U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Moxostoma sp.*

COMMON NAME: Sicklefin redhorse

LEAD REGION: 4

INFORMATION CURRENT AS OF: March 30, 2010

STATUS/ACTION

___ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status
__New candidate
_X_ Continuing candidate
    _X Non-petitioned
    ___ Petitioned - Date petition received:
        _ 90-day positive - FR date:
        _ 12-month warranted but precluded - FR date:
        _ Did the petition request a reclassification of a listed species?
    FOR PETITIONED CANDIDATE SPECIES:
    a. Is listing warranted (if yes, see summary of threats below)?
    b. To date, has publication of a proposal to list been precluded by other higher priority listing actions?
        c. If the answer to a. and b. is “yes”, provide an explanation of why the action is precluded.

____ Listing Priority Change
Former LP: ___
New LP: ___
    Date when the species first became a Candidate (as currently defined): 5/11/05
___ Candidate removal: Former LP: ___
    ___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
    ___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
    ___ F – Range is no longer a U.S. territory.
    ___ I – Insufficient information exists on biological vulnerability and threats to support listing.
    ___ M – Taxon mistakenly included in past notice of review.
    ___ N – Taxon does not meet the Act’s definition of “species.”
    ___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Fish; Catostomidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: TN, NC, & GA

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: NC & GA

LAND OWNERSHIP

Approximately 65 percent of the lands bordering the riverine portion mainstem of the Little Tennessee River inhabited by the Sicklefin Redhorse are owned by the state of North Carolina and are managed by the North Carolina Wildlife Resources Commission (NCWRC). A small percentage of the Tuckasegee River and roughly the lower 25 percent of Hanging Dog Creek are bordered by lands belonging to The Eastern Band of Cherokee Indians. Approximately 95 percent of the lands bordering Hiwassee Lake and approximately 50 percent of the lands bordering Fontana Reservoir are within the boundaries of the Nantahala National Forest. An additional 40 percent of the lands bordering Fontana Reservoir are within the boundaries of the Great Smoky Mountains National Park. With the exception of state roads and highway rights-of-way, the remaining streams and stream reaches currently occupied by the Sicklefin Redhorse are bordered by lands in private ownership.

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BIOLOGICAL INFORMATION

Unless otherwise cited, the following is adapted from Jenkins 1999, and personal communications with Dr. Robert Jenkins, Department of Biology, Roanoke College, Salem, Virginia, 2000-2008.

<u>Species Description</u>: The sicklefin redhorse, a freshwater fish species, can grow to a length of approximately 650 millimeters (roughly 25.5 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 approximately 20 years of age and females approximately 22 years of age. (The above is adapted from Jenkins 1999, pp 8-16 and R. Jenkins, Roanoke College, Roanoke, Virginia, personal communication 2005).

<u>Taxonomy</u>: Although the sicklefin redhorse is now known to have been collected in 1937 (based upon preserved specimens collected at the then unimpounded mouth of Forney Creek near its confluence with the Tuckasegee River), it was not recognized as a distinct species until 1992 when Dr. Robert Jenkins obtained and examined two specimens collected from the Little

Tennessee River by Dr. Edward Menhinick (University of North Carolina at Charlotte, Charlotte, North Carolina) in 1981 and 1982 (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 Service has reviewed the available taxonomic literature, and is not aware of any challenges to the validity of this species.

Habitat/Life History: The species 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). In streams, it is generally associated with moderate to fast currents, in riffles, runs, and well-flowing pools and feeds and spawns 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 possibly adapted to spending at least part of its early life stages in the near-shore areas of impounded streams (Jenkins 1999, pp. 19 and 20). Current observations indicate that adults are year-round residents of rivers and large creeks (Jenkins personal communication 2007; Favrot 2008, pp. 2 and 39) 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). It is likely that after emerging from the stream substrata, many of the larvae and post-larvae are carried downstream to the mouths of streams or into reservoirs (Jenkins 1999, p.20). Newly mature fish ($\geq$5 years of age) 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 (2008, pp. 2 and 39) reported in his study of sicklefin redhorse movement and habitat utilization within the Hiwassee River system that he was unable to detect radio-tagged adult sicklefin redhorse utilizing Hiwassee Reservoir for other than brief periods between occupying a spawning tributary and the Hiwassee River or Valley River, suggesting these fish were only migrating between streams. 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 but rather are a factor limiting habitat for adult sicklefin redhorse.

Stomach analysis indicates that the sicklefin redhorse feeds on benthic macroinvertebrates (insect larvae, crustaceans, snails, etc.) (Jenkins, pers. com. 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 the 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, p. 75-76) documented that post-spawning (herein referring to the stream reach occupied following spawning and before migrating to deeper waters for the winter), the species typically relocates to stream reaches supporting 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, p. 84-85). Unlike the sicklefin redhorses' foraging habitat, the species' appears to spawn exclusively over coarse substrates lacking river weed (Favrot 2008, pp. 3, 49, 56, 59-60, and 84-85). Favrot's study (2008, p. 67) indicates the species begins upstream migration to spawning sites in late winter/early spring when water temperatures reach 10.0-12.0 degrees (º) Celsius (C) (50.0-53.6 º Fahrenheit (F)) and peak at water temperatures of 15.0-16.0 ºC (59.0-60.8 ºF). 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 down stream to deeper waters and more suitable foraging areas (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). 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, travelling only short distances up and down stream within the occupied river reach; and, 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 stream, and generally the stream reaches each year (Favrot 2008, pp. 37-42 and 69-75).

Historical Range/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).

Current Range/Distribution: Currently, there are only two meta-populations 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 sicklefin redhorses' current known occupied range as: (1) a relatively short reach (approximately 9.0 miles) of the main stem of the Hiwassee River, between Mission Dam and Hiwassee Lake, Cherokee County, North Carolina; (2) Brasstown Creek (approximately 16.9 miles), a tributary to the Hiwassee River in Cherokee County, North Carolina, extending into Towns County, Georgia; (3) the main stem of the Valley River, between the community of Buffalo and backwaters of Hiwassee Lake (approximately 22.3 miles), Cherokee County, North Carolina (Jenkins; Favrot); in addition, Favrot (2008, pp. 33, 35-36, and 38-39) provides recent records for the species in (1) Hanging Dog Creek (approximately 3.0 miles), a tributary to Hiwassee River (at Hiwassee Lake) in Cherokee County, North Carolina;

and, (2) a short reach of the Nottely River (approximately 2-3 miles) between the cold water discharge from Nottely Reservoir and the backwaters of Hiwassee Reservoir in Cherokee County, North Carolina (Favrot 2008, pp. 33, 35-36, and 38-39). In addition, several juveniles have been collected from the near-shore portions of Hiwassee Lake, Cherokee County, North Carolina (Jenkins personal communications 2003, 2004, and 2006). Also, as mentioned previously, a few adult sicklefin redhorse have been detected in Hiwassee Reservoir but these appear to have been migrants moving from one stream to another (Favrot 2008, pp. 2 and 39).

Estimated occupied stream habitat in the Hiwassee river systems totals about 53.0 miles (adapted from Jenkins 1999, p. 26 and Favrot 2008, pp. 2, 33, 35-36, 38-39). However, use of various streams and stream reaches within this total appears to be seasonal. Available information indicates that the sicklefin redhorse uses the Brasstown Creek, Hanging Dog Creek, Beaverdam Creek, Nottely River and the mid 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 mainstem of the Hiwassee River (Favrot 2008, p. 69); the mid 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) and; the lower un-impounded reaches of the Hiwassee River (Favrot 2008, pp. 38 and 39) and to a lesser extent, the lower Valley River, during the winter (Favrot 2008, p. 38).

The Little Tennessee River system meta-population of the sicklefin redhorse includes a total of approximately 41.65 miles of creek and river reaches plus near-shore areas of Fontana Reservoir, including: (1) the main stem of the Little Tennessee River in Macon and Swain Counties, North Carolina, between the Franklin Dam and Fontana Reservoir (approximately 24.2 river miles), and its tributaries, Burningtown Creek (approximately 3.1 river miles) and Iotla Creek (approximately 0.1 river mile) in Macon County, North Carolina; (2) the main stem of the Tuckasegee River in Swain County, North Carolina, from Oconaluftee River downstream to Fontana Reservoir (approximately 18.5 miles), and its tributaries, Forney Creek (mouth of the creek), Deep Creek (approximately 2.35 river miles), and the Oconaluftee River below the Bryson Dam (approximately 0.5 river mile), in Swain County, North Carolina; and, (3) sub-adults of the species have been collected in the near-shore portions of Fontana Reservoir, Swain County, North Carolina (Jenkins personal communication 2007).

Like Hiwassee Reservoir, current evidence indicates Fontana Reservoir likely serves only as maturation sites for sub-adult sicklefin redhorse, though additional research is needed to confirm this (Jenkins 1999, p. 34). Likely 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, the lower Oconaluftee River and possibly the lower reaches of Deep Creek (a single adult was observed in Deep Creek in 2000, but no sicklefins have been observed in subsequent surveys) (Jenkins personal communication 2006).

<u>Population Estimates/Status</u>: The species has apparently been eliminated from roughly 58.4 percent 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 within the present range of the species (although portions of these reservoirs appear to provide survivable habitat for

juvenile sicklefins, they do not appear to provide spawning, foraging, or wintering habitat for adults of the species; however, they likely did prior to impoundment); (2) does not include within the species' historic range the higher reaches of some of the creeks where the sicklefin redhorse occurs in their lowermost reaches and which may have been part of the species' historic range; and, (3) does not include portions of the Cheoah River, 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.

THREATS:

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>. Many populations of the species were apparently extirpated when large portions of suitable habitat in the upper Tennessee River system were destroyed as a result of impoundments created when dams were constructed (Jenkins 1999, p. 26). These impoundments also resulted in fragmentation and isolation of the remaining populations, making them more vulnerable to extirpation from other environmental impacts. In addition to impoundments, other factors contributing to habitat destruction and modification that resulted in population losses and curtailment of the range of this species are believed to include inadequate erosion/sedimentation control (Jenkins 1999, p. 27) during agricultural, timbering, and construction activities; run-off and discharge of organic and inorganic pollutants (Jenkins 1999, p. 27) from industrial, municipal, agricultural, and other point and nonpoint sources; habitat alterations associated with channelization and instream dredging/mining activities; and other natural and human-related factors that adversely modify the aquatic environment. As described below, many of these factors continue to threaten the surviving populations.

The construction and operation of the dams on the rivers in the Hiwassee and Little Tennessee River systems, for hydroelectric generation, navigation, and flood control, are the most significant factors contributing to the extirpation of the species from much of its historic range. The impoundments created by these dams destroyed or modified stream conditions (flowing, highly oxygenated, cool water and coarse sand, gravel, and rocky bottoms) that are suitable habitat for the sicklefin. The existence and effects of the operation of these dams continues to limit the species' expansion back into portions of streams it is believed to have once occupied, both upstream and down stream of the dams.

Lakes do not naturally occur within the historic range of the sicklefin redhorse. Like the majority of our other native aquatic species in these areas, the sicklefin redhorse is adapted to stream conditions. The impoundments created by the dams eliminated spawning and foraging habitat of the adult sicklefin redhorse by changing the conditions from flowing to still water; increasing water depth, decreasing flow, and accumulating silts and other sediments on the bottom (Williams et al. 1992, pp. 1-8).

Impoundments not only destroy riverine habitat within the impounded portion of the stream, but they alter the quality and stability of the downstream reaches by adversely affecting water flow regimes, velocities, temperature, chemistry, and nutrient cycles (Ligon et al. 1995, pp. 183-192; Collier et al. 1996, pp. 1-94; Watters 1999, pp. 261-264; McAllister et al. 2000, p. iii). Dams that operate by releasing cold water from near the bottom of the reservoirs lower the water temperature downstream, changing downstream reaches from warm- or cool-water streams to cold-water streams and affecting their suitability for many of the native species historically inhabiting these stream reaches (Layzer et al. 1993, p. 69). The effects of impoundments result in changes in fish and macroinvertebrate communities (the main prey items of the sicklefin), and species requiring clean gravel and sand substrates are eliminated. In addition, dams result in the fragmentation and isolation of populations of species, acting as effective barriers to the natural upstream and downstream expansion or recruitment of fish species. This reduction in range and isolation of the populations greatly increases the vulnerability of a species to extinction. It reduces the species' ability to respond to changes (natural or manmade) within its environment and to recover from impacts (large or repeated small scale impacts) to its numbers that a species with widely dispersed, interconnected healthy populations would likely be able to overcome (Frankel and Soulé 1981, pp. 1-327).

Within the Valley River and Brasstown Creek in the Hiwassee River system, the species likely still inhabits the same length of stream that it did historically; the small size of the upper reaches of these streams are thought to be the major factor limiting the species' current upstream distribution (Jenkins personal communication 2000). The same is likely also true of Hanging Dog Creek and Beaverdam Creek. These four streams appear to be the only un-impounded streams in the Hiwassee River system that provide suitable spawning habitat for the sicklefin redhorse.

Prior to construction and operation of Nottely Dam, the range of the sicklefin redhorse in the Nottely River, likely extended much further upstream than its current range (Jenkins 1999, p. 23). Construction of the dam appears to have contributed to elimination of the species from the river above the dam (Jenkins 1999, p. 23) and the dam's cold water discharge appears to be reducing the species' range below the dam to the lowest 2-3 miles of the river above the backwaters of Hiwassee Reservoir (Favrot 2008, p. 46). The high degree of flow fluctuation (significant rises and falls in water levels and velocities) below Nottely Dam, associated with operations for hydroelectric power generation at the dam, also appears to be having a significant adverse effect on the health of the river and the suitability of habitat for the sicklefin redhorse downstream of the dam by contributing to bank erosion and channel siltation, and periodic dewatering of channel substrates (M.Cantrell, Service, Asheville, North Carolina, personal communication 2009). As stated above, river weed is an important element of sicklefin redhorse foraging habitat; however, river weed is intolerant of desiccation (drying out due to dewatering) and excessive fine silts (Farvrot 2008, p. 81).

The sicklefin redhorses' range in the Hiwassee River currently extends upstream to Mission Dam, so it is reasonable to believe that the species' historic range in the mainstem of the Hiwassee River once extended much further upstream, likely at least to the headwaters upstream of the North Carolina/Georgia state line (Jenkins personal communication 2000). The construction of the Mission Dam likely fragmented the species' range in this river, isolating the upstream portion of the population and prohibiting recruitment from the downstream population segment. Jenkins (1999, p. 21) was unable to find evidence of a surviving population of the sicklefin redhorse upstream of Mission Dam; so if, as believed, the species' range did once extend upstream of Mission Dam, this portion of the population now appears to be extirpated. Fragmentation of the population, alterations of the natural flow regime, and lowered stream temperature associated with the operation of the dam at Lake Chatuge on the Hiwassee River, a few miles downstream of the North Carolina/Georgia state line, together with other impacts to habitat quality, likely lead to this extirpation (Jenkins 1999, p. 26).

Likewise, Appalachia Dam and Hiwassee Dam prohibit downstream expansion/repopulation of the surviving Hiwassee River system population into the rest of the Blue Ridge portion of the Hiwassee River downstream in Tennessee. The Hiwassee Dam impounds about 22.2 miles of the Hiwassee River; Appalachia Dam impounds roughly 9.8 miles of river and its backwaters generally extend up to Hiwassee Dam. In addition, water from Appalachia Lake is piped and bypasses (partly dewaters) an additional 12.4 miles of river channel below the dam, to the Appalachia Powerhouse in Polk County, Tennessee. The discharge from the Appalachia Powerhouse is a cold water discharge effecting stream temperatures in the river channel for approximately 26 additional miles downriver (Jenkins 1999, p. 23).

Also, the Little Tennessee River population of the sicklefin redhorse in the mainstem of the Little Tennessee River and the portion of the population in Tuckasegee River and Oconaluftee Rivers has been fragmented and adversely affected by the construction and operation of hydroelectric dams (Jenkins 1999, pp. 23-24, and 26). Construction of the Porters Bend (Franklin) Dam on the Little Tennessee River, Dillsboro Dam on the Tuckasegee River, and the Bryson Dam on the Oconaluftee River resulted in the fragmentation of the species' ranges in these rivers. Once isolated, the remaining portions of the population of the species in these streams above these dams are believed to have been extirpated by the general deterioration of water and habitat quality associated with industrial and domestic wastewater discharges, and runoff of silt and other pollutants from development, agriculture, and forestry activities implemented without adequate stormwater and erosion control measures (adapted from Jenkins 1999, p. 27-28; personal observations 1987-2008). In the case of the Tuckasegee River, the combined effects on natural flow regimes and cold water discharges associated with the operation of hydroelectric dams (a total of six) in its headwaters have also likely had a significant role in the loss of the sicklefin redhorse in the upper reaches of this river.

In addition to impoundments, factors contributing to population losses are believed to include inadequate erosion/sedimentation control during agricultural, timbering, and construction activities; run-off and discharge of organic and inorganic pollutants from industrial, municipal, agricultural, and other point and nonpoint sources; habitat alterations associated with channelization and instream dredging/mining activities; and other natural and human-related factors that adversely modify the aquatic environment. Many of these factors continue to threaten the surviving populations.

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 making it unsuitable for feeding and reproduction. It eliminates breeding sites and results in increased mortality of eggs and juveniles; it eliminates feeding areas, reduces the species' ability to detect prey, and eliminates aquatic insect larvae and other food items of the sicklefin. Suspended sediment also irritates and clogs fishes' 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 Mission Dam and 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 species' survival, 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 non-point sources. These pollutants not only poison and kill the fish and their food items, but can adversely affect stream pH, conductivity, dissolved oxygen concentrations, and cause other changes in water chemistry which in turn affect aquatic life. 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.

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 stream-bank scouring that leads 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 that ordinarily would help maintain water quality and the stability of stream banks and channels by absorbing, filtering, and slowly releasing rainwater. Also, when storm water runoff increases from land-clearing activities, less water is absorbed to recharge ground water levels. Therefore, flows during dry months can decrease and adversely affect aquatic resources.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

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 still existing, prehistoric and early-historic rock fish weirs in the Tuckasegee and Little Tennessee rivers, this species, along with other redhorse species, was likely utilized at least occasionally as a food source by Native American Indians and early settlers inhabiting the watersheds of these streams. There are also anecdotal reports that as recently as 30 years ago, local residents of the areas shot and ate redhorse, the sicklefin likely included; however, other redhorse species in the Clinch River in Virginia have been "much-gunned" for decades without apparent ill effect to their population levels. Anglers may also on occasion harvest sicklefin along with other redhorse species; however, recreational harvest of the sicklefin by anglers is not currently believed to pose a significant threat to the species (Jenkins 1999, p. 28).

C. Disease or predation.

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 that, if introduced into the rivers currently supporting the species, have the potential to seriously affect population levels. The introduction of non-native 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 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 non-native species could pose a significant threat to the sicklefin redhorse.

Recently, non-native blueback herring (*Alosa aestivalis*) were introduced to 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 predation of drifting eggs and early juveniles of both walleye and white bass by blueback herring has been observed in the transition zone between the free-flowing Hiwassee and Valley rivers and Hiwassee Reservoir. Blueback herring have been observed several miles upstream in Valley River and have unobstructed access to the Hiwassee River, Mission Dam, and lower Brasstown Creek. Blueback herring have also been observed congregating at the mouths of other tributaries to Hiwassee Reservoir in March and April (above is condensed from personal observations by A.P. Wheeler, D.L. Yow, and S.J. Fraley NCWRC 2005-2006). The presence of large numbers of known predators of drifting fish eggs and larvae at or near the time of spawning and hatching of sicklefin redhorse poses a potentially significant threat. Further investigation is required to determine the degree of threat posed to sicklefin redhorse survival and recruitment in the Hiwassee River system. To date, no blueback herring have been collected from Fontana Reservoir or elsewhere in the Little Tennessee River system upstream from Fontana Dam.

D. <u>The inadequacy of existing regulatory mechanisms</u>.

The sicklefin redhorse does not currently have any official status in North Carolina; however, the North Carolina Non-Game Advisory Committee has recommended that the species be state-listed as threatened. It is anticipated that the listing will become official in the coming year. In Georgia, the sicklefin redhorse is state-listed as endangered. Both states prohibit the collection of the fish for scientific purposes without a valid State collecting permit. However, this requirement does not protect the species from "incidental" harm, injury, death (impacts resulting from activities not specifically intend to the harm the species) or provide any protection to the species' habitat except on state-owned lands.

In the un-impounded portions of the mainstems of the Little Tennessee River and Tuckasegee River where the sicklefin redhorse survives, the species' habitat is indirectly provided some Federal protection from Federal actions and activities through the Endangered Species Act, due to the fact that the mainstem portions of both of these rivers that are inhabited by the sicklefin redhorse, also support, and are designated as critical habitat for, populations of the federally endangered Appalachian elktoe (*Alasmidonta raveneliana*). In addition to the Appalachian elktoe, the portion of the Little Tennessee River where the sicklefin redhorse occurs also supports populations of the federally endangered little-wing pearlymussel (*Pegias fabula*) and a federally threatened fish species, the spotfin chub (*Erimonax monachus*) and is also designated as critical habitat for the spotfin chub. However, the sicklefin redhorse' habitat in the other streams and the two impoundments, Fontana Reservoir and Hiwassee Lake, where the species survives, is not afforded this indirect protection.

Neither of the states of North Carolina or Georgia, nor the local governments with jurisdictions within the watersheds of streams supporting populations of the sicklefin redhorse, currently have regulations/ordinances that are adequate to protect the species from many of the adverse effects of agriculture, private forestry, and residential and commercial development activities (e.g., loss of riparian buffers; impacts to the streams' hydrographs; stormwater runoff of sediments and other non-point source pollutants; wastewater discharges, etc.). The majority of the land use activities in watersheds of streams supporting the sicklefin redhorse are occurring without any federal nexus or in cases where a federal nexus has existed, many of the measures necessary for the protection of the sicklefin and its habitat are not within the permitting or funding federal agencies' authority to implement.

E. Other natural or manmade factors affecting its continued existence.

Moyer et. al. (2009; p. 1441) conducted a study of the genetic diversity and relatedness of sicklefin redhorse within the Little Tennessee River population of the species and indicated that although genetic diversity within the adults of this population currently appears relatively high, this may be due to the longevity of the species – the adults sampled represent progeny from reproductive events that likely occurred 7-20 years ago and the effects of population and range reduction and isolation resulting from impoundments (Fontana Reservoir and Lake Emory) to genetic diversity may not yet be apparent within the population.

Also, using the Cormack-Jolly-Seber model (Cormack 1964, pp. 429–438; Jolly 1965, pp 225-247; Seber1965, pp. 249-259), based on marked and recaptured spawning sicklefin redhorse, Cantrell (pers. comm. 2009) estimated the number of spawning Sicklefin at the best and currently only known spawning site in the Little Tennessee River at 85-116 males and only 15-16 females. Additional research is needed to determine what percentage of the breeding population of the sicklefin redhorse within the Little Tennessee River is represented at this site, but these numbers indicate potentially low breeding population levels and concern about the future genetic health of the population, especially if any significant loss in the number of breeding adults were to occur.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

In October 2003, the Service, together with other stakeholders, signed an agreement (Tuckasegee Cooperative Stakeholders Team Settlement Agreement) with Duke Energy, LLC. Measures in the agreement that will potentially benefit the sicklefin redhorse include: (1) plans for removal of a small hydropower dam, the "Dillsboro Dam", on the mainstem of the Tuckasegee River that may eventually allow for the expansion of sicklefin redhorse back into upstream reaches of the river; (2) funding for stream/stream bank restoration in the Tuckasegee River system; and, (3) funding for research activities, a portion of which were used in 2006, 2007, and 2008 to help fund a sicklefin movement study.

The Service is working with Conservation Fisheries, Inc. (CFI), the NCWRC, and the Eastern Band of the Cherokee Indians (EBCI) to propagate the sicklefin redhorse (following hatchery propagation guidelines recommended by the Service's Warm Springs Technology Center, Conservation Genetics Lab in Warm Springs, Georgia [Moyer and Rousey 2008; pp. 5-6]) and reintroduce the species into currently unoccupied habitat within the species' historic range. In 2007, approximately 800 juvenile sicklefin redhorse, successfully reared by CFI from eggs collected from the Little Tennessee River stock, were released into the Oconaluftee River above Ela Dam. Additional propagation and reintroduction efforts were carried out in the Oconaluftee River in 2008 and 2009 (and continuing into the future as necessary), as well as population monitoring and studies of movement patterns, habitat use, and water quality requirements. Efforts are also underway to identify other suitable areas for potential reintroduction within the species' historic range.

In addition, the Service has been working with biologists with the Tennessee Valley Authority; the states of North Carolina and Georgia; and, personnel with Roanoke College in Salem, Virginia and North Carolina State University in Raleigh, North Carolina and other partners to identify threats and other potential recovery measures for the sicklefin redhorse.

SUMMARY OF THREATS

Hydroelectric operations, inadequate erosion/sedimentation control during agricultural, timbering, and construction activities; run-off and discharge of organic and inorganic pollutants from industrial, municipal, agricultural, and other point and nonpoint sources; habitat alterations associated with channelization and instream dredging/mining activities; predation by non-native species; ; fragmentation and isolation of surviving populations; and, other natural and human-related factors that adversely modify the aquatic environment have resulted in a significant reduction in the species' range and habitat availability, and pose a significant threat to the survival of the species. We find that this species is warranted for listing throughout all its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

RECOMMENDED CONSERVATION MEASURES

Assuring the long-term survival of the sicklefin redhorse will require, at a minimum: (1) protecting the existing water and habitat quality of the reaches of the river systems were the species is still surviving; and (2) improving degraded portions of the species' habitat to allow for the expansion of existing populations and reestablishment of the extirpated populations. This will require compliance with existing State and Federal regulations, assistance from the public, Tribes, and local governments and industries in implementing conservation measures; and, developing agreements with power companies and other partners to provide a means of allowing the species to expand into historic habitat currently inaccessible due to dams and hydropower operations. Also, there is a need for additional research on the threats to the sicklefin redhorse, the species' life history, the environmental requirements of the species (especially its early life stages), movement patterns, and propagation and population augmentation/reintroduction techniques for the species.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	**5***
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: All of the surviving occurrences of the sicklefin redhorse are restricted to relatively short reaches of the streams they occupy. Their limited distributions make them extremely vulnerable to the effects from single catastrophic events (such as toxic chemical spills, major sedimentation events, channel modification, etc.) and/or the cumulative effects of lesser impacts to their habitat and numbers. Although the majority of the streams still occupied by the species occur in areas that are presently primarily rural, many of the communities within the watersheds of these streams are experiencing increasing development pressure, both commercial and residential, and are developing plans for upgrading and improving their infrastructure (e, g., roads, water supplies, sewer/wastewater treatment systems, etc.) to provide for increased densities of development. Because of the effects this development can have on water quality and habitat suitability of the sicklefin, the magnitude of the threat to the species is high.

Imminence: Although the threats faced by the sicklefin redhorse are significant, it is not anticipated that the species will be eliminated by these threats in the immediate future.

Yes Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed?

Is Emergency Listing Warranted? No, although the threats to the species are high, because they are not imminent, emergency listing is not warranted at this time.

DESCRIPTION OF MONITORING

Scott Favrot with NCSU completed his study of the reproduction and habitat ecology of adult sicklefin redhorse in the Upper Hiwassee River Basin and provided the Service with a copy of his thesis reporting on his findings. His thesis/report contained much valuable information on movement and habitat utilization of the species. Much of the information contained in his thesis has been incorporated into the appropriate sections above (cited as: Favrot 2008).

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

A response was received from Bryn Tracy, NCDWQ, providing information concerning sites surveyed by the NCDWQ and stating that no information regarding the distribution of the species was discovered. Michael LaVoie with the EBCI responded indicating that they did not have any new information. The sicklefin redhorse is identified as a priority species in both the NC and GA State Wildlife Action Plans. (GADNR, 2005, Appendix A. pp. 6, 26, 32, 33, 37, and 68; NCWRC, 2005 pp. 286, 288, 289, 291, 295 - 298, and 301)

Indicate which State(s) did not provide any information or comments:

No new information or comments were received from TN; however, the species is not known to occur in TN and all known surviving occurrences of the species are isolated from any potential former range in TN by hydroelectric dams and operation of these dams – natural reoccupation of likely former habitat of the species in Tennessee streams is unlikely. Also, a response was not received from GA.

LITERATURE CITED IN BACKGROUND REVIEW

Published Literature:

Collier, M., R.H. Webb, and J.C. Schmidt. 1996. Dams and rivers: primer on the downstream effects of dams. U.S. Geological survey Circular 1126, Tucson, Arizona. 94 pp.

Cormack, R.M. 1964. Estimates of survival from the sighting of marked animals. Biomatrika 51:429–438.

Georgia Department of Natural Resources, Wildlife Resources Division. 2005. A Comprehensive Wildlife Conservation Strategy for Georgia. Georgia Department of Natural Resources, Atlanta, Georgia. 202 pp. 14 Appendices.

Favrot, S.D. 2008. Sicklefin Redhorse (Catostomidae) reproductive and habitat ecology in the upper Hiwassee River basin of the southern Appalachian Mountains. Master of Science Thesis, North Carolina State University, Raleigh.

Frankel, O.H., and M.E. Soulé. 1981. Conservation and evolution. Cambridge University Press, Cambridge, England. 327 pp., 36 illustrations, 20 tables.

Gilpin, M.E. and M.E. Soulé. 1986. Minimum viable populations: Processes of species extinction. In: Soulé, M.E., Editor, 1986. *Conservation Biology: The Science of Scarcity and Diversity*, Sinauer, Sunderland, MA, pp. 19–34.

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.

Jenkins, R.E. 1999. Sicklefin Redhorse (*Moxostoma* sp.), undescribed species of sucker (Pisces, Catostomidae) in the upper Tennessee River drainage, North Carolina and Georgia--description, aspects of biology, habitat, distribution, and population status. Unpublished report to the U.S. Fish and Wildlife Service, Asheville Field Office, Asheville, NC, and the North Carolina Wildlife Resources Commission, Raleigh, NC. 34 pp., tables 1-7, and figures 1-15.

Jenkins, R.E. 2000-2008. Personal Communication. Department of Biology, Roanoke College, Salem, Virginia. 2000-2008.

Jolly**,** G. M. 1965**.** Explicit estimates from capture-recapture data with both death and immigration-stochastic model. Biometrika 52: 225-247.

Layzer, J.B., M.E. Gordon, and R.M. Anderson. 1993: Mussels: the forgotten fauna of regulated rivers. A case study of the Caney Fork. Regulated rivers: Research and Management 8:63-71.

Ligon, F.k., W.E. Dietrich, and W.J. Trush. 1995. Downstream ecological effects of dams. Bioscience 45(3):183-192.

McAllister, D., J. Craig, N. Davidson, D. Murray, and M. Seddon. 2000. Biodiversity impacts of large dams. In: G. Berkamp, M. McCartney, P. Dugan, J. McNeely and M. Acreman. 2000. Dams, Ecosystem Functions and Environmental Restoration. Thematic Review 11.1. World Commission on Dams, Cape Town, SA. Pp. iii-iv.

Moyer, G.R. and J.D. Rousey. 2007. Evaluation of genetic diversity for Sicklefin redhorse (Moxostoma sp.) in the Little Tennessee River. Unpublished report. US Fish and

Wildlife Service, Warm Springs Fish Technology Center, Conservation Genetics Lab, Warm Springs, GA 31830. 13 pp.

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.

North Carolina Wildlife Resources Commission. 2005. North Carolina Wildlife Action Plan. Raleigh, North Carolina. 577 pp.

Seber**,** J.A.F. **1**965**.** A note on the multiple recapture census. Biometrika 52: 249-259.

Waters, T. F. 1995. Sediment in streams: sources, biological effects and control. American Fishery Society Monograph 7. Bethesda, MD. 251 pp.

Watters, G.T. 1999. Freshwater mussels and water quality: a review of the effects of hydrologic and instream habitat alterations. Proceedings of the First Freshwater Mollusk Conservation Society Symposium: pp. 261-266.

Wheeler, A.P., D.L. Yow, and S.J. Fraley, 2005-2006. North Carolina Wildlife Resources Commission, personal observations 2005-2006.

Williams, J.D., S.L.H. Fuller, and R. Grace. 1992. Effects of impoundments on freshwater mussels (Mollusca: Bivalvia: Unionidae) in the main channel of the Black warrior and Tombigbee rivers in western Alabama. Bulletin of the Alabama Museum of Natural History 13:1-10.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: ____________________________________ June 15, 2010__
for Regional Director, Fish and Wildlife Service Date

Concur: ____________________________________ ____________
Director, Fish and Wildlife Service Date

Do Not Concur: ____________________________________ ____________
Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: March 2010

Conducted by: Asheville, North Carolina Field Office