Appalachian elktoe
(Alasmidonta raveneliana)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Asheville Ecological Services Field Office
Asheville, North Carolina

5-YEAR REVIEW

Appalachian elktoe (*Alasmidonta raveneliana*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: Public notice of this review was given in the *Federal Register* and a 60-day comment period was opened. Pertinent status data were obtained from the Recovery Plan, published papers, unpublished reports, and experts on this species. Once all known and pertinent data were collected for this species, the status information was compiled and the review was completed by the species' recovery lead biologist in the Asheville, North Carolina, Field Office with assistance from Steve Fraley, Aquatic Wildlife Diversity Coordinator, Western Region, North Carolina Wildlife Resources Commission (NCWRC). A draft of this document was internally reviewed by Jim Widlak and Tim Merritt, Cookeville Field Office, Tennessee and peer reviewed by six experts familiar with the Appalachian elktoe (see Appendix A). Comments received were evaluated and incorporated as appropriate.

B. Reviewers

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

Lead Field Office - Asheville, North Carolina, Ecological Services: John Fridell, 828/258-3939 Ext. 225

Cooperating Field Office – Cookeville, Tennessee, Ecological Services: Jim Widlak, 931/528-6481

C. Background

1. FR Notice citation announcing initiation of this review: September 20, 2005: 70 FR 55157

2. Species status: Declining (2008 Recovery Data Call): The species appears to have been eliminated from most of the Cane River as a result of problems associated with a wastewater discharge. A die-off of unknown cause in the Little Tennessee River appears to be continuing and spreading upstream. Ongoing (since summer 2007) exceptional drought conditions are becoming an increasing threat (especially lack of dilution of pollutants in wastewater treatment plant discharges and increasing accumulations of sediment from lack of flushing flows - elevated water temperature may also be of concern).

3. Recovery achieved: 1 (1-25% recovery objectives achieved)

4. Listing history

Original Listing
FR notice: 59 FR 60334
Date listed: November 23, 1994
Entity listed: species
Classification: endangered

5. Associated rulemakings

Critical Habitat; 67 FR 61016, September 27, 2002

6. Review History:

Final Recovery Plan – August 26, 1996.

Recovery Data Call – 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, and 1998.

7. Species' Recovery Priority Number at start of review (48 FR 43098):

5. This number indicates a high degree of threat, and a low recovery potential.

8. Recovery Plan

Name of plan: Recovery Plan for the Appalachian elktoe (*Alasmidonta raveneliana*) Lea
Date issued: August 26, 1996

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy: The Appalachian elktoe is an invertebrate and, therefore, not covered by the DPS policy. The other DPS questions will not be addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

2. Adequacy of recovery criteria.

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

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The Appalachian elktoe will be considered for downlisting to threatened status when the likelihood of the species' becoming extinct in the foreseeable future has been eliminated by achievement of the following criteria:

1. Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of four distinct viable populations exist. (A viable population is defined as a naturally reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural environmental changes.) These four populations shall be distributed throughout the species' historic range, with at least one each in the Little Tennessee, French Broad, or Nolichucky River systems. Also, these populations must be extensive enough that it is unlikely that a single event would not eliminate or significantly reduce one or more of these populations.

At the time of listing, only 2 populations of the Appalachian elktoe were known to exist: one in the main stem of the Little Tennessee River in Swain and Macon Counties, North Carolina and one in the Nolichucky River system including the mainstem of the Toe River, Yancey and Mitchell Counties, North Carolina; the mainstem of the Cane River, Yancey County, North Carolina; and the mainstem of the Nolichucky River in Yancey and Mitchell Counties, North Carolina and Unicoi County, Tennessee. Since listing, 5 additional populations have been discovered: (1) in 1996, a population was discovered in the Tuckasegee River in Jackson and Swain Counties, North Carolina; (2) another population was discovered in 1999 in the West Fork Pigeon River and the Pigeon River in Haywood County, North Carolina; (3) a small population was discovered in 2000 in the Cheoah River in Graham County, North Carolina; (4) a population was discovered in the Little River in 2000 (Service 2002) and this population was found in 2005 to extend into the French Broad River near the mouth of the Little River, Transylvania County, North Carolina (S. Fraley, NCWRC, personal communication 2005); and, (5) in 2003, a population was discovered in the Mills River, Henderson County, North Carolina (T. Savidge, The Catena Group, pers. comm. 2003).

Of the 7 known surviving Appalachian elktoe populations, 2 – the Nolichucky River system population and the Tuckasegee River population, currently appear to meet the definition of a viable population given in the Recovery Plan (though the number of individuals needed to comprise a viable population is presently unknown and is one of the tasks identified in the Recovery Plan to be completed). However, the Cane River portion of the Nolichucky River system population appears to have been all but eliminated in 2008, apparently due to toxicants and other water quality issues associated with the Burnsville Wastewater Treatment Plant (WWTP) discharge (see C. 1. a. and C. 2. below) (J. Fridell, Service,

Asheville, NC pers. observ. 2008). The other 5 populations of the Appalachian elktoe currently appear to be comprised of scattered individuals restricted to very short stream reaches, and their viability is presently questionable.

The Nolichucky River system population is scattered throughout roughly 111.1 kilometers (km) (69.03 river miles [rm]), Little Tennessee River population 38.5 km (23.9 rm), and Tuckasegee River population 41.6 km (25.8 rm). Accordingly, these 3 populations are likely widely distributed enough that it is unlikely a single event would eliminate one or more of them. The Cheoah River, Pigeon River, Little River, and Mills River populations are restricted to scattered areas of suitable habitat in stream reaches of approximately 5.8 km (3.60 rm), 22.6 km (14.04 rm), 17.8 km (11.1 rm), and 3.2 km (2.0 rm), respectively, making them vulnerable to extirpation from a single catastrophic event, such as a major chemical spill.

2. Three distinct naturally reproduced year classes exist within each of the four populations. One of these year classes must have been produced within the 3 years prior to the time the species is reclassified from endangered to threatened. Within the year prior to the downlisting date, gravid females and the mussel's host fish must be present in each populated river/stream reach.

Evidence of at least three year classes, albeit limited in some of the streams, and gravid females have been documented in all of the surviving populations, with the exception of the Cheoah River population. Also, at least some of the fish species documented in the lab to successfully transform Appalachian elktoe glochidia (larvae) to juveniles have been documented in all areas currently occupied by the species (Fridell pers. observ. 2006 - 2008).

3. Biological and ecological studies have been completed and any required recovery measures developed and implemented from these studies are beginning to show signs of success, as evidenced by an increase in population density and/or an increase in the length of the river reach inhabited by each of the four populations.

Personnel with the Tennessee Technological University at Cookeville, Tennessee, identified the banded sculpin (Cottus carolinae) as a host species for glochidia of the Appalachian elktoe (M. Gordon, Tennessee Technological University, pers. comm., 1993). The Environmental Protection Agency's (EPA) Science and Ecosystem Support Division's Aquatic Lab in Athens, Georgia, documented the mottled sculpin (C. bairdi) as another suitable host for Appalachian elktoe (A. Keller, EPA, Athens, Georgia, pers. comm., 1999). Dr. Jim Layzer (Tennessee Tech University, unpublished data) has also recently identified eight additional species of fish that successfully transformed glochidia (larvae) of Appalachian elktoes into juveniles under laboratory condition.

Biologists with the NCWRC completed a 2-year study to determine the periods of spawning, gravidity, and release of glochidia in the Little Tennessee River population. Results indicate that the Little Tennessee population spawns in late August-mid September and brood larvae overwinter until they are released in late April-mid May (report in progress, Fraley, pers. comm., 2006). NCWRC is also conducting a study of age and growth using dead shell thin-sections, primarily from the Little Tennessee with limited material from the Nolichucky, Pigeon, and Little River populations (data analysis in progress, Fraley pers. comm. 2006). General information on the species habitat requirements have been gathered through observations made during surveys/monitoring activities. However, numerous aspects of the Appalachian elktoes' life history have yet to be studied and remain unknown such as the species' food requirements, mirohabitat requirements of its various life stages, etc.

While no work has been conducted directly with Appalachian elktoe, experiments in captive propagation and culture have been initiated with closely related Brook floater (*Alasmidonta varicosa*) and slippershell (*A. viridis*), which may be considered as surrogates for Appalachian elktoe. In the past, researchers have had little success with captive propagation among species in the genus *Alasmidonta*; however, work in progress by North Carolina State University (NCSU) with cooperation from NCWRC personnel and facilities has shown some progress (Fraley, pers. comm., 2006). Slippershells have been successfully propagated to the juvenile stage and are presently surviving in controlled culture (nearly 5 months since dropping from the fish hosts). In 2005, Brook floater were successfully propagated and grown out for 6 months until a cooling system failure lead to their premature demise (this malfunction actually allowed some insight into the upper limits of water temperature tolerance). The present 2006 cohort is now 2 years old and adequate cooling system back-ups should prevent similar mishaps this year (C. Eads, NCSU pers. comm., 2008). Continued experiments along these lines with both surrogates and directly with Appalachian elktoe may provide valuable insight into the early life history, food requirements, and microhabitat requirements of juveniles, which could then inform habitat monitoring and conservation. Other goals for this line of investigation include developing the capability to produce surplus individuals in a hatchery setting to augment populations when short-term impacts are experienced (e.g. severe flood impacts or chemical spills) and assist in the establishment of new (or augment severely depleted) populations when degraded habitats are restored (e.g. Cheoah River), and to provide surplus individuals for toxicity testing and other threat assessment work (Fraley, pers. comm., 2006).

4. Where habitat has been degraded, noticeable improvements in water and stratum quality have occurred.

Several of the populations of the Appalachian elktoe, including populations in the Little River/French Broad River, Mills River, West Fork Pigeon River/Pigeon River, and Cheoah Rivers, have only recently been discovered and adequate

monitoring to determine overall habitat trends in these streams have not yet been conducted. Also, to date there has not been any formal habitat monitoring or detailed analysis of habitat conditions in any of the streams supporting populations of the Appalachian elktoe other than documenting general habitat conditions present at sites during monitoring surveys of the species.

At the time of listing, suitable mussel habitat in the Nolichucky River system appeared limited due to large quantities of unstable, shifting sand and other sediments from past landuse activities; however, noticeable improvements in the habitat quality in portions of the upper Nolichucky River system were occurring, primarily in reaches of the Nolichucky River, Toe, and North Toe Rivers. The Appalachian elktoes' range and numbers in the upper Nolichucky River system were increasing in response to these habitat improvements. Whether due to improvements in habitat quality or previous lack of adequate surveys (likely a combination of both), known population levels in the South Toe River have risen from non-existent to the highest densities of mussels observed among all sites in the system (NCWRC unpublished data, Fraley and Simmons 2006). However, flooding associated with remnants of hurricanes Frances, Ivan, and Jeanne in September 2004 resulted in scour of stream banks and the stream channel in several areas in the Upper Nolichucky River system, reducing the species' numbers and distribution in portions of this river system (Fraley and Simmons 2006). Also, the Cane River portion of the Nolichucky River system population appears to have been eliminated from approximately 19 miles of the river in 2008, apparently due to toxicants and other water quality issues associated with the Burnsville WWTP (Fridell pers. observ. 2008).

The amount of suitable habitat in the reach of the Little Tennessee River supporting the Appalachian elktoe appears to be declining. This population occurs in the reach of the river between the dam at Lake Emory below the city of Franklin, North Carolina and the backwaters of Fontana Reservoir. The river channel above Lake Emory (above the reach of the river supporting the Appalachian elktoe) carries a very high load of unstable sediments and is devoid of mussels. It is believed that Lake Emory has served in the past as a sediment trap that has helped to protect the integrity of river below the dam at Lake Emory. However, the lake has filled in with sediments and sediment accumulations affecting habitat quality in the river below the lake are becoming increasingly common.

Only limited surveys have been conducted in the Tuckasegee River and habitat trends are not currently available. However, Duke Power currently has plans to remove a small hydroelectric dam, the Dillsboro Dam, as part of a re-licensing agreement, and will be funding detailed monitoring of habitat conditions as part of the dam removal plan.

5. Each of these four populations and their habitats are protected from any present and foreseeable threats that would jeopardize their continued existence.

There has been limited success in meeting this criterion and all surviving populations continue to be threatened by many of the same factors identified at the time of listing as leading to the loss and decline of the species throughout significant portions of its historic range and threats to surviving populations (see the Five Factor Analysis below). We have been and will continue working with state, private, and other federal resource agencies, state and federal regulatory agencies, and local governments and landowners to address threats and improve the status of the species in the streams where it occurs.

Some examples include: we are involved in on-going projects with the Natural Resources Conservation Service and other partners to repair and restore stream banks, riparian buffers, and instream habitats and establish conservation easements on streams supporting the Appalachian elktoe; and we assisted The Nature Conservancy (TNC), NCWRC, and other partners to acquire and preserve approximately 4600 acres of land bordering part of the reach of the Little Tennessee River supporting the Appalachian elktoe and portions of its tributaries. We also are working with Duke Power on a dam removal project on the Tuckasegee River to restore approximately 0.9 mile of river channel currently impounded by the dam, and Tapoco Power Company to improve flows in the reach of the Cheoah River supporting a population of the Appalachian elktoe. We are working with local governments to support landuse plans and establishment of protective ordinances to protect stream habitat. In addition, we are working in cooperation with NCWRC and North Carolina Natural Heritage Program (NCNHP) to support Site Specific Water Quality Planning for Waters that Support Listed Species (pursuant to *North Carolina Procedures for Assignment of Water Quality Standards* Rule 15A NCAC 02B .0110, which became effective August 1, 2000), etc. However, the majority of the surviving populations of the Appalachian elktoe continue to face significant threats associated with development activities, agriculture operations, wastewater discharges, stormwater runoff and non-point source pollutants, etc.

6. All four populations remain stable or increase over a period of 10 to 15 years.

As indicated above, while some of the populations of Appalachian elktoe meet some of the criteria for downlisting, none of the populations meet all of the above criteria. Accordingly this criterion is currently not relevant. However, prior to 2004, the Nolichucky River system, Pigeon River, Little/French Broad River, and Mills River populations of the Appalachian elktoe appeared to be overall increasing in range and numbers and Tuckasegee, Little Tennessee, and Cheoah River populations appeared to be remaining stable or relatively stable. Severe floods in the fall of 2004 adversely affected population levels, in some cases the

range, of all of the surviving populations; a major die-off of Appalachian elktoe was documented to be occurring in the Little Tennessee River in 2005 and appears to be continuing (this population appears to have been reduced by at least 70-80 percent) (Fraley pers. comm. 2006; Fridell pers. observ. 2008); and, the Cane River portion of the Nolichucky River system population appears to have been all but eliminated, apparently due primarily to the discharge of pollutants from the Burnsville WWTP (Fridell pers. observ. 2008).

Note: Appalachian elktoe will be considered for delisting when the above criteria have been met for six populations (as opposed to the four populations necessary for downlisting).

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Nolichucky River system: In the Nolichucky River system, at the time of listing, the Appalachian elktoe was known to be surviving only a few scattered areas of suitable habitat in the Nolichucky River in North Carolina downstream to the vicinity of the city of Erwin, Tennessee, and the Toe River and lower Cane River in North Carolina (Service 1994). Since listing, monitoring surveys conducted by the Service, NCWRC, NC Department of Transportation (NCDOT), Tennessee Valley Authority (TVA), and other researchers have also documented the species in the North Toe River (McGrath 1996, 1999; Service 2002), South Toe River (pers. observ., 1998 and 2000; Fraley pers. comm., 1999; Service 2002), and further up the Cane River (Service 2002) in North Carolina. This represents a significant increase in range and numbers within the Nolichucky River system for this population. However, in September 2004, flooding associated with remnants of hurricanes Frances, Ivan, and Jeanne resulted in stream bank erosion and stream channel scour in several areas in the upper Nolichucky River system, significantly reducing the species' numbers and distribution at several sites throughout this river system (Fraley and Simmons 2006). Fraley and Simmons (2006) reported decreases in numbers of the Appalachian elktoe at nearly all of the sites they surveyed. They also reported that they failed to detect the Appalachian elktoe in the Cane and South Toe Rivers at sites that represented the upstream limit of their distribution prior to flooding; however, they noted that only a single individual had been found at each of these sites during previous surveys and these individuals may have been lost or may have not been detected during the post-flood surveys. Also, in April 2008 the Catena Group reported an on-going fish kill in the Cane River below the Burnsville WWTP (Savidge pers. comm. 2008). Available evidence indicates that the WWTP had been experiencing problems with their treatment tank and had been discharging

untreated wastewater into the river since at least March 2008 (Roy Davis, NC Division of Water Quality, Asheville, NC pers. comm. 2008). Follow-up surveys by biologists with the Service, NCWRC, and the Catena failed to find any live mussels in the river for approximately 19 miles below the WWTP discharge – only 7 live Appalachian elktoes were found in the river near the confluence of the Cane and Toe Rivers (Fraley pers. comm. 2008) and 2 live Appalachian elktoes were recorded in the river immediately above the WWTP discharge (Fridell pers. observ. 2008).

Little Tennessee River population: The Little Tennessee River population occupies the reach of the river between the dam at Lake Emory below the city of Franklin, North Carolina and the backwaters of Fontana Reservoir, North Carolina (Service 1994, 1996, 2002; McGrath 1999). Up and down stream expansion of this population is prevented by these reservoirs. At the time of listing and until just recently, this had been considered the healthiest population of the Appalachian elktoe in terms of overall numbers, number of year classes represented, quality of habitat, etc. However, recent surveys conducted by biologists with the NCWRC have documented a substantial decline in the numbers of Appalachian elktoes at several sites scattered throughout the occupied reach of the river (Fraley, pers. comm., 2006). The cause(s) of this decline is(are) presently unknown, but the decline appears to be continuing; several weak/dying Appalachian elktoes were observed in the river during monitoring surveys for the spotfin chub (*Erimonax monachus*) by the NCWRC, Conservation Fisheries Inc., and the Service in the spring of 2008 (Fridell pers. observ. 2008). Also in 2004, hundreds of Appalachian elktoes and other mussel species were found dead in a short reach of the river immediately below the dam at Lake Emory (M. Cantrell, Service, Asheville, NC pers. comm. 2004). The cause of this kill is unknown but a local resident reported smelling a strong chlorine odor in the area the day before the kill was discovered.

A large portion (approximately 4600 acres) of the land bordering the reach of the Little Tennessee River supporting Appalachian elktoe was purchased through a cooperative effort by the Little Tennessee River Watershed Association, NCWRC, NC Clean Water Management Trust Fund, TNC, Service, and other conservation organizations and has been turned over to the NCWRC to manage. However, tributary headwaters and a long reach of the Little Tennessee River above Lake Emory are almost entirely in private ownership and sedimentation from development and other land disturbing activities, and possibly other pollutants from wastewater and stormwater discharges, continue to adversely affect the habitat and water quality in the protected reach of the river.

Tuckasegee River population: Prior to listing, surveys in the Tuckasegee River system failed to detect the presence of the Appalachian elktoe; this population was first discovered in 1996 (Cantrell pers. comm. 1996). This population occurs in scattered areas of suitable habitat from below the town of Cullowhee, North Carolina downstream to Bryson City, North Carolina; (Fridell pers. observ. 1996,

1997; McGrath 1998; Savidge pers. comm. 2001; Fraley 2002). Upstream expansion of this population is restricted by coldwater discharges and peaking operations from hydropower facilities in the headwaters of the Tuckasegee River and by the Bryson Dam on the Oconaluftee River which presents a physical barrier a short distance upriver from the confluence of the Oconaluftee River with the Tuckasegee River (Fraley 2002). Adequate surveys for determining population trends have not yet been conducted for the Tuckasegee River population but the limited work that has been conducted indicates this population has remained stable or increased in numbers since its discovery. In addition, through a relicensing agreement with the Federal Energy Regulatory Commission and Duke Power, the Service is working with Duke Power on plans for the removal of a small hydroelectric dam located on the Tuckasegee River in the city limits of Dillsboro, North Carolina. The dam currently divides this population of the Appalachian elktoe and will hopefully result in the eventual reestablishment of the species in an approximately 0.9 mile reach of the river currently impounded by the dam.

Cheoah River population: A single live individual and one shell of the Appalachian elktoe was discovered in the Cheoah River, North Carolina, below Santeetlah Dam in 2000 (W. Pennington, Pennington and Associates, Inc., Cookeville, Tennessee, pers. comm. 2000). Subsequent surveys in 2002, 2003, and 2004 by biologists with the NCDOT, NCWRC, US Forest Service, the Service, and others recorded additional live individuals from the river below Santeetlah Dam, but less than 20 in each survey (Savidge pers. comm., 2002; Fridell pers. observ. 2002; Cantrell pers. comm., 2005). Upstream expansion of this population is blocked by Santeetlah Dam and downstream expansion by a series of impoundments on the Little Tennessee River (including Calderwood Reservoir at the mouth of the Cheoah River). Water from Santeetlah Reservoir is piped (bypassed) downstream to a power house located near the confluence of the Cheoah River with the Little Tennessee River. Suitable Appalachian elktoe habitat in this bypassed reach of the Cheoah appears to be limited by the reduced/altered flows and unsuitable substrate – in most areas of the bypassed reach the substrate is comprised primarily of cobble, boulder, and bedrock, substrates too large for the elktoe. As a result, this population appears to be very small and restricted primarily to 2 short reaches of the river, though additional surveys may turn up other sites in the river supporting the species. Through a recent relicensing agreement, Tapoco Power Company has agreed to maintain minimum flows from the dam that closely approximate flows in the river prior to construction of the dam and to add coarse sand and gravel to the river channel below the dam to help improve the quality of the substrate. It will likely be several years before it can be determined how successful these measures will be in improving Appalachian elktoe habitat in the river.

Pigeon River system population: In the Pigeon River system in North Carolina, a small population of the Appalachian elktoe occurs at scattered sites in a short reach of the Pigeon River from Canton, North Carolina upstream to the

confluence of the West and East Fork Pigeon Rivers, and upstream in the West Fork Pigeon River to approximately 3.2 km (2.0 rm) downstream of the confluence of the Little East Fork River (Fridell pers. observ. , 1999; McGrath 1999; Service 2002; Fraley and Simmons 2006). Additional monitoring of this population is needed to determine long-term population trends.

Little River/French Broad River population: The Little River population was discovered in 2000 (Fridell pers. observ. , 2000), and is restricted to the reach of the river below the powerhouse at Cascade Lake and a reach of the French Broad River downstream of the mouth of the Little River (Fraley pers. comm., 2005). Additional monitoring surveys are needed to determine long-term population trends but the limited work that has been conducted indicates that this population has remained stable since it was first discovered.

Mills River population: The Mills River population was discovered in 2003 (T. Savidge, The Catena Group, pers. comm., 2003). In Mills River, the Appalachian elktoe occurs in a short reach of the river from just above the Highway 280 Bridge to about 1.6 km (1 rm) below the bridge (J. Simmons, NCWRC, pers. comm., 2004). This appears to be a small population, occurring only at scattered locations within this river reach. One of the sites previously supporting the species was recently disturbed by a trenched sewerline crossing of the river (the species was relocated from this site prior to the construction). Several sites within the occupied reach were destabilized by the floods of September 2004, requiring removal of the species from the general areas to allow for instream restoration activities necessary to repair the storm damage. Additional monitoring is needed to determine long-term population trends.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

No information is currently known concerning population genetics. However, tissue samples from throughout the known distribution of all extant populations sufficient to assess intra- and inter-population genetic variation were collected during 2004 and 2005 and are presently stored in deep freeze (Fraley pers. comm., 2005). To date, funding to support completion of laboratory analyses has not been obtained.

c.Taxonomic classification or changes in nomenclature:

There has been no change in the classification or nomenclature of this species.

d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The currently known populations of the Appalachian elktoe are only remnants within this species' historical range and exist as fragmented and, for the most part, separate entities (there is a potential that there may be some genetic interchange between the Little River and Mills River populations and the between the Little Tennessee River and Tuckasegee River populations but genetic studies are needed to confirm this). All of the surviving populations are separated from one another by major impoundments and/or apparently unsuitable habitat.

e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

The Appalachian elktoe has been reported from relatively shallow, medium-sized creeks and rivers with cool, clean, well-oxygenated, moderate- to fast-flowing water. The species is most often found in riffles, runs, and shallow flowing pools with stable, relatively silt-free, coarse sand and gravel substrate associated with cobble, boulders, and/or bedrock (Gordon 1991; Service 1994, 1996, 2002; J. Alderman, formerly with NCWRC, pers. comm., 2000; McGrath pers. comm., 2000; Savidge pers. comm., 2000; Fridell pers. observ., 1989 through 2004). Stability of the substrate appears to be critical to the Appalachian elktoe, and the species is seldom found in stream reaches with accumulations of silt or shifting sand, gravel, or cobble (Fridell, pers. observ. 1989 through 2001; Fraley and Simmons 2006). Individual specimens that have been encountered in these areas are believed to have been scoured out of upstream areas during periods of heavy rain and have not been found during subsequent surveys (McGrath pers. comm. 1996; Fridell pers. observ. 1995, 1996, 1999).

Suitable habitat in the majority of streams where the species survives is limited – the majority of the surviving populations are comprised of scattered occurrences of the species, restricted to pockets or short reaches of suitable habitat. Large reaches of many of the streams supporting the species have been degraded by past and/or on-going land disturbance activities and alterations to natural flow and temperature regimes. In many instances, habitat for the mussels has been degraded and is marginal or unsuitable. Although there have been noticeable improvements in habitat quality in recent years in some areas supporting the species, particularly in portions of the Nolichucky River system, most of the watersheds of the rivers supporting the Appalachian elktoe are experiencing or are threatened with a significant increase in residential and industrial development. Without adequate regulations or other forms of protection in place, habitat and water quality in many of these rivers is expected to decline.

2. Five-Factor Analysis

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

The Service's 1994 listing of the Appalachian elktoe as endangered, 1996 recovery plan for the species, and 2002 rule designating critical habitat for the Appalachian elktoe identify several factors as leading to loss and decline of the species throughout a significant portion of its historic range and significant threats to the species' continued existence including; habitat loss and alteration associated with impoundments, channelization, mining, and dredging operations; pollutants in wastewater discharges (sewage treatment plants and industrial discharges); and, run-off of silt, fertilizers, pesticides, and other pollutants from land disturbance activities implemented without adequate measures to control erosion and storm water runoff. Many of these same factors continue to threaten the surviving populations of Appalachian elktoe.

Impoundments scattered throughout the upper Tennessee River system continue to fragment and isolate all of the surviving populations from one another. Both upstream and downstream expansion of the Tuckasegee, Little Tennessee, and Cheoah River populations are prohibited by dams and impoundments, and in the case of the Tuckasegee River, by peaking operations and cold discharge from operation of hydroelectric dams in the river's headwaters. On-going instream and floodplain rock and cobble mining are affecting habitat stability and quality in portions of the Cane River and West Fork Pigeon Rivers.

With the exception of land surrounding the Cheoah River population and a large portion of land adjacent to the Little Tennessee River population, the watersheds of all of the streams supporting populations of the Appalachian elktoe are almost entirely in private ownership and their watersheds are experiencing a significant increase in residential and industrial development (with exception of a few private in-holdings, the reach of the Cheoah River supporting the Appalachian elktoe is surrounded by the Nantahala National Forest and a large tract of land adjacent to a portion of the Little Tennessee River population was recently acquired and is now owned and managed by the NCWRC; however, most tributaries and the river's upper reaches and headwaters are primarily privately owned and unprotected). Although there have been improvements in protecting and restoring riparian buffers and instream habitat in portions of the watersheds of some these streams (through federal and state programs), private forestry, agriculture, and development activities continue to result in the narrowing and loss of riparian buffers and streambank vegetation, and an increase in the runoff of non-point source pollutants in many areas throughout the watersheds of these streams. A reach of the lower the Cane River (~3.5 rm), including part of the occupied reach of the river; a reach of the North Toe River (~11.3 rm), including all of the occupied reach; and the entire length of Jacks Creek (~8.5 rm), a tributary to the occupied reach of the Toe River, were both recently added by the North Carolina Division of Water Quality (NCDWQ) to North Carolina's list of impaired streams [303(d) list]. The Cane River was added because of turbidity standard violations, the North Toe River because of violations of the turbidity standard and impaired biological integrity and Jacks Creek because of impaired biological integrity. Non-point source runoff of silt/sediments is identified as the most likely cause of

impairment of the reaches of the Cane and North Toe Rivers; the cause(s) of impairment of Jack's Creek is (was) not yet identified by NCDWQ.

Also, point source discharges continue to pose a substantial threat to the several surviving populations. The majority of streams supporting populations of the Appalachian elktoe do have adequate designations for protecting occupied reaches from pollutants associated with new or expanded wastewater discharges. In 2008, problems with the effluent from the Burnsville WWTP on the Cane River were implicated as resulting in the kill and loss of the Appalachian elktoe from approximately 19 miles of the river (Fridell pers. observ. 2008). The NCDWQ recently permitted a new wastewater discharge into occupied habitat on the South Toe River; expansion of two wastewater discharges into occupied habitat on the Tuckasegee River (one of which is currently operating in violation of their discharge standards); and, expansion of wastewater discharges short distances above occupied habitat on the Little Tennessee and French Broad Rivers (the discharge from the wastewater treatment plant on the Little Tennessee River discharges into the river at Lake Emory immediately above occupied habitat; this plant expanded its discharge in 1999 and has recently requested a modification of their permit to more than double their current permitted level of discharge).

Biologists with the NCWRC, NCNHP, and the Service have been and will continue to work with the NCDWQ in the development of "Site Specific Management Plans" for the watersheds of streams supporting federally listed aquatic species, including plans for the streams supporting the Appalachian elktoe that will hopefully at some point in the future help to protect these streams from additional point and non-point sources of pollution; however, it will likely be several years before these plans are drafted, finalized, and regulations necessary for implementation of the plans are adopted by the state. The North Carolina Division Of Water Quality is presently in violation of *North Carolina Procedures for Assignment of Water Quality Standards* Rule 15A NCAC 02B .0110 Rule, which authorized the "Site Specific Management Plans." The Rule states that "…plans shall be developed within the basinwide planning schedule with all plans completed at the end of each watershed's first complete five year cycle following adoption of the Rule." The Rule became effective August 1, 2000, and one full five-year planning cycle has since occurred for the French Broad River Basin without adoption of a plan or even development of a draft plan. The first full five-year cycle for the Little Tennessee River Basin expired in 2007 and draft plan has not yet been developed for this basin.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

The overutilization for commercial, recreational, scientific or educational purposes was not specifically considered to be a limiting factor in 1994 when the species was listed as endangered or in the Recovery Plan. We have no new information to indicate that this has changed.

c. Disease or predation:

Although no specific information was available at the time of listing concerning the degree to which disease and predation posed a threat to the species, both disease and predation were identified as potential threats. The same is still true. The Little Tennessee River population appears to be in significant decline – several individuals have been found dead or dying, and many surviving individuals are in poor condition (Fraley pers. comm., 2006; Fridell pers. observ.2007 and 2008). Disease has been suggested as a possible cause of this decline though limited preliminary analysis of dead and moribund specimens by researchers at the U.S. Geological Survey's National Fish Health Laboratory in Leetown, West Virginia was unsuccessful in confirming the cause (Clifford Starlipper, USGS, pers. comm., 2006). We are currently working with the NCWRC and NC State University Veterinary College to try and identify the cause(s).

Predation is not thought to be a significant threat to a healthy mussel population, but could, as suggested by Neves and Odum (1989), contribute to the local extirpation of populations already depleted by other factors.

d. Inadequacy of existing regulatory mechanisms:

The Appalachian elktoe is listed as endangered by both the states of North Carolina and Tennessee. Though this designation prohibits the collection of the species without a valid state collecting permit, it does not provide any protection to the species from other forms of take, or offer any regulatory protection to its habitat.

Many of the activities that pose a significant threat to the surviving populations of the Appalachian elktoe and its habitat are not subject to the regulations of section 7 of the Endangered Species Act (Act) (i.e., they do not have any federal involvement – no federal permits, authorization, or funding associated with the activity – and therefore no requirement for consultation with the Service if they may adversely affect federally-listed species). Accordingly, most of these activities occur without any coordination with the Service and are reviewed and regulated, if any review/regulation takes place, only by state and local regulatory agencies/governments for compliance with any applicable state and local regulations/ordinances[1]. Neither of the states nor the local governments with jurisdictions within the watersheds of streams supporting populations of the Appalachian elktoe currently have regulations/ordinances that are adequate to

[1] Unless it can be proven: (1) in a federal court of law that violation of section 9 of the Act, which prohibits the "take" of federally listed species, or other federal regulation, has occurred as a result of the activity; or, (2) that violation of section 9 will occur and a permit pursuant to section 10(a)(1)(B) of the Act is required. However, under the former scenario impact(s) to the species has (have) already occurred or is(are) occurring, and the later requires notification of the Service of the impending activity.

protect the species from the effects of residential and commercial development activities; private, county, and state road construction, maintenance, and runoff; agriculture and forestry activities, etc. (e.g., loss of riparian buffers, adequate stormwater controls to protect the stream hydrographs and to control non-point source pollution, etc.). Accordingly, many of the activities occurring in the watersheds of streams supporting the Appalachian elktoe continue to impact or contribute to impacts to the species and/or limit the species recovery; or, pose a significant threat to the species and its recovery.

Also, while we have had success through section 7 of the Act in eliminating or reducing impacts to the Appalachian elktoe and its habitat from some federal activities (activities subject to section 7 of the Act – activities authorized/permitted, funded, or carried out by federal agencies), we have not been successful in eliminating all of the adverse effects from all of these activities. Several of these activities have adversely affected the species, at least in the short-term, and/or affected or are limiting recovery[2].

e. Other natural or manmade factors affecting its continued existence:

The genetic viability of the surviving populations remains a concern. All of the remaining populations of the Appalachian elktoe appear to be effectively isolated from one another by impoundments and several of these populations may be below the level required to maintain long-term genetic viability.

D. Synthesis

Although there has been documented expansion of the Nolichucky River system population and discoveries of additional populations of the Appalachian elktoe since the species was listed as endangered in 1994, the species continues to have a very fragmented relict distribution. The surviving populations are mostly small isolated fragments of what likely were once widely dispersed populations. Although the complete historical range of the Appalachian elktoe is unknown, available information suggests that the species once lived in the majority of the rivers and larger creeks of the upper Tennessee River system in North Carolina, with the possible exception of the Hiwassee and Watauga River systems (the species has not been recorded from either of these river systems). Of the seven surviving populations, five – Little River/French Broad River, Mills River, West Fork Pigeon River/Pigeon River, Little Tennessee River, and Cheoah River populations – are restricted to scattered areas of suitable habitat in short stream reaches and their genetic viability is of concern. Two of the populations, previously considered the healthiest of the surviving populations – Little Tennessee River and Nolichucky River populations – appear to have declined in number in recent years, though the present status of Appalachian elktoe in the Nolichucky River system is still better than what it was at

[2] Section 7 (a)(2) of the Act requires federal agencies to ensure that their activities do not "jeopardize the continued existence" of federally-listed species or "destroy or adversely modify designated critical habitat"; however, it does not prohibit federal activities that adversely affect the species, its habitat, or designated critical habitat if these affects fall below the jeopardy and/or destruction/adverse modification of critical habitat thresholds.

the time of listing. Continued monitoring is needed to assess these potential trends. Additional surveys are also needed to determine population trends for the seventh population in the Tuckasegee River population. All of the surviving populations continue to be threatened by many of the same factors identified at the time of listing as leading to the loss and decline of the species throughout significant portions of its historic range and threats to surviving populations, including habitat fragmentation, loss, and alteration resulting from impoundments, operation of hydroelectric dams, instream mining, wastewater discharges, and the runoff of silt and other pollutants from ground disturbance activities. In view of the above, the Service believes this mussel continues to meet the definition of endangered.

III. RESULTS

A. Recommended Classification:

__X__ No change is needed

B. New Recovery Priority Number __5C___

Although adverse effects associated with development activities were identified as threats to the Appalachian elktoe when the species was listed in 1994, threats to water and habitat quality associated with residential, commercial, and other economic development activities have increased substantially. Development activities, which lead to increased wastewater discharges, loss of upland forest and riparian forest buffers, soil erosion, runoff of pollutants, etc., are increasing significantly in all of the watersheds of streams supporting the Appalachian elktoe, with the current exception of the Cheoah River population. Increasing land prices associated with infrastructure improvements/expansions leading to on-going and anticipated developments are making it increasingly difficult for the Service and our partners to purchase or obtain voluntary buffers, conservation easements, etc. Many landowners are unwilling to implement measures they fear may affect the development potential or the value of the lands and local governments are unwilling to implement buffer and stormwater control regulations/ordinances necessary for protecting populations of the Appalachian elktoe from the effects of development because of perceived economic impacts and private property rights issues.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Improve planning, coordination, and efficacy of recovery activities with key partners (e.g., NCWRC, NCDWQ, NRCS, TVA, local governments, local conservation NGOs, researchers, etc.) by meeting at least annually to share information and review and recommend priority recovery actions.
2. Continue working with state and local governments to implement protective regulations/ordinances for addressing the impacts and threats from development

and other land disturbance activities. One of the highest priorities is to continue to work closely with NCDWQ and other state and local partners to develop, encourage public support for, and effectively implement site specific water quality management strategies to protect listed species in the Little Tennessee and French Broad river basins as required by *North Carolina Procedures for Assignment of Water Quality Standards* Rule 15A NCAC 02B .0110.

3. Formalize a detailed population and habitat monitoring plan for all surviving populations.
4. Continue analyzing threats to the species and measures for off-setting these threats; conduct studies to determine the extent and cause of the recent decline of the Little Tennessee River population and measures necessary for stabilizing and recovering this population; determine species specific vulnerability to commonly discharged wastes (e.g. ammonia, chlorine) for which present discharge limits may not be protective of mussels.
5. Fund or seek funding for analysis of existing samples to determine intra- and inter-population genetics. This information is necessary to estimate the relative viability of populations, to provide guidance for augmentation and reintroduction efforts, and inform other potential management actions.
6. Continue habitat, life history, and captive propagation studies aimed at specific conservation applications, including: water temperature tolerances and optimal range; instream flow requirements and specific impacts from altered flow regimes; support continued controlled propagation experiments with congeneric surrogates and permit work directly with Appalachian elktoe.
7. Develop a population augmentation plan for the Cheoah River population and evaluate necessity for augmentation of other populations.
8. Continue working with partners to establish conservation easements and restore forested buffers and instream habitat.

V. REFERENCES

Fraley, S.J. 2002. Mussel surveys associated with Duke Power Nantahala Area projects in the Little Tennessee and Hiwassee river systems. Prepared for Duke Power Engineering & Services, Charlotte, NC. Tennessee Valley Authority, Resource Stewardship, Norris, TN. 37p.

Fraley, S.J. and J.W. Simmons. 2006. An assessment of rare mussel populations in western North Carolina following extraordinary floods of September 2004. Unpublished report, North Carolina Wildlife Resources Commission. 26pp and appendices 1 and 2.

Gordon, M. E. 1991. Species account for the Appalachian elktoe (Alasmidonta raveneliana). Unpublished report to The Nature Conservancy. 5 pp.

McGrath, C. 1996. Mountain Aquatic Survey. Pages 22 - 26 *in* Annual Performance Report Vol. V, July 1995 - June 1996, Nongame and Endangered Wildlife Program, North Carolina Wildlife Resources Commission. 185 pp.

McGrath, C. 1998. Mountain Aquatic Survey. Pages 12 - 16 *in* Annual Performance Report Vol. VII, July 1997 - June 1998, Nongame and Endangered Wildlife Program, North Carolina Wildlife Resources Commission. 184 pp.

McGrath, C. 1999. Mountain Aquatic Survey. Pages 28 - 36 *in* Annual Performance Report Vol. VIII, July 1998 - June 1999, Nongame and Endangered Wildlife Program, North Carolina Wildlife Resources Commission. 225 pp.

Neves, R. J., and M. C. Odum. 1989. Muskrat predation on endangered freshwater mussels in Virginia. Journal of Wildlife Management 53(4):939-940.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; Appalachian elktoe determined to be an endangered species. Federal Register 59(225):60324-60334.

U.S. Fish and Wildlife Service. 1996. Recovery plan for the Appalachian elktoe (*Alasmidonta raveneliana*) Lea. U.S. Fish and Wildlife Service, Atlanta, Ga. 31 pp.

Peer Reviewers:

Steve Fraley, Aquatic Wildlife Diversity Coordinator, Western Region, North Carolina Wildlife Resources Commission

Dr. Arthur Bogan, Curator of Aquatic Invertebrates, North Carolina Museum of Natural Sciences, Raleigh, North Carolina

Steve Ahlstedt, retired US Geological Survey, Norris, Tennessee; Telephone
Tim Savidge, The Catena Group, Raleigh, North Carolina

Stephanie Chance, Aquatic Biologist, Regional Natural Heritage Project, Tennessee Valley Authority, Knoxville, Tennessee

Angie Rodgers, Aquatic Ecologist, North Carolina Natural Heritage Program, Weaverville, North Carolina

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Appalachian elktoe

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

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

Review Conducted By: John Fridell, Asheville Field Office, NC

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 2/19/09

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 3/3/09

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. If a change in classification is recommended, written concurrence from other regions is required.

APPENDIX A: Summary of peer review for the 5-year review of the Appalachian elktoe

Reviewers: A list of peer reviewers is provided on above on page 20

A. Peer Review Method: A draft 5-year review of the Appalachian elktoe was sent to each of the reviewers, as an attachment to an email, requesting their review and any other changes or additions that should be included in the document. All 5 reviewers have extensive knowledge of this and/or similar species.

B. Peer Review Charge: Reviewers were charged with providing a review of the document including any other comments and/or additions appropriate to include. Reviewers were not asked to comment on the legal status of the species.

C. Summary of Peer Review Comments/Report: Reviewers responded by email. All reviewers agreed that the species should remain classified as endangered and thought the information in the document provided to them was accurate. They did provide some additional references and recommendations that were incorporated into the 5-year review as appropriate.

D. Response to Peer Review: Recommendations from the reviewers were incorporated into the document as appropriate. These consisted primarily of additional information concerning the status of certain populations, threats to the species, and recommendations for future actions.