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Candidate Conservation Agreement

for the

Sicklefin Redhorse
(*Moxostoma sp.*)

between

United States Fish and Wildlife Service
North Carolina Wildlife Resources Commission
Duke Energy Carolinas, LLC
Tennessee Valley Authority
Eastern Band of Cherokee Indians
Georgia Department of Natural Resources

December 2015

Table of Contents

		Page No.
I.	Purpose of This Candidate Conservation Agreement	4
II.	Objectives of This CCA for the Sicklefin Redhorse	5
	A. Range-wide Conservation and Management	5
	B. Cooperation and Collaboration	5
III.	Parties and Cooperators to This CCA	5
	A. Parties to This CCA	5
	B. Cooperators	6
IV.	Authority	7
	A. Parties to This CCA	7
	B. Non-governmental Parties	7
V.	Enrolled Lands	7
VI.	CCA Management and Administration	8
VII.	Conservation Efforts	9
VIII.	Species Description, Taxonomy, Life History, and Range	13
	A. Species Description	13
	B. Taxonomy	13
	C. Habitat and Life History	14
	D. Historic Range and Distribution	17
	E. Current Range and Distribution	17
IX.	Primary Threats Influencing the Survival of the Species	19
	A. The present or threatened destruction, modification, or curtailment of its habitat or range (Factor A)	19
	B. Overutilization for commercial, recreational, scientific, or educational purposes (Factor B)	21
	C. Disease or Predation (Factor C)	21
	D. The inadequacy of existing regulatory mechanisms (Factor D)	22
	E. Other natural or manmade factors affecting its continued existence (Factor E)	23
	F. Summary of Threats	24
X.	Range-wide Conservation, Management, and Reporting Actions	25
	A. Information Management	25
	B. Conservation Measures	25
	C. Responsibilities of the Parties	25
	1. Duke Energy Carolinas, LLC	25
	2. Eastern Band of Cherokee Indians	27
	3. Georgia Department of Natural Resources	28

	4. North Carolina Wildlife Resources Commission	28
	5. Tennessee Valley Authority	30
	6. U.S. Fish and Wildlife Service	31
	7. All Parties	32
	D. Adaptive Management	32
XI.	Monitoring and Data Collection	32
	A. Compliance Monitoring	32
	B. Biological Monitoring	33
XII.	Reporting of Conservation Actions and Monitoring	33
XIII.	Duration of This CCA and Termination by Any Party	34
XIV.	Additional Participants	34
XV.	Modification and Merger	34
XVI.	Remedies	35
XVII.	Succession and Transfer	35
XVIII.	Availability of Funds	35
XIX.	Relationship to Other Agreements	35
XX.	Choice of Law and Severability	35
XXI.	Notices and Reports	36
XXII.	Effect of This CCA in the Event of a Listing Decision	37
XXIII.	References	37
Appendix A: Sicklefin Redhorse Distribution Map		39
Appendix B: Signature Page(s)		40

Common Name:	Sicklefin Redhorse
Scientific Name:	*Moxostoma* sp.
Current Range:	Little Tennessee River and Hiwassee River Watersheds in North Carolina and Georgia
Listing Status and Date:	Candidate (May 2005)
Lead Agency/Region:	U.S. Fish and Wildlife Service, Region 4
Lead Field Office:	Asheville Ecological Services Field Office 160 Zillicoa Street Asheville, North Carolina 28801 828/258-3939
Lead Biologist:	Jason Mays, Asheville Ecological Services Field Office 828/258-3939, Ext. 226; email: *jason_mays@fws.gov*

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I. Purpose of This Candidate Conservation Agreement

This Candidate Conservation Agreement (CCA) for the Sicklefin Redhorse (*Moxostoma sp.*) has been developed as a cooperative effort among tribal, state, federal, nongovernmental, and private organizations to establish a formal agreement to cooperate on actions that conserve, manage, and improve Sicklefin Redhorse populations range-wide with the goal of working to preclude the need to list the species under the Endangered Species Act of 1973, as amended (ESA). This CCA is voluntary and adaptive in nature, and it has been developed so that different conservation and management actions can be agreed to and implemented.

Under Federal Executive Order 13352 (Facilitation of Cooperative Conservation), the Departments of the Interior, Agriculture, Commerce, and Defense and the Environmental Protection Agency are to carry out their environmental and natural resource programs in a manner that facilitates cooperative conservation. This CCA is an example of such a cooperative conservation approach.

II. Objectives of This CCA for the Sicklefin Redhorse

A. Range-wide Conservation and Management: By addressing Sicklefin Redhorse conservation across its range, the Parties (Section III.) hope to conserve Sicklefin Redhorse populations; develop and implement management strategies that maintain or enhance Sicklefin Redhorse populations; and monitor the response of the species to conservation and management activities.

B. Cooperation and Collaboration: By managing Sicklefin Redhorse conservation actions in a proactive and collaborative manner, the Parties to this CCA intend to promote existing individual Sicklefin Redhorse conservation actions and efforts and to share knowledge and information among Parties and other organizations. This allows for an organized approach to the implementing of conservation actions and the reporting of conservation efforts, including integrated efforts for hatchery support, rearing, and stocking of the Sicklefin Redhorse; expansion of the current range of the species; population assessment and monitoring; habitat management activities; conservation-based research; and providing public information on conservation achieved through this collaborative effort.

III. Parties and Cooperators to This CCA

A. Parties to This CCA

- U.S. Fish and Wildlife Service (USFWS)
- North Carolina Wildlife Resources Commission (NCWRC)
- Duke Energy Carolinas, LLC (Duke Energy)
- Tennessee Valley Authority (TVA)
- Eastern Band of Cherokee Indians (EBCI)
- Georgia Department of Natural Resources (GADNR)

The Parties share a desire to conserve, protect, and expand Sicklefin Redhorse populations and habitat in order to ensure long-term viability of the species. The Parties recognize the benefits of proactive management as a means to avoid additional regulatory requirements, which will allow the Parties to carry out their missions to the best of their ability. Once all the Parties have signed this CCA, the management actions outlined in this document will be implemented as determined to be appropriate by a Management Board (Board) designated by the Parties and as funding allows. The initial Board shall establish and schedule at least one meeting of the Board per calendar year (Annual Meeting) for the duration of this CCA. On an annual basis, the Board shall elect a chairperson (Chair) and may elect other officers as deemed necessary. The Chair will select the meeting location, develop the meeting agenda with input from the Board members,

and provide notice of the meeting of the Board along with the agenda at least 30 days prior to the meeting. The Chair will also provide draft meeting minutes of the previous meeting within two weeks following each meeting and require all Board members to return their comments within two weeks following receipt of the draft minutes. Minutes from the previous Board meeting will be approved at each successive Board meeting. Meetings of the Board will be held in compliance with the sunshine laws for the jurisdiction where the meeting is held. The Board will consist of one representative appointed by each Party. However, each Board member may designate an alternate who may function as the Party representative in the absence of the appointed Board member. The representatives of the Parties, or their alternates, may participate, which participation includes voting, in meetings by any means of communication by which all participants may simultaneously hear each other during the meeting. A member's representative or its alternate participating in a meeting by this means is deemed to be present in person at the meeting. No proxy voting shall be permitted. A member's alternate shall not vote if that member's regular representative is present. A majority of the Board members will be necessary to constitute a quorum to take action on any matter. The Board will strive to reach consensus on matters before it. In the absence of consensus, decisions will be made by a vote of the majority of the Board members present at its regularly scheduled meeting. The Board will also convene an Annual Meeting of a Working Group as described in Section XIV of this CCA, and the Board will appoint a chairperson for the Working Group. The reporting of conservation actions implemented under this CCA is described in Section XII of this CCA.

B. Cooperators

- Brookfield Smoky Mountain Hydro (Brookfield)
- Conservation Fisheries, Inc. (CFI)
- Warm Springs National Fish Hatchery (WSNFH)
- North Carolina Department of Transportation

Cooperators consist of any agencies, non-governmental organizations, or individuals who share a desire to conserve, protect, and expand Sicklefin Redhorse populations and habitat but do not request formal representation on the Board. Cooperators may designate one individual as a contact person and may attend meetings of the Board. Cooperators may become a Party to this CCA upon written request by the Cooperator and approval by all the Parties to this CCA at the time such a request is made.

IV. Authority

A. Parties to This CCA

The Parties enter into this CCA under authority provided by federal, tribal, and state law. Nothing in this CCA is intended to limit the authority of the USFWS to fulfill its responsibilities under federal laws. Nothing in this CCA is meant to imply that any Party is in any way abrogating or ceding any responsibility, sovereign immunity, or authority or responsibility inherent in its sovereign ownership of, jurisdiction over, or control of its property interests or wildlife. All activities undertaken pursuant to this CCA must be in compliance with all applicable tribal, state, and federal laws and regulations.

Sections 2 and 7 of the ESA (16 U.S.C. § 1531 et seq.) authorize the USFWS to enter into this CCA. Section 2 of the ESA states that encouraging interested parties, through federal financial assistance and a system of incentives, to develop and maintain conservation programs is essential to safeguarding the Nation's heritage in fish, wildlife, and plants. Section 7 of the ESA requires the USFWS to review the programs it administers and to utilize those programs to further the purposes of the ESA. By entering into this CCA, the USFWS is using the Candidate Conservation Program and its authority to enter into CCAs to further the conservation of the Nation's fish and wildlife.

B. Non-governmental Parties

The inclusion of non-governmental Parties to this CCA is intended to provide for voluntary conservation efforts for rare species with respect to private and state lands outside of federal land management areas while recognizing the limited applicability of the ESA's provisions on non-federal lands and lands not subject to federal permit action. Inclusion of non-governmental Parties is not intended to expand the jurisdictional areas or actions subject to the ESA, and non-governmental Parties are afforded the same protections and limitations in the ESA.

V. Enrolled Lands

This CCA is intended to benefit the Sicklefin Redhorse throughout its range, which presently includes the Hiwassee and Little Tennessee River basins in North Carolina and Georgia, including all of their tributaries and associated uplands. Based on the present distribution of the Sicklefin Redhorse (Appendix A - Sicklefin Redhorse Distribution Map) and a lack of presently known suitable habitat in the Tennessee portions of these river basins, the Enrolled Lands are defined to cover the entire watersheds of the Hiwassee and Little Tennessee Rivers, where the watersheds occur within the States of North Carolina and Georgia. The downstream limit of the Enrolled Lands is the border of North

Carolina and Tennessee within these two basins. Within the Enrolled Lands, several water-control project boundaries administered by the Parties have particular importance to the management of the Sicklefin Redhorse. Such water-control project boundaries include the project boundaries of Duke Energy's Bryson, Franklin, and Mission Dams; TVA's multi-purpose[1] project boundaries of the Apalachia, Hiwassee, Fontana, Nottely, and Chatuge Dams; and Brookfield's project boundaries of the Santeetlah, and Cheoah Dams.

The Enrolled Lands identified in Table 1 below are owned in fee simple or with appropriate rights-of-way by either Duke Energy, TVA, or Brookfield. This CCA does not in any way restrict the current or future uses of these Enrolled Lands. Rather, the designation of "Enrolled Lands" merely signifies that these lands may need to be traversed in order to reach certain areas for conducting activities associated with the conservation measures and monitoring obligations prescribed under Sections X and XI of this CCA. The Parties hereby agree to allow the USFWS, NCWRC, and any other organization approved by the Parties, to enter the properties over which they exercise ownership (after reasonable prior notice, receipt of any required safety training, and in adherence to any necessary safety or security limitations) to implement the conservation measures prescribed in this CCA, such as those to conduct compliance and biological monitoring.

Table 1. Reservoirs Within the Enrolled Lands

Reservoir Project	***Owner***	***County***	***River***	***First Operation***	***Reservoir Area (acres)***
Bryson	Duke Energy	Swain	Oconaluftee	1925	38
Franklin	Duke Energy	Macon	Little Tennessee	1925	174
Mission	Duke Energy	Clay	Hiwassee	1924	47
Apalachia	TVA	Cherokee	Hiwassee	1943	1,070
Hiwassee	TVA	Cherokee	Hiwassee	1940	6,000
Fontana	TVA	Graham/Swain	Little Tennessee	1944	10,230
Nottely	TVA	Union	Nottely	1942	4,180
Chatuge	TVA	Clay	Hiwassee	1942	7,000
Santeetlah	Brookfield	Graham	Cheoah	1928	644
Cheoah	Brookfield	Graham/Swain	Little Tennessee	1919	644

VI. CCA Management and Administration

In order to meet the objectives of this CCA, the Parties will cooperatively manage, administer, and annually review this CCA. The responsibility of the Parties is to coordinate the implementation and administration of this CCA

[1]TVA dams included in this CCA are operated for multiple purposes, including hydropower production, flood control, augmentation of flows for navigation, water quality, recreation, and aquatic ecology.

without superseding the jurisdictional authorities of any Party. The Parties will cooperate to develop and make recommendations for the conservation and research needs of the Sicklefin Redhorse and to identify new threats in its range. The USFWS's Ecological Services Field Office in Asheville, North Carolina, will initiate and coordinate an annual review by this CCA's Parties and Cooperators in accordance with Section XII of this CCA related to reporting.

VII. Conservation Efforts

The Parties listed have been working to conserve, manage, and expand the range of the Sicklefin Redhorse. Localized improvements in population size and range expansion have occurred from these efforts. A few examples of work to conserve the Sicklefin Redhorse by Parties to this CCA are highlighted below.

Duke Energy Carolinas, LLC - As envisioned in the Tuckasegee Cooperative Stakeholder Team Settlement Agreement (TCSTSA) in 2003 and ordered by the Federal Energy Regulatory Commission (FERC) in 2007, Duke Energy removed the Dillsboro Dam and Powerhouse (FERC Project No. 2602) in 2010. The small hydroelectric facility was located on the main stem of the Tuckasegee River in Jackson County, North Carolina. Project demolition included a pre- and post-dam-removal study (conducted by Duke Energy in 2012) of the macroinvertebrate and fish communities in addition to streambank restoration within the former impounded river reach. Also included in the TCSTSA was the establishment of a partnership fund for conservation of the Sicklefin Redhorse. While most of this funding is still available, Duke Energy has already funded North Carolina State University (NCSU) (Favrot 2008) to conduct research on the reproductive habitat and ecology of the Sicklefin Redhorse in the upper Hiwassee River basin. Duke Energy recently invested almost $500,000 in funding for soil and water and riparian habitat conservation initiatives in the Nantahala Area for the purpose of long-term enhancement and protection of riverine corridors in the Nantahala Area.

In 2010, Duke Energy worked cooperatively with state and federal resource agencies to develop measures for enhancing run-of-river operations for the Bryson, Franklin, and Mission Hydro Projects. These measures included the following:

- Developed Lake Level and Flow Management Plans for each of these run-of-river hydro projects.
- Conducted a Short-Term Sediment Study through the United States Geological Survey on the Little Tennessee River at the Franklin Hydro Project.
- Developed a Long-Term Sediment Management Plan for run-of-river hydro projects.

- Provided emergency power supplies to maintain gate operations during high inflow and storm events.
- Developed the Nantahala Area Run-of-River Maintenance and Emergency Protocol, which prescribes consultation and communications with resource agencies during the most likely planned and unplanned maintenance situations.

Duke Energy has also enhanced operations of run-of-river hydro projects for providing stable downstream flows in the following ways:

- Installed more effective Programmable Logic Controllers (PLC) at the Mission and Franklin Hydro Projects.
- Installed new spillway gates (and PLC) at the Franklin Hydro Project.
- Installed a Feamster Rake System at the Bryson Hydro Project. The Feamster Rake is an automated system for removing trash and reducing sediment accretion in the intake of the hydro station. This system reduces the need for periodic sediment removal from the intake. Similar systems are planned for the Franklin and Mission Hydro Stations over the next several years.

Duke Energy is partnering with CFI, the NCWRC, and the EBCI to propagate the Sicklefin Redhorse and to reintroduce the species into currently unoccupied habitat. This reintroduction and the removal of the Dillsboro Dam should allow for further expansion of the Sicklefin Redhorse into upstream reaches of the Tuckasegee River within the species' historic range.

Eastern Band of Cherokee Indians - From 2007 to 2015, Sicklefin Redhorse juveniles, reared by CFI and WSNFH from eggs collected from Little Tennessee and Tuckasegee River stock, have been released into the Oconaluftee River above the Ela Dam. In 2011, biologists from WSNFH radio-tagged juvenile and adult fish to be monitored by researchers from EBCI Fisheries and Wildlife Management and Western Carolina University. The EBCI, USFWS, and NCWRC also conducted telemetry studies on adult Sicklefin Redhorse translocated from the Tuckasegee River to the upper Oconaluftee River in 2014 and 2015. Additional propagation and reintroduction efforts, population monitoring, and studies of movement patterns, habitat use, and water-quality requirements will continue into the future (as necessary) with the assistance of agency, academic, and nonprofit partners.

Georgia Department of Natural Resources - The GADNR began annual monitoring of the Sicklefin Redhorse breeding population in Brasstown Creek in 2005. In 2013, they contracted with Dr. Jonathan Davis of Young Harris College to develop a monitoring protocol based on visual observations and seining. This protocol was carried out between 2013 and 2015 and will be continued into the future. GADNR and Young Harris College have also carried out surveys in the

upper Nottely and Hiwassee Rivers in search of undocumented populations of the Sicklefin Redhorse within its putative historic range.

In 2006, the Sicklefin Redhorse was listed as endangered under Georgia's Endangered Wildlife Act. The Georgia Natural Heritage Program routinely comments on projects that may impact state-listed species, such as recent and proposed bridge replacements, sewage treatment plant upgrades, and development in the Brasstown Creek watershed. Based upon the occurrence of the Sicklefin Redhorse and several other rare aquatic species with populations in Brasstown Creek, this watershed was designated as a high priority in the 2015 revision of Georgia's State Wildlife Action Plan. This status should help prioritize the watershed for protection through the environmental review process and other conservation efforts.

North Carolina Wildlife Resources Commission - NCWRC biologists have cooperated with many partners since the mid-1990s to learn much about the taxonomic status, distribution, life history, ecology, and population genetics of the Sicklefin Redhorse. Cooperative efforts with the Parties to assess spawning habitat, estimate population size and genetic structure, and collect gametes for captive propagation in the Little Tennessee River system have been coordinated annually since 2005. Extension of the occupied range of the Sicklefin Redhorse in the Tuckasegee River upstream from the former Dillsboro Dam site is NCWRC's goal. Since 2007, thousands of juvenile Sicklefin Redhorse (propagated in captivity) have been released into this reach. The NCWRC chairs an informal working group of partners, including many of the Parties, which meets annually to cooperatively plan research and management actions, identify needs for the species, and develop strategies to address the identified needs. NCWRC personnel routinely include measures for conservation of the Sicklefin Redhorse in technical guidance, review comments, and requirements for Section 401 and 404 Clean Water Act permits for disturbance within its known distribution area.

Tennessee Valley Authority – Currently, the TVA is participating in the Little Tennessee River Native Conservation Area (LTRNCA) partnership. The partnership is made up of federal, state, and local agencies and organizations who work to conserve and restore habitat in the Little Tennessee River basin for the benefit of native fishes and other aquatic wildlife. In 2016, the TVA is providing financial support to the "Shade Your Stream" Outreach Project in the Little Tennessee River system in North Carolina and Georgia. This outreach effort will provide local citizens with information needed to plant and establish riparian buffers on private properties.

The TVA has contributed to Sicklefin Redhorse conservation efforts and the informal working group specifically through the implementation of the TVA River and Stream Monitoring Index of Biotic Integrity and the Reservoir Fisheries

Assemblage Index programs. These routine monitoring programs have provided both significant information on effective methods for collection of the Sicklefin Redhorse and important contributions to understanding the life history and distribution of the Sicklefin Redhorse. Additionally, the aquatic monitoring team at the TVA has participated in Sicklefin Redhorse gamete collection for captive propagation since the program began, through in-kind efforts outside their routine monitoring.

The TVA Reservoir Release Improvement (RRI) program, implemented in 1996 to improve the quantity and quality of water releases from 20 dams throughout the Tennessee River system, includes 4 dams intersecting the range of the Sicklefin Redhorse—the Nottely, Chatuge, Apalachia, and Fontana. The RRI program was developed through working with resource agencies and non-governmental organizations to set minimum flow and dissolved oxygen targets and update facilities and operating procedures to meet target values. The RRI program is a significant financial investment in infrastructure to meet water-quality needs, and it continues to the present. The RRI program has been documented to be effective at improving benthic macroinvertebrate and fish communities in dam tailwaters in rivers where the Sicklefin Redhorse occurs and has resulted in substantial water-quality improvements in both the Little Tennessee and Hiwassee Rivers.

The Clean Water Initiative (CWI) was created by the TVA in 1992 and continued until 2012. The CWI built partnerships with communities and businesses as well as government agencies to promote watershed protection throughout the Tennessee River system. Through the CWI, the TVA supported numerous watershed efforts in the Hiwassee and Little Tennessee River basins, primarily through the Hiwassee River Watershed Coalition and participation in the Hiwassee River Interagency Team.

U.S. Fish and Wildlife Service - The USFWS has participated with the Parties on many of the conservation measures previously mentioned. Since 2011 the USFWS has provided financial support to NCSU for conducting research into the life history of the Sicklefin Redhorse. Additionally, the USFWS has provided financial support to assess Sicklefin Redhorse genetic health and information necessary for rearing this species in a hatchery setting. The USFWS has provided material and in-kind support to benefit the NCWRC's annual collection efforts. The USFWS's Warm Springs National Fish Hatchery has participated in the rearing of Sicklefin Redhorse hatchery stock for population augmentation and reintroduction. The USFWS has also provided annual funding to CFI for the rearing of Sicklefin Redhorse hatchery stock for population augmentation and reintroduction.

VIII. Species Description, Taxonomy, Life History, and Range

A. Species Description

The Sicklefin Redhorse, a freshwater fish species, can grow to a length of approximately 650 millimeters (roughly 25.6 inches). It has an elongate, somewhat compressed, body and a highly falcate (sickle shaped) dorsal fin (back fin). Its body is olive-colored, with a coppery or brassy sheen; its lower fins (pectoral, pelvic, and anal fins) are primarily dusky to dark, often tinted yellow or orange and pale-edged; the caudal fin (tail fin) is mostly red; and its dorsal fin is olive in color, sometimes partly red. Based on an analysis of preserved specimens, the species is relatively long-lived, with males of the species living to at least 20 years of age and females at least 22 years of age (Jenkins 1999, pp. 8-16; and R. E. Jenkins, personal communication [pers. comm.], 2005).

B. Taxonomy

Although the Sicklefin Redhorse is only recently known to science; this species was an important food resource for Native American tribes inhabiting the Southeast region of the United States. Altman (2006) elicited from native speakers of the Cherokee language that they recognized pictures of the Sicklefin Redhorse as a species called “junigihtla.” which translates in English as “wearing a red feather.” This name is a fitting description of the red, falcate dorsal fin of this species. Modern fish biologists were slow to recognize the distinct morphological features of this species despite encountering it for several decades before its recognition as distinct from other co-occurring redhorse species. The Sicklefin Redhorse was collected in 1937 (based upon preserved specimens collected at the then unimpounded mouth of Forney Creek near its confluence with the Tuckasegee River), but this and subsequent collections were misidentified until 1992, when Dr. Robert Jenkins obtained and examined two specimens collected by Dr. Edward Menhinick in 1981 and 1982 from the Little Tennessee River and recognized they were a distinct species (Jenkins 1999, p. 4).

Based on the characteristics of specimens’ lower lips, dorsal fins, and pharyngeal teeth, Jenkins (1999, pp. 3-4, 9, and 13) recognized the species as possibly a previously unidentified species or a hybrid of the Smallmouth Redhorse (*M. breviceps*) and the River Redhorse (*M. carinatum*). Subsequent detailed morphological and behavioral studies (Jenkins 1999, pp. 3-6 and 8-25, Tables 1-3, and Figures 1-12) and genetic studies (Harris et al. 2002, pp. 1433-1452) have concluded that the Sicklefin Redhorse is, in fact, a distinct species. The USFWS has reviewed the available taxonomic literature and is not aware of any challenges to the validity of this determination regarding the Sicklefin Redhorse.

C. Habitat and Life History

The Sicklefin Redhorse is currently known to occupy cool to warm, moderate gradient creeks and rivers and, during at least parts of its early life, large reservoirs (Jenkins 1999, p. 19; Stowe 2012, p. vi). In streams, adults of the species are generally associated with moderate to fast currents, in riffles, runs, and well-flowing pools (Jenkins 1999, pp. 15, 17, and 19; Favrot 2008, pp. 49, 62-64, and 80), while juveniles show a preference for moderate to deep pools with slow currents and large boulder crevice cover (Stowe 2012, pp. vii and 18-19). Adults feed and spawn over gravel, cobble, boulder, and bedrock substrates with no, or very little, silt overlay (Jenkins 1999, pp. 15, 17, and 19; Favrot 2008, pp. 49, 62-64, and 80).

Like many other redhorse species, the Sicklefin Redhorse is known mainly from flowing streams; however, also like many other redhorse species, the Sicklefin Redhorse appears to have adapted to spending at least part of its early life stages in the near-shore areas of impoundments (Jenkins 1999, pp. 19 and 20; Stowe 2012, pp. 23 and 29). Current observations indicate that adults are year-round residents of rivers and large creeks (Jenkins, pers. comm., 2007; Favrot 2008, pp. 2 and 39; Stowe 2012, p. 23) and that young, juveniles, and sub-adults occupy primarily the lower reaches of creeks and rivers and near-shore portions of certain reservoirs (Jenkins 1999, p.20; Stowe 2012, p. 23 and 29). After emerging from the stream substrata, it is likely that many of the larvae and post-larvae are carried downstream to the mouths of streams or into reservoirs (Jenkins 1999, p.20). The fish are believed to mature at around 5 to 8 years of age (males 5 to 7 years, females 7 to 8 years), and newly matured fish appear to migrate from the reservoirs to spawn; after which, most remain in the streams with the other adults (Jenkins 1999, p. 20). Although a few adult Sicklefin Redhorse have been observed in the Hiwassee and Fontana Reservoirs, Favrot's (2008, pp. 2 and 39) study of movement and habitat utilization within the Hiwassee River system indicated that he was unable to detect radio-tagged adult Sicklefin Redhorse using the Hiwassee Reservoir for extended periods between occupying a spawning tributary and the Hiwassee River or Valley River. This suggests that these fish were only inhabiting the reservoirs as they migrated between streams, and the currently impounded reaches likely provided habitat for the Sicklefin Redhorse before they were impounded. However, as discussed in the "Threats" section below, the dams prevent upstream and downstream expansion of the populations. This suggests that, while reservoirs may serve as maturation sites for sub-adult Sicklefin Redhorse, they do not provide suitable spawning, foraging, or winter habitat for adults of the species. Rather, reservoirs are a factor in limiting habitat for adult Sicklefin Redhorse.

Stomach analysis indicates that the Sicklefin Redhorse feeds on benthic macroinvertebrates (insect larvae, crustaceans, snails, etc.) (Jenkins, pers. comm., 2004). The species has rarely been observed foraging on substrates with even a thin covering of silt (Jenkins 1999, p. 15). When feeding, the species exhibits a well-defined preference for coarse substrates with abundant river weed (*Podostemum ceratophyllum*) (Favrot 2008, pp. 3, 48-50, 56-57, 59, 62, 64, and 80). Studies indicate that river weed significantly enhances the abundance of benthic macroinvertebrates (Favrot 2008, p. 81), and Favrot (2008, pp. 75-76) documented that post-spawning, the species typically relocates to stream reaches that support high densities of river weed, where individuals appear to feed almost exclusively over river weed beds (Favrot 2008, p. 80).

Spawning typically occurs over cobble, with usually only a small portion of sand and gravel, in moderate- to fast-flowing water in open areas and pockets formed by boulders and outcrops (Jenkins 1999, p. 18; Favrot 2008, pp. 84-85). Distinct from the foraging habitat, the species appears to spawn exclusively over coarse substrates that lack river weed (Favrot 2008, pp. 3, 49, 56, 59-60, and 84-85). Both Favrot's (2008, p. 67) study of Sicklefin Redhorse movement in the Valley and Hiwassee Rivers and Stowe's (2012, p. 26) study of Sicklefin Redhorse movement in the Oconaluftee and Tuckasegee Rivers indicate that the species begins upstream migration to spawning sites in late winter/early spring. Favrot (2008, pp. 67) reported that the adults began their spawning migration when water temperatures reached 10.0 to 12.0 degrees (º) Celsius (C) (50.0 to 53.6º Fahrenheit [F]) and peaked at water temperatures of 15.0 to 16.0ºC (59.0 to 60.8ºF); and Stowe (2012, p. 26) reported that the adults monitored in his study began their spawning migration when water temperatures reached 9.42°C (48.9°F). The species appears to exhibit strong spawning site fidelity, returning to the same stream and stream reach each year to spawn (Favrot 2008, pp. 3, 9, 36, 41-42, 70, and 72), possibly returning to their natal streams and spawning reaches similar to many salmonids (Favrot 2008, p. 36).

Following spawning, the species appears to generally move downstream to more suitable foraging areas in deeper waters (Favrot 2008, pp. 37, 47, 57, 58, 74-76, and 80) and to migrate further downstream to even deeper waters for the winter (Favrot 2008, pp. 38, 39, 57, 58, 63, 74, 82, and 84; Stowe 2012, p. 21). Except during its migrations to and from spawning and wintering sites, the Sicklefin Redhorse appears relatively sedentary at its spawning, post-spawning, and wintering sites, traveling only short distances upstream and downstream within the occupied river reach. In addition to exhibiting strong spawning site fidelity, the Sicklefin Redhorse also appears to show a high degree of site fidelity to its post-spawning and wintering sites, returning to the same streams and stream reaches each year (Favrot 2008, pp. 37-42 and 69-75).

Table 2. Known habitat needs of the Sicklefin Redhorse by life stage

Life Stage	Resource Needs	References
Eggs – Emergence of Fry	• Spawning migration begins when water temperatures reach 9.5 to 12.0ºC and peak at water temperatures of 15.0 to 16.0ºC.	Favrot 2008, p. 67 Stowe 2012, p. 26
	• Spawning occurs over cobble, with only a small portion of sand and gravel, in moderate- to fast-flowing water in open areas and pockets formed by boulders and outcrops.	Jenkins 1999, p. 18; Favrot 2008, pp. 84-85
	• Eggs are adhesive (initially), fragile, and negatively buoyant, indicating they likely remain in substrate.	Petty et al. 2013, p. 7
	• Developmental stages and behaviors are likely temperature-dependent. In-lab hatching begins after ~5 days (at ~18 to 21°C), at which time larvae lay mostly motionless (probably still buried in gravel in the river); after an additional ~4 to 6 days, the larvae exhibit a strong swim up.	Petty et al. 2013, p. 7
Fry	• Habitat usage/needs?	
	• Feed on invertebrates. In-lab, the fry initially began to feed ~17 days after hatching.	Petty et al. 2013, p. 7
Juveniles	• Habitat usage/needs? Current observations indicate they use lower reaches of creeks and rivers and near-shore portions of reservoirs.	Jenkins 1999, p. 20; Stowe 2012, pp. 23 and 29
Adults	• Mature at ~5 to 8 years of age (males 5 to 7 years, females 7 to 8 years).	Jenkins 1999, p. 20
	• Year-round residents of cool to warm, moderate gradient creeks and rivers.	Jenkins 1999, p. 19; Stowe 2012, p. vi
	• Feed on benthic macroinvertebrates; rarely observed foraging on substrates with even a thin covering of silt; exhibits a well-defined preference for coarse substrates with abundant river weed.	Jenkins 1999, p. 15

	• Post spawning move down stream to deeper waters and more suitable foraging areas.	Favrot 2008, pp. 3, 48-50, 56-57, 59, 62, 64, and 80
	• Migrate further downstream to even deeper waters for the winter.	Favrot 2008, pp. 38, 39, 57, 58, 63, 74, 82, and 84; Stowe 2012, p. 21
	• Exhibiting strong spawning site fidelity and also high degree of site fidelity to its post-spawning and wintering sites, returning to the same streams and stream reaches each year.	Favrot 2008, pp. 37-42 and 69-75

D. Historic Range and Distribution

Past and recent collection records of the Sicklefin Redhorse, together with what is known about the habitat utilization of the species, indicate that the Sicklefin Redhorse once inhabited the majority, if not all, of the rivers and large creeks in the Blue Ridge portion of the Hiwassee and Little Tennessee River systems in North Carolina, Tennessee, and Georgia (Jenkins 1999, pp. 20-26).

E. Current Range and Distribution

Currently, there are only two metapopulations of the Sicklefin Redhorse known to survive--one in the Hiwassee River system and one in the Little Tennessee River system (Jenkins 1999, pp 20-25 and 29).

In the Hiwassee River system, Jenkins (1999, pp. 20-25 and 29) and Favrot (2008, pp. 33, 35-36, and 38-39) recorded the current known occupied range of the Sicklefin Redhorse as: (1) a relatively short reach (approximately 9.0 river miles [rm]) of the main stem of the Hiwassee River between the Mission Dam and Hiwassee Lake, Cherokee County, North Carolina; (2) Brasstown Creek (approximately 16.9 rm), a tributary to the Hiwassee River in Cherokee and Clay Counties, North Carolina, extending into Towns County, Georgia; (3) the main stem of the Valley River between the community of Buffalo and the backwaters of Hiwassee Lake (approximately 22.3 rm), Cherokee County, North Carolina (Jenkins 1999; Favrot 2008). In addition, Favrot (2008, pp. 33, 35-36, and 38-39) provides recent records for the species in: Hanging Dog Creek (approximately 3.0 rm), a tributary to Hiwassee River (at Hiwassee Lake) in Cherokee County, North Carolina, and a short reach of the Nottely River (approximately 2 to 3 rm) between the cold-water discharge from the Nottely Reservoir and the backwaters of Hiwassee Lake in Cherokee County, North Carolina (Favrot 2008, pp. 33, 35-36, and 38-39). Also, juveniles have been collected from the near-shore

portions of Hiwassee Lake in Cherokee County, North Carolina (Jenkins, pers. comms., 2003, 2004, and 2006). As mentioned previously, a few adult Sicklefin Redhorse have been detected in the Hiwassee Reservoir, but these appear to have been moving from one stream to another (Favrot 2008, pp. 2 and 39).

Estimated occupied stream habitat in the Hiwassee River system totals about 53.0 rm (adapted from Jenkins 1999, p. 26; Favrot 2008, pp. 2, 33, 35-36, and 38-39). However, the use of various streams/stream reaches within this total appears to be seasonal. Available information indicates that the Sicklefin Redhorse uses Brasstown Creek, Hanging Dog Creek, Beaverdam Creek, the Nottely River, and the middle and upper reaches of the Valley River, primarily for spawning (Favrot 2008, pp. 2, 35-36, 51, and 69). No spawning or courting behavior was observed within the main stem of the Hiwassee River (Favrot 2008, p. 69); the middle and lower Hiwassee River and lower reaches of the spawning tributaries (primarily from the post-spawning period through the fall and early winter) (Favrot 2008, pp. 2, 36-39, and 75); the lower unimpounded reaches of the Hiwassee River (Favrot 2008, pp. 38 and 39); and the lower Valley River (during the winter months) (Favrot 2008, p. 38).

The Little Tennessee River system metapopulation of the Sicklefin Redhorse in North Carolina includes 59.15 rm of creek and river reaches plus near-shore areas of the Fontana Reservoir, including: (1) the main stem of the Little Tennessee River in Macon and Swain Counties, between the Franklin Dam and Fontana Reservoir (approximately 23.2 rm), and its tributaries, Burningtown Creek (approximately 5.5 rm) and Iotla Creek (approximately 0.1 rm) in Macon County; and (2) the main stem of the Tuckasegee River in Swain and Jackson Counties, from approximately rm 27.5, downstream to the Fontana Reservoir (approximately 27.5 rm), and its tributaries, and the Oconaluftee River below the Bryson Dam (also sometimes referred to as the Ela Dam) (approximately 0.5 rm), in Swain County. Also, sub-adults of the species have been collected in the near-shore portions of the Fontana Reservoir in Swain County (Jenkins, pers. comm., 2007; T. ("TR") Russ, NCWRC, pers. comm., 2012).

Like the Hiwassee Reservoir, current evidence indicates that the Fontana Reservoir likely serves as a maturation site for the sub-adult Sicklefin Redhorse, though additional research is needed to confirm this finding (Jenkins, pers. comm., 2010; Stowe 2012 p. 23). Adult spawning, foraging, and/or wintering habitat in the Little Tennessee River system appears to be restricted to the Little Tennessee River and its tributaries, Burningtown Creek and possibly the lower Iotla Creek; and the Tuckasegee River and its tributaries, including the lower Oconaluftee River (Jenkins, pers. comm., 2006).

The species has apparently been eliminated from roughly 50% of its former range (adapted from Jenkins 1999, p. 26). This is a conservative estimate that: (1) includes several miles of the Hiwassee and Fontana Reservoirs (totaling ~62.3 rm) within the present range of the species (36% of the species' estimated present range) (although portions of these reservoirs appear to provide survivable habitat for the juvenile Sicklefin Redhorse, current evidence indicates they do not provide spawning, foraging, or wintering habitat for adults of the species; however, they likely did prior to impoundment); and (2) does not include portions of the Cheoah River, the Cullasaja River, Cartoogechaye Creek, and several other large tributaries in the Hiwassee and Little Tennessee River systems that may also have been part of the historic range of the Sicklefin Redhorse.

IX. Primary Threats Influencing the Survival of the Species

A description of each of these threats is presented below; each is classified according to the five listing/delisting factors identified in Section 4 of the ESA (16 USC 1531 et seq.).

A. The present or threatened destruction, modification, or curtailment of its habitat or range (Factor A)

According to Jenkins (1999), the Sicklefin Redhorse is currently distributed in the Little Tennessee, Tuckasegee, and Hiwassee River systems in western North Carolina and northwest Georgia. Spawning populations are known in Brasstown Creek and the Valley River (tributaries of the Hiwassee River), the Tuckasegee River, and the Little Tennessee River just downstream of Duke Energy's Franklin Dam and Hydroelectric Station. A substantial spawning aggregation of the Sicklefin Redhorse occurs at the Little Tennessee River site below the Franklin Dam. There appear to be additional stream and river reaches where suitable Sicklefin Redhorse habitat exists, but there are no known populations of the species. Historical impacts to river systems have contributed to the current distribution pattern for the Sicklefin Redhorse, including the following:

- Loss of riverine habitat from dam construction and hydroelectric operation, alteration in riverine flow, and adverse impacts to water quality due to dam flow releases and the consequent creation of migratory barriers.
- Sedimentation due to poor land-use practices.
- Water pollution due to human-introduced pollutants into the river systems.

Present threats to the existing Sicklefin Redhorse populations continue to be sedimentation, pollution, and other sources of water-quality degradation

from excessive runoff created by increased development and riparian habitat losses. The Sicklefin Redhorse has been observed feeding and spawning only in substrates with no or very little silt accumulation. Excessive siltation and suspended sediment, which can occur as a result of land-disturbance activities with inadequate erosion and stormwater controls, affects the habitat of the Sicklefin Redhorse by: (1) eliminating breeding sites, which results in increased mortality of eggs and juveniles; (2) eliminating feeding areas; (3) reducing the ability to detect prey; (4) eliminating aquatic insect larvae and other food items for the Sicklefin Redhorse. Suspended sediment also irritates and clogs fish gills affecting their respiration (Waters 1995, pp. 53-117). Favrot (2008, p. 81) reported that fine sediments are abundant in the section of the Hiwassee River between the Mission Dam and the Hiwassee Reservoir and that Brasstown Creek appears to be a significant contributor to this sediment loading.

In addition to siltation, other water pollutants threaten the survival of the species, including nutrient and chemical pollutants from wastewater discharges and stormwater runoff from logging operations, row crop and livestock fields, roads and parking lots, lawns, and other nonpoint sources. Pollutants in wastewater discharges and stormwater runoff not only poison and kill the fish and their food items; they also can adversely affect stream pH, conductivity, and dissolved oxygen concentrations and can cause other changes in water chemistry which affect aquatic life (USFWS 2000 and references therein, p. 13). Nutrients, usually phosphorus and nitrogen, originating from residential lawns, leaking septic systems, livestock operations, and agricultural fields contribute to eutrophication and reduced oxygen levels in streams (Larkin and Northcote 1969, p. 258; Williamson et al. 1998, p. 1).

The runoff of stormwater from cleared areas, roads, rooftops, parking lots, and other developed areas, which often is ditched or piped directly into streams, not only results in stream pollution but also results in increased water volume and velocity during heavy rains. This change in water volume and velocity causes channel and streambank scouring, leading to the degradation and elimination of aquatic habitat. Construction and land-clearing operations are particularly detrimental when they result in the alteration of floodplains or the removal of forested stream buffers which ordinarily help maintain water quality and the stability of streambanks and stream channels by absorbing, filtering, and slowly releasing rainwater. Also, when stormwater runoff from land-clearing activities increases, less water is absorbed to recharge groundwater levels. Therefore, flows during dry months can decrease and adversely affect aquatic resources.

B. Overutilization for commercial, recreational, scientific, or educational purposes (Factor B)

The species presently has no commercial value, and other collecting is not currently known to have been a significant factor contributing to the species' decline. As evidenced by the existing prehistoric and early-historic rock fish weirs in the rivers inhabited by the Sicklefin Redhorse, this species (along with other redhorse species) was likely used as a food source by Native Americans and early settlers as they inhabited the watersheds of these streams. There are also anecdotal reports, as recently as 30 years ago, that local residents ate redhorse, and the Sicklefin Redhorse likely was included. On occasion, anglers may also harvest the Sicklefin Redhorse, along with other redhorse species; however, recreational harvesting of the Sicklefin Redhorse by anglers is not currently believed to pose a significant threat to the species (Jenkins 1999, p. 28).

C. Disease or predation (Factor C)

There is currently no information to indicate that disease has played a significant role in the past decline of the Sicklefin Redhorse. However, there are numerous fish diseases with the potential to seriously affect population levels (e.g., Spring Viremia, Columnaris, *Aeromonas* spp., Viral Hemorrhagic Septicemia). The introduction of nonnative diseases can be especially devastating to native fish species populations. Fish hatcheries/farms and hobbyist ponds in the watersheds of these rivers, especially those with direct links to streams in the systems, pose a significant threat unless adequate measures are implemented to prevent the introduction and spread of pathogens from these facilities/ponds.

The early life stages (eggs, fry, and juveniles) of the Sicklefin Redhorse are likely preyed upon by a variety of other species. Predation by naturally occurring predators is a normal aspect of the population dynamics and is not considered to currently pose a threat to the species. However, the introduction of nonnative species could pose a significant threat to the Sicklefin Redhorse. Recently, nonnative Blueback Herring (*Alosa aestivalis*) were introduced into the Hiwassee Reservoir, presumably by angler bait release. NCWRC biologists have documented a collapse of natural reproduction of Walleye (*Sander vitreus*) and White Bass (*Morone chrysops*), concurrent with increases in Blueback Herring densities. Heavy Blueback Herring predation of drifting eggs and early juveniles of both Walleye and White Bass has been observed in the transition zone between the free-flowing Hiwassee and Valley Rivers and the Hiwassee Reservoir. Blueback Herring have been observed several miles upstream in the Valley and Nottely Rivers and have unobstructed access to the Hiwassee River upstream to the Mission Dam and lower Brasstown Creek. The occurrence of

the Blueback Herring has also been documented in the Nottely River, both upstream and downstream of Lake Nottely (B. Albanese, GADNR, personal observation). Blueback Herring have also been observed congregating at the mouths of other tributaries to the Hiwassee Reservoir in the months of March and April (above is condensed from personal observations by A. P. Wheeler, D. L. Yow, and S. J. Fraley, NCWRC, 2005 and 2006). The presence of large numbers of known predators of drifting fish eggs and larvae at or near the time of Sicklefin Redhorse spawning and hatching poses a potentially significant threat. Further investigation is required to determine the degree of threat posed to the Sicklefin Redhorse's survival and recruitment in the Hiwassee River system. To date, no Blueback Herring have been collected from Fontana Reservoir, but they are present upstream in Lake Glenville and the upper Tuckasegee River Reservoir. Recent anecdotal evidence suggests the threat the Blueback Herring poses to the Sicklefin Redhorse is not as significant as once feared. Collections in the Hiwassee River system in 2014 and 2015 produced many young adult/late juvenile Sicklefin Redhorse that have clearly recruited since the Blueback Herring invasion, while juvenile Walleye and White Bass steeply declined immediately after the invasion (S. J. Fraley, NCWRC, and T. Ivasauskas, NCSU, pers. comms., 2015). Further research is needed to fully assess the potential threat from the Blueback Herring.

D. The inadequacy of existing regulatory mechanisms (Factor D)

The Sicklefin Redhorse is currently state-listed as threatened in North Carolina. In Georgia, the Sicklefin Redhorse is state-listed as endangered. Both states require a valid state collecting permit for any collection activities associated with scientific purposes, and both states prohibit the direct take of the species. Large portions of the species' range are owned by state or federal agencies, and there are substantial landholdings by non-governmental conservation organizations that provide protection. Further, the EBCI has management jurisdiction over a portion of the lands within both the Hiwassee and Tuckasegee River watersheds. Tribal water-quality ordinances and regulatory oversight related to federal agency funding and permitting provide protective measures for habitat and water quality.

In the unimpounded portions of the main stems of the Little Tennessee and Tuckasegee Rivers where the Sicklefin Redhorse occurs, the species' habitat is indirectly provided some federal protection from federal actions and activities through the ESA because the main-stem portions of both of these rivers that are inhabited by the Sicklefin Redhorse also support, and are designated as critical habitat for, populations the Appalachian Elktoe (*Alasmidonta raveneliana*), which is currently federally listed as endangered. The Little Tennessee River is also designated as critical habitat for the Spotfin

Chub (*Erimonax monachus*) in this area. Sicklefin Redhorse habitat in the other streams and the two impoundments where the species survives is not afforded this indirect protection. However, indirect protection is afforded by the NCWRC's and GADNR's buffer regulations for trout streams, regulations that provide riparian protection for most of the headwater streams in the Sicklefin Redhorse's range.

Neither the states (i.e., North Carolina and Georgia) nor the local governments with jurisdictions within the watersheds of streams supporting populations of the Sicklefin Redhorse currently have regulations/ordinances that directly protect the species from many of the adverse effects of agriculture, private forestry, and residential and commercial development activities (e.g., loss of forest cover, impacts to the streams' hydrographs, stormwater runoff, nonpoint-source pollutants, wastewater discharges, etc.). The majority of the land-use activities in the watersheds of streams that support the Sicklefin Redhorse are occurring without any federal nexus and therefore would not be affected directly by a listing under the ESA.

E. Other natural or manmade factors affecting its continued existence (Factor E)

The potential introduction of *Didymosphenia geminate*, commonly referred to as didymo and rock snot, into streams occupied by the Sicklefin Redhorse poses a potential significant threat to the species. *D. geminate* is an invasive, colonial diatom (single celled algae with silica cell walls). The historical distribution of *D. geminate* is poorly understood but is believed to include parts of northern Europe, northern Asia, and the far northern regions of North America. However, over the last few decades its range has expanded significantly, and it now inhabits scattered streams in parts of the western, central, and eastern continental United States. Although it has not yet been reported from streams in North Carolina, it has recently been documented in the neighboring states of Virginia and Tennessee, including parts of the Tennessee River system in Tennessee, primarily in tailwater reaches below dams. Colonies of *D. geminate* produce large amounts of extracellular stalk material that attaches to rocky stream-bottom substrates. It can form large mats, carpeting up to 100% of the stream substrate in infested reaches. This could seriously affect, and in some areas eliminate, Sicklefin Redhorse spawning and forage habitat and reduce macroinvertebrate diversity and densities, affecting the prey base of the Sicklefin Redhorse. The mechanisms aiding in the spread of *D. geminate* from one stream to another are not fully understood; however, studies have shown it can survive and remain viable out of water in cool, moist conditions for at least 40 days. Waterfowl, wading birds, and contaminated fishing and survey gear (e g., waders, wading boots, and wet clothing) are likely, or at least potential, vectors (Spaulding and Elwell 2007, pp. 1-33).

The genetic health of the surviving occurrences of the Sicklefin Redhorse is a concern. Moyer et al. (2009, p. 1441,) conducted a study of the genetic diversity and relatedness of the Sicklefin Redhorse within the Little Tennessee River population. The study indicated that genetic diversity within the adults of this population currently appears relatively high. Empirical estimates of N_e for the Little Tennessee and Tuckasegee populations are 586 (95% CI of 279-infinity) and 589 (95% CI of 218-infinity) and are above critical threshold levels for inbreeding and the maintenance of evolutionary potential. These estimates are also similar to other estimates of N_e for populations of conservation concern (Palstra and Ruzzante 2008). These findings suggest that genetic factors are not of immediate importance to the persistence of the Sicklefin Redhorse in the Little Tennessee or Tuckasegee Rivers. However, due to the long-lived iteroparous life history and low N_e, these populations should be monitored for any decline in N_e over a period of time. In the Hiwassee population, the estimate of N_e was infinity (95% CI of 126-infinity). An estimated value of infinity suggests that too few samples were used to obtain a precise estimate of N_e. In these cases, the lower bound is still useful in that it is greater than critical threshold levels for inbreeding, but whether this population can maintain its evolutionary potential over time remains uncertain. More data (number of individuals) will be needed to provide a more accurate and precise estimate of N_e for the Hiwassee population (G. Moyer, USFWS, pers. comm., 2015).

F. Summary of Threats

Adverse modification of the aquatic environment have occurred as a result of the following: Water-quality issues and barriers to fish migration posed by dams; inadequate erosion/sedimentation control during agricultural, timbering, and construction activities; runoff and discharge of organic and inorganic pollutants from industrial, municipal, agricultural, and other point and nonpoint sources; predation and habitat suitability impacts by nonnative species; and fragmentation and isolation of surviving populations. These and other natural and human-related factors have potentially resulted in a reduction of the species' range and habitat availability and may affect the future viability of the species. However, the management framework described within this CCA allows the Parties to collaboratively address these threats in a manner that leads to resilient populations with sufficient representation in order to preclude their listing for the foreseeable future. By design, the management actions planned and pursued by the Parties are intended to be adaptive in nature and to leverage the maximum benefit from the available resources and existing conservation environment.

X. Range-wide Conservation, Management, and Reporting Actions

To accomplish the objectives of this CCA, all Parties to this CCA agree to undertake the conservation measures described herein. Actions taken under this CCA are cooperative and voluntary and are intended to increase the understanding of the habitat and life history requirements and to improve the overall status of this species.

The USFWS will support the implementation of this CCA by helping to develop a uniform monitoring and reporting format for the Parties, as described in Section XI of this CCA.

A. Information Management

All reports and data on Sicklefin Redhorse reintroduction, restoration, and monitoring activities from all Parties will be submitted annually to the USFWS's Ecological Services Field Office (USFWS ES-AFO) in Asheville, North Carolina. The USFWS ES-AFO will compile the data into a detailed report that will then be distributed to all Parties of this CCA during an annual review of CCA implementation efforts and to the respective state heritage program.

B. Conservation Measures

The conservation measures implemented in this CCA were chosen based on an analysis of the threats to the Sicklefin Redhorse and the USFWS's knowledge of conservation measures reasonably expected to reduce or eliminate those threats in the Enrolled Lands. Implementation of this CCA is expected to protect and conserve habitat for the Sicklefin Redhorse and expand the range of the species into areas of historical occurrence, which may impact the Sicklefin Redhorse and provide important monitoring data that can be used to develop and/or improve management strategies. Information gathered will inform and guide future discussions and decisions involving fluctuations of river flow or other habitat improvement measures (e.g., temperature, dissolved oxygen, etc.).

C. Responsibilities of the Parties

1. Duke Energy shall undertake the following actions:

a. Reregulate stream flows following the removal of the Dillsboro Dam and Powerhouse. Duke Energy will operate the Bryson, Franklin, and Mission Hydro Projects in compliance with licenses issued by the FERC that require maintaining stable reservoir levels within 0.1 foot (no more than 0.3-foot variance 1% of the time) of Normal Target Elevation when at least two hydro units are operating at a given

project or within 0.3 foot of Normal Target Elevation when less than two hydro units are operating at a given project as described in the respective Project Licenses (Appendix A - Addendum 1 [Lake Level and Flow Management Plan]). These hydro projects will be operated in a manner that minimizes the need to draw down the reservoir for the mechanical removal of sediment. When sediment must be mechanically removed or the reservoir is drawn down for maintenance purposes, Duke Energy will consult with the USFWS to mutually agree on reasonable and necessary measures to minimize downstream environmental impacts. Duke Energy will develop and implement a Long-Term Sediment Management Plan that incorporates trash-rack maintenance guidelines, debris/sediment management and removal, and guidelines for emergency drawdown (including procedures, timing, rates of drawdown and refilling, and agency notifications). Duke Energy will provide a minimum flow release from the Bryson, Franklin, and Mission Projects at least equal to the September median flow at each project to preserve adequate downstream flows during reservoir refill periods.

b. Adhere to terms and provisions of this CCA and the enhancement of survival permit (Permit), and provide funding of $40,000[2], as specified in the TCSTSA, the Queens Creek Settlement Agreement (QCSA), and the Nantahala Cooperative Stakeholder Team Settlement Agreement (NCSTSA), and other resources as necessary and available to implement this CCA.

c. Implement the Lake Level and Flow Management Plans at the Bryson, Franklin, and Mission Hydro Projects.

d. Implement the Long-Term Sediment Management Plans at the Bryson, Franklin, and Mission Hydro Projects.

e. Provide the USFWS, or the USFWS's designee, with funding as identified in the NCSTSA and TCSTSA (Section 6, Paragraph 6.5 in each document).

f. Allow USFWS personnel, or other properly permitted and qualified persons designated by the USFWS, to have Duke Energy-escorted access (escorted by Duke Energy) to the Enrolled Lands, with

[2]Duke Energy has disbursed approximately $10,000 of the original $40,000 for Sicklefin Redhorse research. In 2007, Duke Energy agreed to provide funding of $10,000 for the completion of a Master of Science Thesis (Sicklefin Redhorse Reproductive and Habitat Ecology in the Upper Hiwassee River Basin of the Southern Appalachian Mountains) for a North Carolina State University graduate student (Scott Favrot). After escalation according to the Settlement Agreement terms, approximately $35,000 of these funds remain as of December 2015.

reasonable advance written notice and at reasonable hours and times for the general purposes specified in 50 CFR 13.21(e)(2).

g. Meet with the USFWS if any listed species other than the Sicklefin Redhorse may potentially be impacted by an activity covered by this CCA to discuss ways to avoid the take of listed species and/or to develop an alternative course of action that would avoid the potential take of that species.

h. Follow the Maintenance and Emergency Protocol contained in the Appendix to the Bryson (P-2601), Franklin (P-2603), and Mission (P-2619) Hydroelectric Project licenses.

i. The following additional conservation measures will be conducted or funded annually by Duke Energy for the term of this CCA:

Annual Conservation Measures[3]	Duke Energy Contribution	Funding/In-Kind Services	Cooperating Agencies
Provide assistance and equipment to annual Sicklefin Redhorse broodstock sampling and collection in the Little Tennessee, Oconaluftee, Tuckasegee, and Hiwassee Rivers, as needed.	$10,000[4]	In-kind	• USFWS • NCWRC
Stock fry/fingerling Sicklefin Redhorse as needed.	$5,000[5]	In-kind	• USFWS • NCWRC
Hatchery operations and other species management activities.	$20,000	Funding	• WSNFH • CFI • USFWS
Total Annual Funding	$35,000	Funding and In-Kind	

2. EBCI shall undertake the following actions:

a. The following conservation measures will be conducted or funded annually by EBCI for the term of this CCA:

Annual Conservation Measures[6]	EBCI Contribution	Funding/In-Kind Services	Cooperating Agencies
Provide assistance and equipment to annual Sicklefin Redhorse broodstock sampling and collection in the Little Tennessee, Oconaluftee, Tuckasegee, and Hiwassee Rivers, as needed.	$10,000[7]	In-kind	• USFWS • NCWRC
Hatchery operations and other species management activities.	$5,000	Funding	• CFI • USFWS
Total Annual Funding	$15,000	Funding and In-Kind	

[3]Measures will remain in place for the duration of this CCA.
[4]Basis: Two people, electrofishing boat/sampling equipment and travel expenses for 6 days each year.
[5]Basis: Two people, one overnight trip each spring.
[6]Measures will remain in place for the duration of this CCA.
[7]Basis: Two people, electrofishing boat/sampling equipment and travel expenses for 6 days each year.

3. GADNR shall undertake the following actions:

a. The following conservation measures will be conducted or funded annually by GADNR for the term of this CCA subject to the availability of funds appropriated to or otherwise allocated by GADNR for conservation purposes:

Annual Conservation Measures[8]	GADNR Contribution	Funding/In-Kind Services	Cooperating Agencies
Continue annual monitoring of adult breeding population of the Sicklefin Redhorse in the Georgia portion of Brasstown Creek. Complete at least one additional spawning season survey in the Georgia portions of the Nottely, Hiwassee, and Little Tennessee Rivers for undiscovered populations of the Sicklefin Redhorse before any reintroduction efforts are initiated. Provide assistance and equipment to annual Sicklefin Redhorse broodstock sampling and collection in Brasstown Creek as needed.	$5,000	In-kind	• USFWS • Young Harris College
Stock fry/fingerling Sicklefin Redhorse into Georgia waters if determined to be appropriate.	$5,000	Funding	• USFWS • WSNFH • CFI
Total Annual In-kind Funding	$10,000	Funding and In-kind	

4. NCWRC shall undertake the following actions:

a. Prioritize and implement habitat conservation measures for the Sicklefin Redhorse on the NCWRC-managed Needmore Gameland.

b. Identify research needs for information relevant to the management and survival of the species and initiate action and support to complete needed research.

c. Provide detailed technical guidance and support to citizen watershed groups, United States Department of Agriculture - Natural Resources Conservation Service, local governments, and other relevant cooperators in the occupied watersheds to conserve and improve habitat conditions for the species.

[8]Measures will remain in place for the duration of this CCA.

d. The following conservation measures will be conducted or funded annually by NCWRC for the term of this CCA:

Annual Conservation Measures[9]	NCWRC Contribution	Funding/In-Kind Services	Cooperating Agencies
Provide coordination, leadership, personnel, and equipment to Sicklefin Redhorse broodstock sampling and collection in the Little Tennessee, Oconaluftee, and Tuckasegee Rivers.	$4,000	In-kind	• USFWS • Duke Energy • TVA • EBCI
Periodically assess the distribution, abundance, and conservation status of the Sicklefin Redhorse across its range in North Carolina.	$4,000	In-kind	• USFWS • Duke Energy • TVA • EBCI
Stock fry/fingerling Sicklefin Redhorse in the Tuckasegee River.	$1,000	In-kind	• USFWS • Duke Energy • TVA • EBCI • CFI
Investigate feasibility of expanding populations beyond extant barriers into presently unoccupied habitats (the Cheoah River and Cheoah Dam tailrace/ Calderwood Reservoir; the Hiwassee River and major tributaries upstream from Mission Dam; the Little Tennessee River and major tributaries upstream from the Franklin Dam, Nottely River, and Nantahala River) by stocking.	$2,000	Direct funding and in-kind	• USFWS • Duke Energy • TVA
Additional stocking initiatives in unoccupied reaches per results of above feasibility assessments.	As needed	In-kind	• USFWS • Others as warranted
Total Annual Funding	$11,000	Funding and In-Kind	

[9]Measures will remain in place for the duration of this CCA.

5. The TVA shall undertake the following actions:

a. The following conservation measures will be conducted or funded annually by the TVA for the term of this CCA:

Annual Conservation Measures[10]	TVA Contribution	Funding/In-Kind Services	Cooperating Agencies
Provide assistance and equipment to annual Sicklefin Redhorse broodstock sampling and collection in the Little Tennessee, Oconaluftee, Tuckasegee, and Hiwassee Rivers.	$10,000[11]	In-kind	• USFWS • NCWRC
Stock fry/fingerling Sicklefin Redhorse.	$5,000[12]	In-kind	• USFWS • NCWRC
Total Annual In-kind Funding	$15,000	In-kind	

b. The following conservation measure will be funded by the TVA with two separate payments to be held for the term of this CCA:

(1) The TVA will provide an initial $100,000 contribution for hatchery operations and other species management activities within the first year of the 10-year term of this CCA.

(2) The TVA will provide an additional $100,000 contribution for hatchery operations and other species management activities prior to the end of the fifth year of the 10-year term of this CCA. This additional funding will be made by TVA as either a one-time payment or in installments.

Funding/Conservation Measure	TVA Contribution	Funding	Cooperating Agencies
Hatchery operations and other species management activities.	$200,000	Funding	• WSNFH • CFI • USFWS
Total Funding Provided by TVA	$200,000	Funding	

[10]Measures will remain in place for the duration of this CCA.

[11]Basis: Two people, electrofishing boat/sampling equipment and travel expenses for 6 days each year.

[12]Basis: Two people, one overnight trip each spring.

6. The USFWS shall undertake the following actions:

a. Inspect Enrolled Lands at least annually to ensure the Parties' activities are consistent with this CCA, the respective Hydroelectric Project licenses, and the Settlement Agreements.

b. Require all USFWS personnel and agents acting on their behalf to receive safety training from Duke Energy or the TVA before entering their respective hydroelectric plants, dams, or immediate tailrace areas for the first time.

c. Ensure the Parties have properly implemented this CCA and the conservation measures identified above.

d. Coordinate with the Parties regarding any biological monitoring of the Sicklefin Redhorse or other species of interest in the Enrolled Lands.

e. The following conservation measures will be conducted or funded annually by the USFWS for the term of this CCA:

Annual Conservation Measures[13]	**USFWS Contribution**	**Funding/In-Kind Services**	**Cooperating Agencies**
Provide assistance to annual Sicklefin Redhorse broodstock sampling and collection in the Little Tennessee, Oconaluftee, Tuckasegee, and Hiwassee Rivers.	$16,411[14]	In-kind	• Duke Energy • TVA • NCWRC • EBCI
Stock fry/fingerling Sicklefin Redhorse upstream of the dams within the historic range of the Sicklefin Redhorse.	$2,000	In-kind	• NCWRC • GADNR
WSNFH operations, including employee hours, upkeep of culture systems, propagation, and maintenance/repair of equipment.	$37,354	In-kind	• WSNFH • CFI • USFWS
CFI operations, including employee hours, upkeep of culture systems, propagation, and maintenance/repair of equipment.	$5,000	Funding	• CFI
Total Annual Funding	$60,765	Funding and In-Kind	

[13]Measures will remain in place for the duration of this CCA.

[14]Basis: Three people, sampling equipment, and travel expenses for 14 days each year.

7. All Parties mutually agree to:

a. Ensure the actions covered by this CCA are consistent with applicable federal, state, local, and tribal laws and regulations and other standing cooperative agreements with the EBCI and the NCWRC.

b. Construe this CCA to not limit or constrain the Parties or any other entity from taking additional actions at its own expense to protect or conserve the Sicklefin Redhorse and to not limit the ability of federal and state conservation authorities or the Parties (or its consultants) to conduct investigations within the Enrolled Lands.

c. Work together in good faith to resolve any disputes, using dispute resolution procedures agreed upon by the Parties. The USFWS will engage in such procedures if funding is available, as specified in Section XVIII of this CCA (Availability of Funds).

d. Share information relating to this CCA, if disclosure of such information is not protected by law, confidentiality agreements, or other applicable privileges.

D. Adaptive Management

Those Parties who have the capability to do so will use adaptive management techniques when working to restore and maintain Sicklefin Redhorse populations. Adaptive management is a structured, iterative process of robust decision-making in the face of uncertainty, with an aim to reducing uncertainty over a period of time via monitoring. An adaptive approach involves exploring alternative ways to meet management objectives, predicting the outcomes of alternatives based on current knowledge, implementing one or more of these alternatives, monitoring in order to learn about the impacts of management actions, and then using the results to update and adjust management actions. Adaptive management focuses on learning and adapting through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems. Information learned from adaptive management will be shared with the Parties at the annual review of implementation of this CCA.

XI. Monitoring and Data Collection

A. Compliance Monitoring

The USFWS will be responsible for the compliance monitoring and reporting specified herein related to implementation of this CCA and for assuring fulfillment of its provisions, including implementation of the agreed-upon

conservation measures. The USFWS and NCWRC, or other properly permitted and qualified persons designated by the USFWS or NCWRC, with reasonable advance notice, may enter the Enrolled Lands to implement the provisions of this CCA. Entry onto Enrolled Lands may be subject to escorted access to any secured portions within the Enrolled Lands.

B. Biological Monitoring

Subject to the provisions of Section XI.A., Duke Energy and the TVA will allow the NCWRC, or any other organization or individual approved by all Parties, to conduct periodic biological surveys for the Sicklefin Redhorse within the Enrolled Lands. Survey methodologies will be determined by the approval of all Parties and the owners of the applicable property. Periodic surveys by the USFWS, the NCWRC, and other approved organizations and individuals may be conducted as needed and shall be coordinated with the hydro project owner's operations and maintenance schedules for appropriate projects. These biological monitoring efforts are included in the allowable monitoring specified in this section.

XII. Reporting of Conservation Actions and Monitoring

A. The USFWS will obtain any biological monitoring reports completed by the Parties and Cooperators of this CCA and any third parties investigating the Sicklefin Redhorse or any other species of interest in the Enrolled Lands and provide copies of these reports to the Parties.

B. Duke Energy will provide the USFWS with a copy of the FERC annual compliance reports for the Bryson, Franklin, and Mission Hydroelectric Projects at the same time they are submitted to the FERC.

C. Each Party to this CCA will evaluate activities conducted in compliance with this CCA. When such additional activities have been conducted during the preceding year, each Party will provide a report of such compliance efforts to the USFWS on or before January 31 each year. The annual report will provide and include:

1. A summary of the activities conducted pursuant to this CCA, within the Enrolled Lands, including the date the specific activities were undertaken and the person or persons performing the activities.

2. A summary of any conservation measures implemented within the Enrolled Lands, including the date the specific conservation measures were implemented, the person or persons performing the conservation measures, and the results of the implementation.

D. The USFWS will compile the results of the annual reports and distribute to all Parties by February 28 each year.

XIII. Duration of This CCA and Termination by Any Party

Long-term protection and management, as outlined in this CCA, are necessary for the continued conservation of the Sicklefin Redhorse. The initial term of this CCA will be 10 years. This CCA may be extended, with written consent from the Parties, for additional 5-year increments until long-term habitat management and conservation of the Sicklefin Redhorse is assured. With written notice, any Party may withdraw from this CCA for any reason within 60 days of receipt of said written notice by the other Parties. After the 60 days have passed, the withdrawing Party shall have no further obligations under this CCA. Also, any withdrawing Party shall not be due any refunds of investments (whether financial or in-kind) it has made in this CCA throughout its time as a Party.

XIV. Additional Participants

In order to maximize conservation efforts and effectiveness for the Sicklefin Redhorse, the Board may recruit additional participants who will provide technical and/or funding support. Such additional participants must be approved by the Board, but the additional participants shall not be Parties to this CCA. The Board will also establish and convene Annual Meetings of a Working Group that consists of fisheries biologists or other qualified personnel. The Working Group will convene annually and will develop consensus recommendations to the Board that will guide the design and implementation of conservation actions and management strategies. The Working Group will exist for the duration of this CCA.

XV. Modification and Merger

This CCA contains the entire agreement between the Parties. The terms of this CCA are contractual and not mere recitals. This CCA, including the conditions and requirements contained herein, may not be modified except by written agreement signed by the Parties.

Any Party may propose modifications to this CCA by providing written notice to the USFWS, and the USFWS will distribute the information to all other Parties. Such notice shall include a statement of the proposed modification and the reason for the modification, such as information or new conservation management practices gained through adaptive management. The Parties will use their best efforts to respond to proposed modifications within 60 days of receipt of such notice. Proposed modifications will become effective upon signatory approval of all Parties.

XVI. Remedies

Each Party shall have all remedies otherwise available to enforce the terms of this CCA. No Party shall be liable in damages for any relief under this CCA (including, but not limited to, damages, injunctive relief, personal injury, and attorney fees) for any performance or failure to perform under this CCA. Furthermore, no Party has any right of action under this CCA.

This CCA does not create any new right or interest in any member of the public as a third party beneficiary, nor shall it authorize anyone not a Party to this CCA, to maintain a suit for personal injuries or damages pursuant to the provisions of this CCA. The duties, obligations, and responsibilities of the Parties to this CCA with respect to third parties shall remain as imposed under existing law.

XVII. Succession and Transfer

This CCA shall be binding on and shall inure to the benefit of the Parties and their respective successors and assigns in accordance with applicable regulations (50 CFR §§ 13.24 and 13.25).

XVIII. Availability of Funds

Implementation of this CCA is subject to the requirements of the Anti-Deficiency Act and the availability of appropriated funds. This CCA will not be construed by the Parties to require the obligation, appropriation, or expenditure of any funds from the U.S. Treasury. Thus, the Parties acknowledge that the USFWS will not be required under this CCA to expend any federal agency's appropriated funds unless and until an authorized agency official affirmatively acts to commit to such expenditures as evidenced in writing.

XIX. Relationship to Other Agreements

Nothing herein affects rights or duties arising from other agreements entered into, including (but not limited to) the Settlement Agreements. If a conflict exists between the terms of this CCA and the terms of the TCSTSA, the NCSTSA, or the QCSA; the terms of the TCSTSA or the terms of the NCSTSA or the terms of the QCSA shall prevail.

XX. Choice of Law and Severability

This CCA shall be governed by and interpreted under the laws of the State of North Carolina, except that the TVA's obligations, and any determinations regarding authorization of TVA representatives to act on its behalf, shall be governed by federal law. If any part of the terms of this CCA is adjudged to be contrary to law by a court of competent jurisdiction, such other CCA terms shall,

in all other respects, be and remain legally effective and binding to the fullest extent permissible.

XXI. Notices and Reports

This CCA may be executed in separate counterparts, with each counterpart deemed to be an original having the full force and effect thereof. Any notices and reports, including monitoring and annual reports, required by this CCA shall be in writing and shall be delivered to the persons listed below, as appropriate:

Steve Johnson
Duke Energy Carolinas, LLC
526 South Church Street/P.O. Box 1066
Mail Code EC12Y
Charlotte, North Carolina 28201-1006

John Tracy ("Bo") Baxter
Tennessee Valley Authority
Manager, Natural Resources Compliance Programs
400 West Summit Hill Drive
Knoxville, Tennessee 37902

Mike LaVoie, Program Manager
Fisheries and Wildlife Management
Eastern Band of Cherokee Indians
P.O. Box 1747
Cherokee, North Carolina 28719

Sicklefin Redhorse Conservation Committee Representative
Georgia Department of Natural Resources
Nongame Conservation Section
Wildlife Resources Conservation Center
2065 US Hwy 278 SE
Social Circle, Georgia 30025

Todd D. Ewing, Supervisor
Aquatic Wildlife Diversity Program
Inland Fisheries Division
North Carolina Wildlife Resources Commission
808 Briggs Street NW
Valdese, North Carolina 28690

Janet Mizzi, Field Supervisor
Asheville Ecological Services Field Office
U.S. Fish and Wildlife Service
160 Zillicoa Street
Asheville, North Carolina 28801

CCA Permit Coordinator
Southeast Regional Office
U.S. Fish and Wildlife Service
1875 Century Boulevard
Atlanta, Georgia 30345

XXII. Effect of This CCA in the Event of a Listing Decision

It is the intent and expectation of the Parties that the execution and implementation of this CCA will lead to conservation of the Sicklefin Redhorse in its range. If, subsequent to the effective date of this CCA, the Secretary of the Interior should determine, pursuant to Section 4(a) of the ESA (16 U.S.C. §1533(a)), that the Sicklefin Redhorse is threatened or endangered, the Parties will be encouraged to participate in recovery planning for the Sicklefin Redhorse. It is also the expectation of the Parties that the conservation and management commitments made in this document will be considered in the event of a listing under the ESA. The USFWS will consider implementation of this CCA as a good-faith attempt on the part of the Parties to conserve the species and will use this CCA as a basis for establishment of a Candidate Conservation Agreement with Assurances should the need become apparent in the future. In the event the Sicklefin Redhorse is listed by the USFWS, this CCA shall serve as a basis to provide conservation credit for any actions reviewed under Section 7 of the ESA.

XXIII. References

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Harris, P. M., R. L. Mayden, H. S. Espinosa Perez, and F. Garcia de Leon. 2002. Phylogenetic relationships of *Moxostoma* and *Scartomyzon* (*Catostomidae*) based on mitochrondrial cytochrome b sequence data. Journal of Fish Biology 61:1433 1452.

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Moyer, G. R., J. D. Rousey, and M. A. Cantrell. 2009. Genetic evaluation of a conservation hatchery program for reintroduction of Sicklefin Redhorse *Moxostoma* sp. in the Tuckasegee River, North Carolina. North American Journal of Fisheries Management 29:1438-1443.

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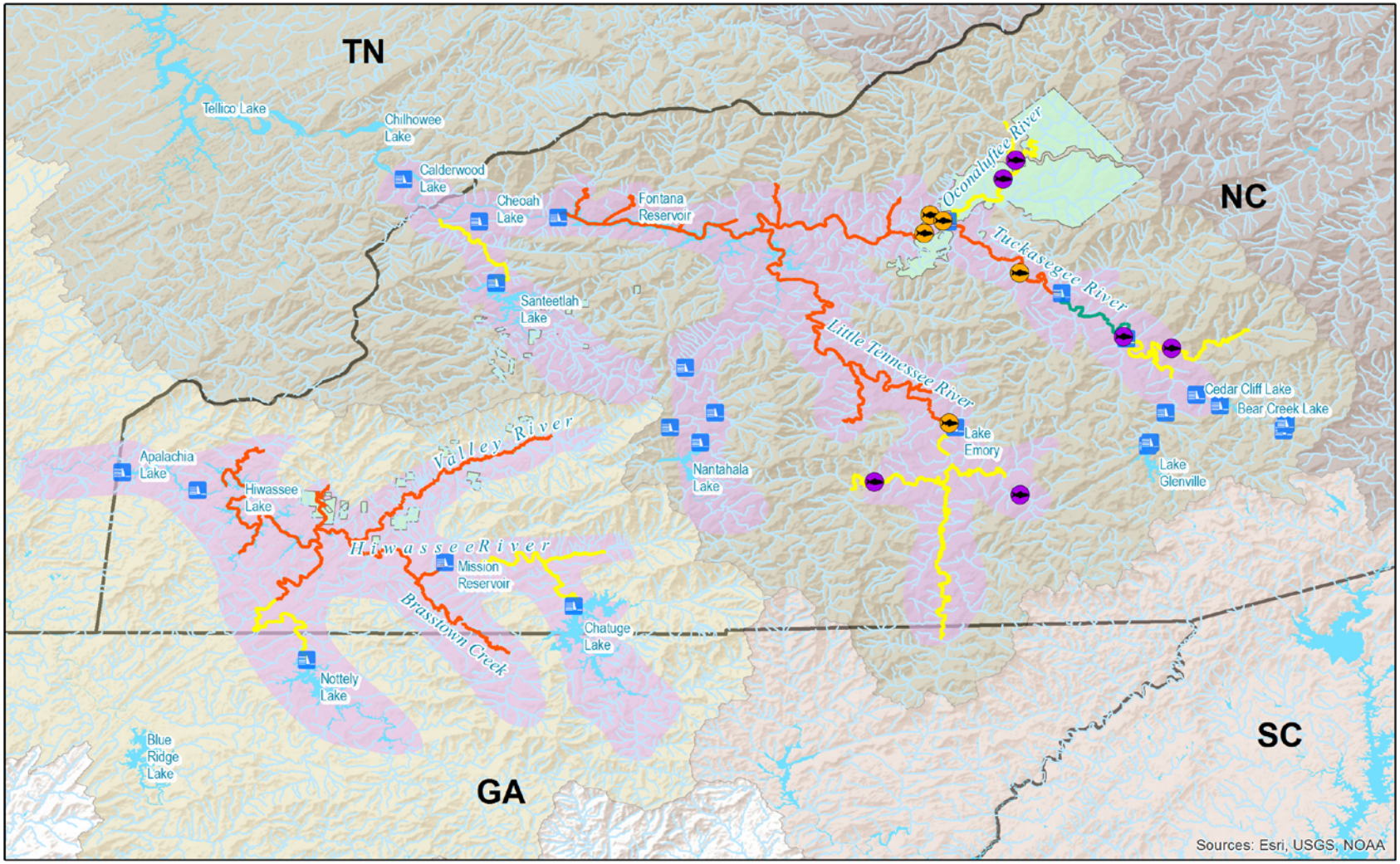
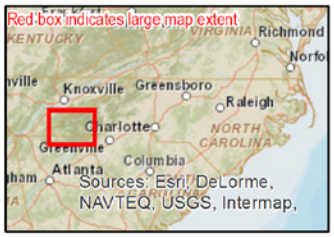
APPENDIX A: Sicklefin Redhorse Distribution Map





Sicklefin Redhorse Distribution

- Brood Stock Collection Site
- Fry Stocking Site
- Expansion After Dillsboro Dam Removal
- Potential Range Expansion
- Extant Range
- Historic Range
- Dams
- Eastern Band of Cherokee
- State Boundary

Hydrologic Basin

- French Broad-Holston
- Middle Tennessee-Hiwassee
- Savannah
- Upper Tennessee

0 5 10 Miles

N

Produced by Ecological Services
Asheville, North Carolina
Basemap: ESRI World Terrain
Map Date: 12/10/2015

APPENDIX B: SIGNATURE PAGE

CANDIDATE CONSERVATION AGREEMENT FOR THE SICKLEFIN REDHORSE

This page may be reproduced as necessary to facilitate the obtaining of signatures of the appropriate Parties to this Candidate Conservation Agreement. It is anticipated there will be one signature per page.

United States Fish and Wildlife Service:

Printed Name and Title_____

Signature and Date_____

Duke Energy Carolinas, LLC:

Printed Name and Title_____

Signature and Date_____

Tennessee Valley Authority:

Printed Name and Title_____

Signature and Date_____

North Carolina Wildlife Resources Commission:

Printed Name and Title_____

Signature and Date_____

Eastern Band of Cherokee Indians:

Printed Name and Title_____

Signature and Date_____

Georgia Department of Natural Resources:

Printed Name and Title_____

Signature and Date_____