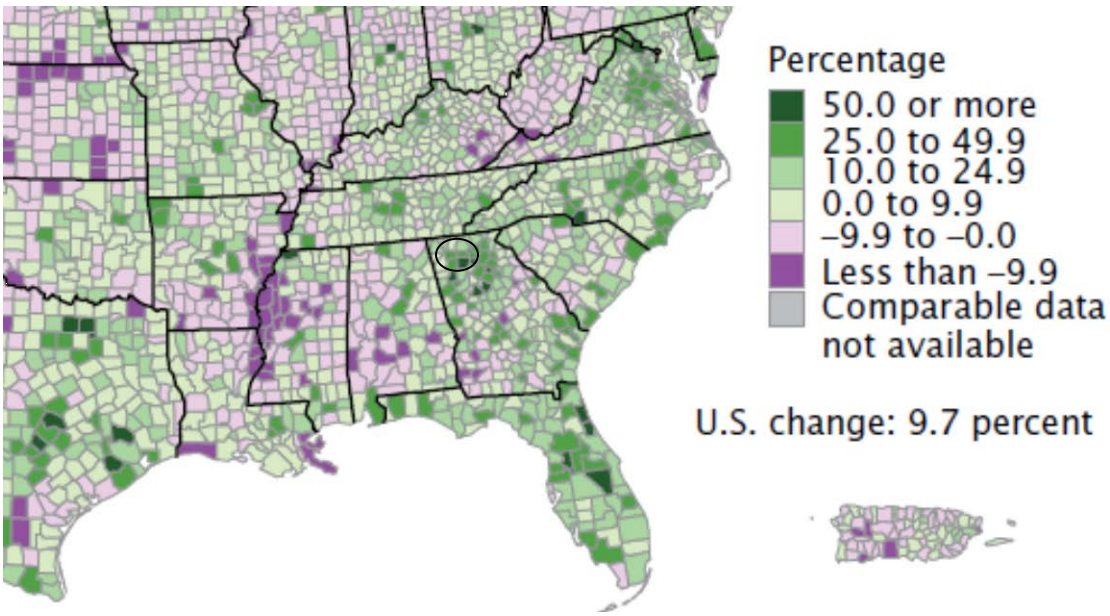


Fig. 10. Change in the Southeastern United States population, by county, 2000-2010 (figure from Mackun and Wilson 2011). The Etowah River basin and surrounding areas are circled.

1. **Altered stream flow**: Reservoir operations and water withdrawals can alter stream flow volume, frequency, and/or duration, but the primary source of hydrologic alteration in the Etowah basin, and the single most significant stressor to the Etowah's imperiled species, is stormwater runoff from impervious surfaces. Hydrologic alteration has two components: increase in storm flow frequency/intensity and a decrease in base flows, which together create a "flashy" hydrologic regime. Reduced baseflows can reduce the habitat available to Etowah, Cherokee, and amber darters (Power et al. 1996, Armstrong et al. 2001, Freeman and Marcinek 2004, Walsh et al. 2004, Freeman and Marcinek 2006), while increases in flow frequency or intensity can

result in channel widening (i.e., bank erosion) or deepening (i.e., channel degradation) to accommodate the additional discharge unless the channel is physically constrained (Wolman 1967, Arnold et al. 1982, Booth 1990, Trimble 1997, Doyle et al. 2000). This results in increased downstream sedimentation and unstable beds, both of which degrade spawning, feeding and refugia habitat for riffle-dwelling species that rely on sediment-free gravel. Increased storm flows, in addition, can cause physical washout of eggs and larval fishes, stress on adults (Freeman et al. 2001, Power et al. 1996), and/or alter the quantity and quality of primary and secondary production in a stream (Bunn and Arthington 2002), indirectly affecting many fish species.

Reservoirs can substantially alter hydrology downstream, especially when dams, like Allatoona Dam on the Etowah River, are operated for hydroelectric power generation (Freeman et al. 2001, Power et al. 1996). Hydropeaking dams release high flows only when power generation is needed. This produces a pulsing flow cycle very different from the natural flow regime. Water released from Lake Allatoona is pulled from the lower lake levels; Duncan et al. (2010) estimated that water released from Lake Allatoona is 8.4°C colder than the temperature predicted in an unimpounded scenario. Releases, in addition to being colder than natural water temperatures, are oxygen depleted. These Allatoona dam operational factors -- flashy flows, cold water, and/or low dissolved oxygen -- likely are factors in the absence of Etowah and amber darters in much of the Etowah mainstem below the impoundment. Non-hydropeaking reservoirs, farm ponds, amenity lakes, and other impoundments may substantially alter hydrologic regimes by storing water during low flow periods, effectively dampening moderate to high flows and in some cases augmenting low flows.

Water withdrawals for drinking water, agriculture, industry, or other purposes lower downstream water levels. Recent studies in the Georgia Piedmont show that fish assemblage integrity levels decline as water withdrawal levels increase (Freeman and Marcinek 2006). In the Etowah Basin ten years ago, there were 21 water withdrawal sites (Freeman et al. 2005); although none appeared to withdraw at a level that causes major downstream problems, further growth in the area will continue to increase pressure for additional water withdrawals. The Hickory Log Creek Reservoir and both proposed reservoirs in the Etowah basin (Russell and Richland Creeks) are designed as pump-storage facilities that refill primarily by pumping water from the Etowah River.

Runoff from impervious surfaces is a near-ubiquitous source of hydrologic alteration in the developed portion of the Etowah basin. Impervious surfaces, such as roads, parking lots, and rooftops, alter the natural hydrologic cycle. In a natural forested system, most rainfall soaks into the soil and is carried to nearby streams via subsurface flow paths. Some evaporates or transpires, and a relatively small amount becomes surface runoff. In an urbanized system with high levels of impervious cover, most stormwater hits impervious surfaces and becomes runoff, which then is channeled quickly to streams via stormwater drain pipes or ditches. Relatively little infiltrates into the soil. As a result, storm flows in the receiving stream are higher and more frequent, although briefer in duration, and base flows are lower. The storm discharge of urban streams can be twice that of rural streams draining watersheds of similar size (Pizzuto et al. 2000, Rose and Peters 2000), and the frequency of channel-forming events can be ten times that of the pre-development conditions (Booth and Jackson 1997).

2. **Sedimentation**: Streams draining highly urbanized portions of the Etowah Basin have finer bed texture, higher turbidity, and fewer endemic or sensitive fishes than those draining less urbanized areas, even after accounting for the effect of stream gradient (Walters et al. 2003). Predevelopment, agriculturally-derived sediment and legacy sediment remobilized in the stream are often dominant sediment sources. As a watershed begins to urbanize, much sediment comes from construction sites. As development progresses, construction sites are replaced with impervious cover, and there is a decrease in sediment delivery to streams; however, scouring flows associated with increased runoff increase the amount of sediment eroding from the bed and banks (Wolman 1967, Arnold et al. 1982, Doyle et al. 2000). In urbanizing watersheds, this stream channel erosion can be the major source of sediment (Trimble 1997).

3. **Extensive riparian buffer loss**: Removal of riparian buffers can destabilize stream banks, increasing stream sedimentation and turbidity (Barling and Moore 1994, Beeson and Doyle 1995); reduce the stream's capacity for trapping and removing contaminants and nutrients from runoff (Barling and Moore 1994, Beeson and Doyle 1995, Peterjohn and Correll 1984, Osborne and Kovacic 1993, Vought et al. 1994); increase water temperature (Brazier and Brown 1973, Barton et al. 1985, Pusey and Arthington 2003, Meyer et al. 2005); increase light penetration to streams, thereby, increasing primary production (Noel et al. 1986, Pusey and Arthington 2003); reduce woody debris inputs, removing a source of aquatic habitat (Karr and Schlosser 1978); and reduce leaf litter and terrestrial invertebrate inputs, decreasing production (Nakano et al. 1999, Wallace et al. 1999, Pusey and Arthington 2003). Buffers are an essential component of an overall program of stream ecosystem protection. However, studies that compared open and forested reaches in the Etowah basin along five small streams in suburban catchments (Roy et al. 2005) concluded that riparian buffers - although necessary for protecting fish assemblages - were insufficient alone to maintain healthy assemblages in an urban setting where much stormwater runoff is transported to the stream in pipes, bypassing the buffer.

4. **Contaminants**; Contaminants, including metals, hydrocarbons, pesticides and other potentially harmful organic and inorganic compounds, are common in urban streams and may be partially responsible for the absence of sensitive fish in those systems. The most recent database of NPDES-permitted point sources lists 96 wastewater discharges in the Etowah. These include wastewater treatment plants, mines, and industrial facilities. Non-point sources are more difficult to pinpoint. Pesticides are frequently found in streams draining agricultural land uses, with herbicides being the most commonly detected (McPherson et al. 2003). Many agricultural streams still contain DDT and its degradation products (Zappia 2002). Pesticides also are heavily used in urban and suburban areas, and many of these find their way to streams and groundwater (Schueler 1995). A comparison of agricultural and urban groundwater quality in the Mobile Basin (which includes the Etowah Basin) found a greater variety and frequency of pesticide compounds in the urban groundwater (Robinson 2003). Chlordane and other now-banned organochlorine pesticides are still common in urban streams, including those in the Mobile Basin (Zappia 2002). Streets and parking lots can contribute large quantities of heavy metals that are largely derived from automobiles (Van Hassel et al. 1980, Bannerman et al. 1993). Oil and other hydrocarbons are also common constituents in urban runoff (Paul and Meyer 2001). It

is generally accepted that most of the contaminants in stormwater are washed off in a "first flush" although there is evidence that, in highly urbanized watersheds, significant contaminants continue to be delivered after the first flush (Goonetilleke et al. 2005, Schueler 1994).

5. **Movement barriers**: Culverts and other road crossings, channelized stream segments, dewatered stream segments and dams all can block fish passage to suitable habitat, limit drift of pelagic larvae to downstream reaches, and block exchange of genetic material between populations. Movement barriers fragment populations, making isolated groups more vulnerable to local extinction and preventing recolonization of upstream areas where such extirpations have occurred.

   The construction of Allatoona, Hickory Log, and Hollis Lathem Reservoirs isolated many previously-connected fish populations, including all three listed fishes; construction of the proposed 305-acre Richland and 137-acre Russell Creek Reservoirs will further fragment Cherokee darter habitat. In addition to these large structures, there are over 2000 smaller dams in the Etowah that fragment streams. Most occur on small (first or second order) streams, but a number are located on larger tributaries, effectively isolating large sections of headwaters.

   Studies have demonstrated that many pipe culverts and some box culverts are barriers to fish movement (Schaefer et al. 2003). Culverts tend to increase in density with urbanization and generally are on smaller streams, so small stream fish species, like Cherokee darters, may be most severely affected. A study of 70 stream crossings in the Etowah River Basin found 34% of surveyed crossings had characteristics likely to make them impassable to small-bodied fish; 55% of the pipe culverts and 36% of box culverts evaluated were considered impassable, and most surveyed culverts appeared undersized, which produces high velocities and channel scouring at high flows (Millington 2004). Crossings in this study were considered impassible if baseflow velocity through the culvert was greater than 0.4 m/s and the drop from the culvert outlet to the water surface was greater than 0.15 m. Benton et al. (2008) recorded low rates of movements by small fishes through culverts compared to reaches with clear-span bridges over a 1-month period on six streams in the Etowah River system. Norman et al. (2009; see also Norman 2006) conducted mark-recapture studies at four sites in the Etowah basin to estimate fish movement rates through culverts. Fish movement was observed through each culvert, but such movement appeared restricted for benthic and water column fishes at all sites except that with a bottomless box culvert. Norman et al. (2009) observed water-column fishes moving through two perched culverts but only following periods of runoff when water levels exceeded the perched level. Taken together, research on stream crossings in the Etowah basin suggests that (1) many existing stream crossings impede passage by small fish and (2) passage problems are likely to occur where pipe and, to a lesser extent, box culverts are used to cross streams.

6. **Channelization and Piping:** Channelization includes the straightening, deepening, or widening of streams and rivers for flood control, drainage improvement, navigation, and relocation. Piping is the extensive culvertization of a length of stream to allow other land uses, such as large buildings and parking lots. Channelization and piping

destroy riffle and pool habitat in streams, the amount of spawning habitat, refugia and/or food sources. Studies have shown that invertebrate biomass and diversity and the number, biomass, and richness of fish in channelized stream reaches is typically far below that of comparable natural stream reaches (e.g., Huggins and Moss 1975, Moyle 1976). Insect diversity downstream from piped segments is greatly reduced (Meyer et al. 2005). Piping, in addition, can cause upstream impoundment and downstream scour if the pipe is undersized or poorly placed; in worst-case scenarios, a culvert can cause sufficient downstream scour that the outflow end becomes perched and blocks fish movement.

Current Threats to Amber Darters in the Conasauga Basin: Fish surveys in the Conasauga River 1996-2012 have documented declining abundance of a number of fishes, including previously common species, downstream of TN Hwy 64. Comparable declines have not been observed in the adjacent Etowah River basin, which supports several of the same fishes. Algae and other periphyton communities appear to have flourished in the Conasauga at times during this period while the dominant macrophyte, *Podostemum* sp., has decreased in distribution.

Land use in the upper basin has changed little over the past decade -- the dominant land covers remain agriculture and forestry, and the headwaters of the basin are protected by extensive US Forest Service land. Low density urban development has increased throughout the basin, but dense urban sprawl is concentrated downstream of known areas of high aquatic diversity. The only major land use changes we identified in the basin over the past decade were (1) a largescale shift to use of Roundup-ready seed for major row-crop products and (2) greater use of poultry litter to fertilize pastures and row crops (Cindy Askew, NRCS, pers. comm., June 2008). These changes in land use could have significant impact on Conasauga water quality because agricultural fields in the river's floodplain above Dalton are heavily ditched (Fig. 11), facilitating transport of agricultural chemicals into stream systems. The Nature Conservancy located hundreds of agricultural ditches in a 2008 survey of a 40-mile reach of the upper basin (Kathleen Owens, TNC, pers. comm. Feb. 2009). These ditches tend to bypass standard agricultural water quality best management practices, like riparian buffers or grass filter strips, and convey polluted runoff directly into the Conasauga River and its tributaries.

- **Roundup Ready crop seed:** Roundup is the brand name of a systemic, broad-spectrum herbicide produced by the U.S. company - Monsanto. Monsanto introduced Roundup Ready soybean and corn seeds in 1996 and 1998, followed by Roundup ready wheat a decade later. Farmers quickly began using these seeds, which are genetically modified to allow seedlings to survive application of Roundup. Much of the cropland in the Conasauga basin is planted in corn, soybeans, and wheat using no-till farming methods. NRCS personnel in the basin estimate that farmers in the Conasauga began using Roundup Ready soybean and corn seeds extensively 10-12 years ago (Cindy Askew, NRCS, pers. comm. June 2008). Roundup's active ingredient is glyphosate, which impedes photosynthesis. Glyphosate is non-toxic to slightly toxic to most fish, although toxicity appears to be higher in several important sport or food fish, including brown trout, rainbow trout, channel catfish, bluegill, and tilapia (Ayoola 2008; Pesticide Action Network Pesticide database, http://www.pesticideinfo.org). Glyphosate is an acid, but in

Figure 11. Conasauga agricultural drainage ditch that discharges directly into the River.

Roundup it commonly is used in salt form (isopropylamine salt). This salt, as well as the surfactant normally found in Roundup (polyethoxylated tallowamine; POEA) and/or other 'inert' ingredients in the Roundup formulation appear more toxic to fish and mussels than glyphosate alone, causing death of mussel glochidia (Bringolf et al. 2007) and fish (Mitchell et al. 1987) and subcellular changes that may affect survival (Szarek et al. 2000, Cavalcante et al. 2008, Langiano and Martinez 2008). Temperature, pH, suspended sediment, and other water quality parameters may affect glyphosate and Roundup's effects on aquatic species.

- **Increased use of poultry litter as fertilizer:** The poultry industry is a major economic force in the Conasauga basin. In 2007, the State of Georgia recorded over 630 broiler, layer, and pullet houses in Murray and Whitfield Counties, where the majority of the upper Conasauga basin is located; each house is estimated to produce up to 100 tons of litter per year. Poultry litter is a mixture of chicken manure, feathers, spilled food, and bedding material that frequently is used to fertilize pastureland or row crops. Surface-spreading of litter allows runoff from heavy rains to carry nutrients from manure into nearby streams. Repeated and/or over application of poultry litter, in addition, can result in phosphorus buildup in the soil, since the 3N:1P ratio in poultry litter is much narrower than plants generally need (8:1) (Sharpley et al. 2007). Excess phosphorus and nitrogen in stream systems increase blue-green algae and undesirable aquatic plants that rob water of oxygen, causing fish kills and odor and taste problems in municipal water supplies. Litter can contain arsenic, which is formed from a chemical routinely used as a feed additive to prevent disease and stimulate growth (Stolz et al. 2007). Other substances often found in poultry litter include fecal coliforms and other pathogens, other heavy metals, pesticides and larvicides used to control flies and litter beetles,

estrogens and other hormones, and excess carbon, which can deplete dissolved oxygen in surface waters (Moore 1997).

Water quality monitoring in the Conasauga River since 1997 shows an increasing trend in nitrite (NO2) and nitrate (NO3) concentrations and comparatively higher concentrations of total nitrogen in 2011-2012 than 1999-2000 (Hagler and Freeman 2012). Nitrogen concentrations are consistently elevated above the EPA's reference criteria for Ridge and Valley streams. In contrast, soluble reactive phosphorus (SRP) and total phosphorus concentrations have been lower in recent years than from 1997-2000, although the strong trend in the downstream reach may overshadow more subtle differences in other reaches. Low flows and drought in the Conasauga River in recent years may have contributed to lower mean SRP concentrations, since phosphorus cycling in streams is largely driven by precipitation events. In general, nutrient concentrations in tributaries are much greater than those in the mainstem. The three tributaries (Perry, Sumac and Mill (GA)) with the highest NO2 and NO3 concentrations also had the lowest SRP concentrations (Hagler and Freeman 2012).

Hagler and Freeman (2012) concluded that increasing nutrient concentrations, especially nitrogen, suggests eutrophication may be a major stressor for biota in the Conasauga River. Eutrophication, where nutrient concentrations have exceeded some threshold and nutrient supply is greater than the river's assimilative capacity, is associated with deteriorating water quality and diminished species diversity. Baker et al. (2013) also identified eutrophication as a major stressor to biodiversity in the Conasauga. They found evidence of a State change to potential eutrophic conditions beginning within a 10 km reach just downstream of the National Forest boundary, based on the results of a nutrient-diffusing substrate experiment. Baker et al. (2013) documented increases in algal production in the downstream direction.

Emerging Threats: The Service currently is funding a study to evaluate concentrations of agricultural chemicals in the Conasauga's waters, including glyphosate and its major degradation product (aminomethyl phosphonic acid, or AMPA), hormones, metals (particularly arsenic), and nutrients associated with chicken litter. Preliminary results indicate (Lasier et al. 2012):

- widespread AMPA in water samples (77%). Mean concentrations generally were high in the mainstem and major tributaries, compared to aquatic systems in other agricultural areas, with the exception of samples from one large farm's tributaries after April 2011 -- the drop in surface-water AMPA concentrations from this property generally coincided with the farm owners switch from tank-mix herbicide (separate glyphosate and surfactant components) to a commercial product containing both components (Roundup®).
- Increased nitrates in water samples. The primary source of nitrates is inorganic and organic fertilizer applied to the surrounding fields, but substantial amounts can also be found in discharges from waste-treatment plants and feedlot settling ponds. There is growing evidence that long-term low-level exposure to nitrate may reduce fitness and viability in the early life stages of a wide variety of aquatic organisms (Camargo et al. 2005).
- Phosphate was rarely detected.

- Arsenic does not appear to be a stressor.
- Concentrations of heavy metals in surface water samples were low, particularly in samples from the mainstem and major-tributary sites.
- Sediment concentrations of estrogen hormones were elevated July 2010 and increased substantially when sampled May 2012. Lower concentrations and increased variability in July samples may indicate that hormones tend to accumulate up to late spring then degrade with the lower flows and higher temperatures of summer. Estriol concentrations progressively increased downstream in 2010 samples but were non-detectable in all samples collected in 2012. Testosterone levels were elevated as well and also substantially greater in 2012. These concentrations most likely reflect a combination of animal and human waste entering the river from a number of sources.
- Necropsy of collected fishes documented a large percentage of intersex fish -- male fish carrying immature female egg cells in their testes; almost 22% (18 of 82) of male fishes collected at various sites on the mainstem Conasauga above Dalton contained these testicular oocytes. Fishes of the sunfish family (Centrarchidae) had the highest rate of intersex (34.8%), and 20% of males in the minnow family (Cyprinidae) were intersex. No intersex was identified in suckers (Catostomidae) or darters and logperch (Percidae). Intersex data has been reported for only a few speciess. The Servive secured USGS Science Support funding for FY2015-17 to expand research on Conasauga intersex fishes and determine how Conasauga intersex rates compare to a control river and to Conasauga fishes in the past (using museum collections).

Summary: Destruction and modification of Etowah, Cherokee, and amber darter habitat in the Etowah River basin has been reduced, at least temporarily, due to (1) the continuing economic recession that has slowed growth and (2) ongoing Service and partner conservation actions in the basin. Existing development, poorly-designed/installed road and utility crossings, impoundments, and other human activities in the basin are still sources of chronic stress on these fishes. Resumption of rapid urbanization growth patterns, without implementation of adequate best management practices to minimize impacts, would increase threats to the darters associated with increased stormwater runoff, sedimentation, riparian buffer loss, contaminants, movement barriers, and channelization/piping.

Causes of amber darter decline in the Conasauga basin are unknown, but may include degraded water quality, eutrophication, and/or intersex fishes. This document does not evaluate threats to amber darters that may occur in the Coosawattee River, where a single individual was collected July 29, 2010. Additional study is needed to determine if the basin supports a viable amber darter population.

b. **Overutilization for commercial, recreational, scientific, or educational purposes**: There was concern, when the Etowah and Cherokee darters were listed, that rule publication would inform the general public about where these fishes occurred in the Etowah system. The rule described species distribution only in general terms. In the past five years, maps showing general species locations have been published, but the Service has not provided coordinates of survey spots. Multiple Endangered Species Act Section 10 collecting permits have been issued to authorize presence/absence surveys, food evaluation studies, genetic studies, and other projects, but we have no evidence that overutilization is a threat to the species.

c. **Disease or predation:** There was concern, at the time of the Etowah and Cherokee darter listing, that predation in reaches immediately below dams could threaten these species. We have seen no evidence that this is a significant threat.

d. **Inadequacy of existing regulatory mechanisms:** Habitat for the Etowah, amber, and Cherokee darters is protected, to varying degrees, under the State of Georgia's Endangered Wildlife Act of 1973 (O.C.G.A. 27-3-130 *et seq.*), Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974 (Tenn. Code Ann. § 70-8-101), Georgia Erosion and Sedimentation Act (O.C.G.A. 12-7-1 *et seq.*), Tennessee Water Quality Control Act of 1977 (Tenn. Code Ann. § 69-3-102), other State laws and regulations regarding natural resources, the Federal Endangered Species Act (Act) of 1973, as amended (16 U.S.C. §1531 *et seq.)* and Clean Water Act (33 U.S.C. §1251 *et seg*.) .

- The Georgia Endangered Wildlife Act limits protection of listed species to individuals found on State public lands (excluding Georgia Department of Transportation lands). Individuals on private lands are not protected under State law. The Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act is more stringent – it makes it unlawful for any person to take, attempt to take, possess, transport, export, process, sell or offer for sale or ship nongame wildlife.

- Georgia's Erosion and Sedimentation Control Act was passed in 1975 to protect Georgia's waters from soil erosion and sediment deposition. The Act requires an erosion, sedimentation, and pollution control plan for land-disturbing activities on sites ≥1acre. The GDNR's Environmental Protection Division (GEPD) is responsible for enforcing the law, although GEPD, in many jurisdictions, delegates plan review and permitting duties to local issuing authorities. In 1991, the EPA granted GEPD authority to issue NPDES general stormwater discharge permits under Section 402 of the Clean Water Act. Under the terms of the 2014 General Permit, persons and firms that engage in land-disturbing activities on sites >1acre are required to obtain authorization to discharge stormwater and to file a Notice of Intent with GEPD that certifies the site's *Erosion, Sedimentation, and Pollution Control Plan* provides a comprehensive system of best management practices.

  The Georgia Department of Audits and Accounts reviewed the State's joint erosion and stormwater programs shortly after the first Georgia general NPDES permit was issued in 2000, and determined it would be effective only if (1) components were fully implemented and (2) local governments authorized to issue permits had the resources and political will to inspect project sites on a routine basis and take enforcement actions (Georgia Department of Audits and Accounts 2001). A 2004 follow-up review concluded that 2003 revisions to the Erosion and Sedimentation Act helped address many of the problems associated with the Program's overall effectiveness, but that not all recommendations had been fully implemented (Georgia Department of Audits and Accounts 2004). The Upper Chattahoochee Riverkeeper (2007) received an EPA grant in 2005 to study the effectiveness of Georgia's program. Project partners visited more than 100 construction sites in the Altamaha, Etowah, Canoochee, Savannah, and Chattahoochee systems during the two-year study, documenting compliance and logging complaints with local and state regulatory agencies. Major violations of BMP requirements were observed at 60% of the construction sites. Violations included failure to install and/or maintain BMPs, illegal

stream buffer encroachments, poor or nonexistent BMP design plans, and sediment entering state waters. UCR attributed lack of compliance to lack of adequate funding at all levels, which resulted in widespread failure to conduct site inspections and take appropriate enforcement actions. Recommendations to improve the process were incorporated into the 2008 General Permit, but an evaluation of the current process' effectiveness has not been conducted (probably because there's so little ongoing development construction).

The Georgia Erosion and Sedimentation Act also mandates stream buffer protection (although a buffer variance may be obtained from GEPD). For non-trout streams, a 25-foot buffer is required between a permitted land-disturbing activity and streams. In 2000, the Georgia legislature reduced the mandated buffer for trout streams from 100 to 50 feet. A GEPD-funded study to evaluate the impacts of this buffer reduction determined that stream reaches with the narrower buffer, when compared to reaches with 100-foot buffers, had more fine sediments in riffle habitats and higher peak temperatures; the average peak stream temperatures during the warmest week of the year increased by ~2.0 ± 0.3°C, depending on summertime climate conditions (Jones et al. 2006). The Etowah headwaters, which includes priority Etowah darter habitat, and the headwaters of several Etowah tributaries that support both Etowah and Cherokee darters, are designated State trout waters subject to this buffer reduction.

The Tennessee Water Quality Control Act establishes the State's water pollution control program. The Act identifies the responsibilities and extent of authority for the Commissioner of the Water Quality Control Board and establishes the concept of clean water goals and water quality planning and assessment. The Act has an antidegredation statement protecting high quality surface waters, and provides for a permitting program for discharges to, or alterations of, water of the state. Under the Act, one or more of the following permits may be required: Aquatic Resource Alteration Permit (ARAP)/Section 401 certification, NPDES (national pollutant discharge elimination system) and State Operating Permits, Stormwater General Permit, Surface Mining Permit. The ARAP permit is required for any projects that will physically alter the surface waters of the state. Tennessee requires a 60-foot natural riparian buffer between a land-distrubing activity and a receiving stream designated as impaired or an Exceptional Tennessee waters. A 30-foot natural riparian buffer zone is required adjacent to all other streams

- Agriculture and forestry, the predominant land uses in the upper Conasauga basin, are fully or partially exempted from regulation under Georgia's Erosion and Sedimentation Control Act and the Tennessee Water Quality Control Act. The States address threats associated with agriculture and silviculture primarily through voluntary State best management practices (BMPs). The Georgia Forestry Commission (GFC) and Tennessee Division of Forestry (TDF) are the lead agencies for statewide development, education, implementation and monitoring of forestry BMPs.

  In 2013, GFC's initiated their ninth Statewide Forestry BMP Implementation and Compliance Survey (Georgia Forestry Commission 2014). Statewide, correct BMP implementation on the 209 sites evaluated was 89.9%, a 5.3% decrease in BMP implementation from the 2011 survey. Implementation of streamside management zone (SMZ) and stream crossing BMPs was 86.5% and 85.5% respectively. **S**tormwater control

structures in roads within SMZs, logging debris left in stream channels, SMZ width, and residual tree canopy density were the most common BMP deficiencies in the SMZ category. Deficiencies in stream crossing BMPs included stream crossing approach design, culvert sizing to pass storm flows, and culvert installation to minimize impacts on migration of aquatic species.

Similarly, TDF conducted a survey in 2010 to determine how frequently forestry BMPs were implemented in the State (Sherrill et al. 2013). Over 200 harvest sites were visited between spring 2010 and the end of winter 2011 and evaluated for compliance with 53 individual BMPs. The survey showed no significant change in overall BMP implementation rate (88.9 percent) when compared to the 2007 survey (89.2 percent), and substantial improvement was evident when compared to the first BMP implementation survey in 1996 (62.9 percent). BMPs for wetlands and stream crossings had the lowest rate of correct implementation.

We were unable to find studies that evaluated implementation of Georgia or Tennessee's agricultural BMPs.

- The Federal Endangered Species Act prohibits unauthorized take of listed wildlife. Federal agencies are required to consult with the Service under Section 7 of the Act when activities they fund, authorize, or carry out may affect a listed species. If a project that might take listed wildlife does not have a Federal nexus, take may be authorized under Section 10. Some Federal agencies are unfamiliar with Section 7 consultation requirements, and, when consultation occurs, applicants may not implement Service recommendations/requirements (including biological opinion reasonable and prudent measures and implementing terms and conditions).

- Sections 401 and 402 of the Clean Water Act are the primary Federal laws regulating pollution in waters of the United States. Section 402 of the Clean Water Act contains the law's primary point source control program – the National Pollutant Discharge Elimination System (NPDES). EPA has delegated NPDES permit responsibility in Georgia and Tennessee, respectively, to the Georgia Environmental Protection Division and Tennessee Division of Water Resources. NPDES industrial stormwater permits authorize discharges of non-point source effluent, which can come from industrial facilities, including industrial manufacturing and processing. Municipal facilities that may require an NPDES industrial permit include wastewater treatment facilities, land application sites, solid waste or recycling transfer stations, landfills, and fueling stations. Discharges from industrial wastewater systems and municipal sanitary wastewater systems are permitted under other NPDES programs. Permits generally establish specific discharge levels (e.g. pollutant-specific limits and wasteloads) and monitoring requirements.

  Section 404 of the Clean Water Act, which regulates placement of dredge or fill materials in waters of the United States, is administered, in Georgia, by the Savannah District, Corps of Engineers. Service biologists have worked with the Savannah District, GEPD, EPA, National Marine Fisheries Service and others to develop a reservoir permitting process that streamlines permit issuance; stream and wetland mitigation guidelines to compensate for authorized impacts; culvert installation guidelines to minimize impacts of these instream structures on fish passage; and other measures to reduce wetland/stream impacts and ensure compensation for

unavoidable losses. However, like the Service, Corps project managers rarely have time to monitor project compliance with permit conditions, and enforcement of Section 404 violations is rare.

Other sections of the Clean Water Act require states to develop a list of impaired waters that do not meet water quality standards and to establish total maximum daily loads (TMDLs) that allocate pollutant loads among point and nonpoint sources of pollution, including stormwater. The most recent data available suggests multiple causes of water quality impairment remain in both the Etowah and Conasauga basins (data from http://ofmpub.epa.gov/waters10/attains_state.control?p_state=GA).

e. **Other natural or manmade factors affecting its continued existence:** Mid-channel bar removal, which was identified as a threat in the listing document, does not appear to be a major factor in these species' distributions or long-term persistance.

Amber darters in the Conasauga are limited to the river's mainstem, generally occurring in small numbers in shoal habitat. Both amber and Etowah darters occur in the Etowah mainstem and a few large Etowah tributaries, although the Etowah darter, unlike the amber darter, often is common in good habitat. Their limited distribution makes both species vulnerable to localized extinction over much of their ranges in the event of human-caused toxic chemical spills, catastrophic natural events like flood or severe drought, genetic drift, and other stochastic events. The Cherokee darter is more widespread than the other two darters, but has a patchy distribution that limits recolonization of extirpated suitable habitat, particularly as urban development increases the number of culverts, dams, and other structures that block upstream fish passage.

The effects of climate change on aquatic species of the Conasauga and Etowah River systems have not been studied. In the Southeast through the 21st century, climate models project that average annual temperatures will increase, cold days will become less frequent, the freeze-free season will lengthen by up to a month, temperatures exceeding 95 degrees will increase, heat waves will become longer, sea levels will rise an average of 3 feet, the number of category 3 to category 5 hurricanes will increase, and air quality will decline (Ingram et al. 2013). Aquatic systems will be impacted by increasing water temperatures, decreasing dissolved oxygen levels, altered streamflow patterns, increased demand for water storage and conveyance structures, and increasing toxicity of pollutants (Ficke 2007, Rahel and Olden 2007). Reduced spring/summer rainfall, coupled with increased evapotransporation and water demand (because of population growth), could lead to local extirpations if streams dry out more frequently (Ingram et al. 2013). Fishes not constrained by movement barriers could move upstream to cooler waters; however, Etowah and Cherokee darters already occur in the headwaters of the Etowah mainstem and occupied tributaries, so upstream range migration would result in a net loss of occupied habitat. The amber darter could is not known to occur in the upper Etowah, the Conasauga much above the TN Hwy 74 crossing, or in the headwaters of tributaries; these upstream areas may be too small to support the species.

D. Synthesis

Etowah Darter: The Etowah darter persists in stream reaches where it was known to occur when the species was listed, and additional populations have been located in three other tributaries, including one below Allatoona Dam. Etowah darters are fairly numerous in the Etowah mainstem headwaters and several tributary systems. Populations are highly vulnerable to local extirpation when uplands within the immediate upstream watershed began to urbanize, even when the amount of impervious surface is relatively low (Fig. 6). The Service and partners have implemented a number of conservation and habitat restoration measures in the Etowah basin that benefit aquatic resources, but these are insufficient to protect the Etowah darter across its range, particularly when the economy recovers and suburban growth resumes. Although the species, as a whole, likely has been stable since the housing industry crashed around 2008, stressors have not been alleviated, and population impacts likely will resume as the economy recovers. Long-term basin-wide surveys have not been conducted to quantitatively evaluate stability of known Etowah darter populations in the Etowah mainstem and large tributaries. Based on these data, we conclude that the first criterion has not been met, and the second has only been partially met. The Etowah darter still meets the definition of endangered under the Endangered Species Act.

	Etowah Darter Delisting Criteria	
	Known populations stable or increasing for ≥5 years	Plans to protect/monitor water and habitat quality in occupied watersheds
Advances	New populations found, including 1 downstream of Allatoona Dam. The 2007-2009 recession depressed development in the basin, which likely reduced, temporarily, some stressors. The species is currently thought to be stable.	Draft HCP developed that provided both management actions to protect the species and comprehensive watershed monitoring. Several management actions of Draft HCP already implemented to protect riparian buffers and enhance culvert design/installation.
Concerns	No basin-wide monitoring has been conducted to determine if populations are stable. Urban development in the basin is likely to resume as economy recovers, impacting Etowah darters. Stochastic events and climate change could adversely affect this narrow endemic.	HCP lost momentum with the 2007 recession and is not likely to be implemented now in its current state.
Needs	Implementation of conservation plan(s) to reduce threats to species. Development and implementation of robust monitoring program to evaluate population trends.	
Criteria Met?	No. Long-term basin-wide surveys have not been conducted to quantitatively evaluate stability of known populations, although we anticipate, based on limited model results, that the species has been stable since the 2007-2009 recession.	Partially, due to more stringent buffer and stormwater measures adopted by some local governments, and improved culvert and utility line design and installation requirements to acquire Corps authorization under Section 404 of the Clean Water Act.

Cherokee Darter: The Cherokee darter occurs in most of the 26 Etowah tributary systems where it was known to occur when the species was listed and has been found, since being listed, in 20 additional Etowah River tributaries. Seventeen of the 20 new range tributary systems are small, and several drain directly into Lake Allatoona, which reduces the potential for genetic exchange between populations. The largest of the 20 tributaries located since the species was listed, Pettit Creek, drains the Cartersville area, which, until the recession, was rapidly developing commercially and residentially. Two of the other newly-identified Cherokee darter streams, Richland and Russell Creeks, are slated to be impounded as drinking water reservoirs, in addition to the two reservoirs that were constructed since 1997 on Cherokee darter streams.

Research indicates that Cherokee darter population size declines when uplands within the immediate upstream watershed began to urbanize. Most of the Cherokee darter streams in the basin are vulnerable to this stressor. Cherokee darters tend to persist in many tributaries impacted by upstream development, but abundance of these populations declines with increasing upstream impervious surface. The Service and partners have implemented a number of conservation and habitat restoration measures in the Etowah basin that benefit aquatic resources, but these currently are insufficient to protect the Cherokee darter across its range, particularly when the economy recovers and suburban growth resumes. Based on these data, we conclude that the first criterion has not been met, and the second has only been partially met. The Cherokee darter still meets the definition of threatened under the Endangered Species Act.

Amber Darter: Currently, amber darters occur in significant numbers only in the mainstems of the Etowah and Conasauga Rivers (Wenger et al. 2010). The Conasauga population appears to be in decline downstream of TN Hwy 74, possibly due to changes in agricultural practices in the basin that adversely affect water quality. Studies to better understand the amber darter's life history and stressors have been conducted or are ongoing, and these data have been used to identify and implement conservation and habitat restoration measures in the Conasauga and Etowah basins. The Service and partners have implemented a number of conservation and habitat restoration measures in the Etowah basin that benefit aquatic resources, but these currently are insufficient to protect the amber darter in the Etowah River, particularly when the economy recovers and suburban growth resumes. The Service is working to establish a conservation area in the Conasauga River basin, but protection of sufficient land to protect amber darters and other rare species will take years. Based on this information, we conclude that neither of the Delisting Criteria for this species have been met and the amber darter still meets the definition of endangered under the Endangered Species Act.

This evaluation of amber darter status does not consider the ramifications of an amber darter population in the Coosawattee River basin. GDNR collected a single individual in the Coosawattee mainstem July 29, 2010, but additional study is needed to determine if the basin supports a viable population.

	Cherokee Darter Delisting Criteria	
	Known populations stable or increasing for ≥5 years	Plans developed to protect and monitor water/habitat quality in all occupied watersheds
Advances	A number of new populations found. Genetic data indicates known populations occur in 3 distinct ESUs. The 2007-2009 recession has depressed urban development in the basin, which likely reduced, at least temporarily, some Cherokee darter stressors	Draft HCP developed that provided both management actions to protect the species and comprehensive watershed monitoring. Several management actions of Draft HCP already implemented to protect riparian buffers and enhance culvert design/installation.
Concerns	The population is decreasing, although persistence at known locations remains high. Several streams with large populations have been impounded and other new reservoirs are proposed. Construction of infrastructure (roads, utility lines, landfills) continues to impact Cherokee darter habitat. No basin-wide monitoring has been conducted to determine if populations are stable. Urban development in the basin is likely to resume as economy recovers, further impacting Cherokee darters. Stochastic events and climate change could adversely affect this narrow endemic.	County government personnel that we worked with on the draft HCP before the recession no longer are with the government; new contacts will have to be established
Needs	Annual population monitoring to evaluate status	Implementation of basinwide management and monitoring plan to protect aquatic habitats
Delisting Criteria Met?	No. Long-term basin-wide surveys have not been conducted to quantitatively evaluate stability of known populations, although we anticipate, based on limited model results, that the species has been stable since the 2007-2009 recession.	Partially, due to more stringent buffer and stormwater measures adopted by some local governments, and improved culvert and utility line design and installation requirements to acquire Corps authorization under Section 404 of the Clean Water Act.

Amber darter delisting criteria	Viable populations exist in two rivers	Studies of the fish's biological/ecological requirements are completed	Management strategies implemented to prevent extinction
Advances	Amber darter rediscovered in Etowah River basin	Ongoing	Creation of a Conasauga conservation area approved by Director
Concerns	Species vulnerable to effects of upstream urbanization. Conasauga population declining and stressors are unknown. Stochastic events and climate change could adversely affect this narrow endemic.	A main threat in the Conasauga appears to be agricultural chemicals; this threat may be very difficult to reduce without large-scale changes in agricultural practices	Difficult to develop management strategies for Conasauga until stressors better understood. County government personnel in the Etowah basin that we worked with on the draft HCP before the recession no longer are with the government; new contacts will have to be established
Needs	Annual population monitoring to evaluate status	Future research needs will be based on results on ongoing studies	Implementation of basinwide management and monitoring plan in both the Conasauga and Etowah to protect aquatic habitats
Delisting Criteria Met?	Partially. A second population in the Etowah River was rediscovered, but both it and the Conasauga population appear to be declining.	Ongoing	Partially, due to more stringent buffer and stormwater measures adopted by some local governments in the Etowah River basin.

III. RESULTS

A. Recommended Classification:

_X_ No change is needed for all 3 fishes

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

During the next review period, the Service should undertake the following priority actions:

- Work with local governments in the Etowah River basin to develop a new HCP(s) or other basin-wide management plan to protect aquatic resources.
- Develop a conservation banking program in the Etowah River basin to compensate for loss of aquatic habitats that support Etowah, Cherokee, and amber darters.
- Work to establish a Conasauga River conservation area to protect high priority amber darter reaches.

- Fund annual long-term monitoring of these species in the Etowah and Conasauga basins.
- Develop a baseline database on stream geomorphic characteristics in high quality Cherokee darter streams. Use these data to revise stream restoration methods commonly used in the basin to ensure development of habitat for benthic shoal-dwelling fishes is a primary restoration project component (where applicable).
- Complete the chemical profile of the Conasauga. If agricultural contaminants appear to be a major stressor on amber darters and other protected and rare species in the Conasauga, work with NRCS to reduce input into the River.
- Complete the study to evaluate intersex fish incidence in the Conasauga. Concurrently, evaluate the effect of environmental estrogens on public health and communicate these results to GEPD and local governments.
- Develop and implement programs and materials to educate government officials and the public on the need and benefits of ecosystem management and to involve them in watershed stewardship for these and other aquatic species
- Work with GEPD and EPA to incorporate listed species' review into NPDES point-source and construction permit review
- Continue to hold periodic Conasauga and/or Coosa Summits to bring together researchers, land managers, environmental groups, local government officials, and others to discuss recent Conasauga/Coosa research results, new threats, and needed management actions. Continue to meet in smaller committees, as needed, to discuss management actions to address stressors.

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U.S. FISH AND WILDLIFE SERVICE

Five-Year review
Etowah Darter (*Etheostoma etowahae*)
Cherokee Darter (*Etheostoma scotti*)
Amber Darter (*Percina antesella*)

Current Classification:	Etowah darter	Endangered
	Cherokee darter	Threatened
	Amber darter	Endangered

Recommendation resulting from the five-year review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
_X_ **No changes are needed for any of the three fishes**

Review Conducted By: Michael Pixley and Robin Goodloe, Georgia Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Donald W. Imm Date 30 Sept 2014

Donald W. Imm, Georgia Ecological Services

REGIONAL OFFICE APPROVAL:

for
Lead Regional Director, Fish and Wildlife Service

Approve [signature] Date Oct 21, 2014

APPENDIX A: Etowah River Habitat Conservation Plan Website Documents

Fowler, L.A., R.A. Vick, S.J. Wenger, and T.L. Carter. 2008. Runoff limits: An ecologically based stormwater management program. *Stormwater: The Journal for Surface Water Quality Professional.* Online URL: http://www.stormh2o.com/SW/Articles/101.aspx.

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APPENDIX B: Summary of Peer Review for the 5-year Reviews of the Amber Darter, Cherokee Darter, and Etowah Darter

A. Peer Review Method: A copy of the draft review was provided to Dr. Byron J. (Bud) Freeman, University of Georgia (UGA), Dr. Mary C. Freeman, U.S. Geological Survey (USGS), Megan Hagler, UGA, and Dr. Brett Albanese, GDNR. These individuals are considered experts on the three review species and/or are highly knowledgeable about the river systems in which they occur. Dr. Bud Freeman is a UGA Senior Public Service Associate and Director of the Georgia Museum of Natural History. His areas of research include the distribution and abundance of fishes endemic to southeastern systems; quantifying basin characteristics in southeastern watersheds harboring remnant endemic communities; and systematics and taxonomy of southeastern freshwater fishes. Dr. Mary Freeman is a Research Ecologist with USGS' Patuxent Wildlife Research Center. Her areas of research include river ecology and management, and the effects of altering streamflow and instream habitat on biological processes. Ms. Hagler is a UGA Research Professional. Her main research interests include distributions and life history strategies of endemic fishes, quantitative approaches to monitoring fish populations, and preservation of biotic diversity in watersheds with changing land-use. Dr. Albanese is the senior aquatic zoologist with GDNR's Nongame Conservation Section. He is the co-author of the *Field Guide to Gishes of the Conasauga River System* and, with Dr. Bud Freeman et. al., developed the *Georgia Fish Atlas*.

B. Peer Review Charge: Peer reviewers were asked for scientific peer review of presented data. We did not ask for their review of the legal status recommendation.

C. Summary of Peer Review Comments/Report: The peer reviewers identified several typographic and species' life history errors, but had no substantive changes.

D. Response to Peer Review: Peer reviewer edits were incorporated into the revised 5-year review.