

**MUSSEL
SURVEYS IN
THE VICINITY OF THE LEE
NUCLEAR STATION,
CHEROKEE COUNTY
CO., SC**

Prepared for

**Duke Power Company
Charlotte, NC**

by

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29 September 2006

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Introduction

The Broad River originates on the eastern side of the Blue Ridge Mountains in western North Carolina and flows south into the Piedmont of South Carolina where it joins the Saluda River at Columbia, South Carolina, to form the Congaree River. The Broad River in the Lee Nuclear Station study area is generally wide and shallow and carries a large bedload consisting chiefly of sand. The section of the Broad River that brackets the study area (i.e., upstream of the 99-Islands Reservoir and below the 99-Islands Dam) is characterized by bedrock riffles alternating with pools. The reservoir proper has a surface area of approximately 70 ha (175 acres) and is characterized by the main channel of the Broad River flowing through the center of the reservoir with fairly strong current and then two associated major backwater areas that are very shallow. (Duke Power Company, 1978).

The objective of this study was to conduct a field survey of mussels at sites in and around the Lee Nuclear Station project area in Cherokee County, SC. Historically, little is known about freshwater mussel diversity and abundances with the Broad River in South Carolina and North Carolina. Each survey was designed to provide basic information concerning the occurrence of mussels, with special emphasis on protected, endangered, threatened, and special concern species that might be in the area.

Methods

A total of eleven sites upstream, within, and below the project area were surveyed for freshwater mussels. Duke Energy contracted with Alderman Environmental Services to complete the mussel surveys. Specific locales within each sampling sites were selected based upon John Alderman's understanding of various mussel species' microhabitat needs (Figure 1). Habitat descriptions for each surveyed area are provided in the Appendix. SCUBA, snorkeling, and batiscope were used to conduct timed surveys. From 3 to 5 biologists were involved with each survey.

- Batiscope or snorkeling – In clear to slightly turbid waters up to waist deep, or in waters with wind-disturbed surfaces, a batiscope or snorkeling is used to visually survey an area for live mussels and shells.
- SCUBA – In areas with depths up to 9 m, 2 biologists maintain their positions above the substrate to facilitate surveys for live mussels and shells.

Unless otherwise noted, all live mussels were collected, length measured (mm), and returned to appropriate locations from which they were removed.

Results

Four freshwater mussel species were documented as extant within the areas surveyed. In nearly 14 hours of mussel survey time the eastern elliptio (*Elliptio complanata*) and Carolina lance (*Elliptio angustata*) were represented by only single live captures of each species while the paper pondshell (*Utterbackia imbecillis*), and eastern floater (*Pyganodon cataracta*) were much more common. It is worth noting that only the eastern elliptio and the Carolina lance were collected in the Broad River proper while the paper pondshell and the Eastern floater were found exclusively in on-site project ponds.

Description, Distribution, Habitat Preferences, Life History, and Status

Based upon knowledge of presently occupied habitats, most Atlantic Slope freshwater mussel species now occupy only a fraction of the stream miles populated during past centuries. Through various land and water uses, many local populations have been extirpated, abundances have declined, and extant populations have been isolated.

Most Atlantic Slope freshwater mussel species (filter feeding bivalves) live for 10 or more years. They have very complex life histories. Most freshwater mussel species are dioecious. (A few species are known hermaphrodites.) Males release sperm into the water column which is siphoned in by the females. Fertilized eggs mature into parasitic young, known as glochidia, in the gills of the female. Under appropriate conditions, the glochidia are released from the females and parasitize the gills and fins of an appropriate fish host where the glochidia mature into juvenile mussels. (A few mussel species undergo direct transformation of glochidia into juveniles within the gills of the females,

thus eliminating the need for a host fish.) Depending upon the life history characteristics of the fish host, the young mussels may be transported over short or long distances. After a period of time on the fish, the juvenile mussels fall off and settle onto available substrates. Juvenile mussels less than 20 mm in length are rarely seen on the stream/lake bottom. It appears that as mussels mature they spend more of their time at the surface of the substrate; however, even as adults, mussels may often burrow within the substrates. The amount of time juveniles or adults spend at the surface may be a function of needs associated with pedal (foot) and/or filter feeding, reproduction, water temperature, or other habitat parameters. Although much has been learned about the life histories of some species, specific data for most Atlantic Slope species are lacking.

The pages that follow provide information on the description, distribution, and life history of the 4 mussel species collected during this survey. These species accounts and photographs are provided as background information as well as listing the results of the surveys. A glossary and diagrams of mussels are provided on pages 14 - 18 to help the reader with terminology.

Eastern elliptio
***Elliptio complanata* (Lightfoot, 1786)**



Description – Nearly 100 species have been synonymized under *E. complanata* (Johnson 1970). This is a highly variable species (or species complex). The most consistent characteristic for the shell is having a straight to arcuate ventral margin. Pseudocardinal teeth, color of periostracum and nacre, shagginess and smoothness of periostracum, presence of rays, sharpness of posterior ridge, extent of shell inflation, extent of dorsal “wings,” and other shell characteristics vary within and among river basins.

Distribution – The eastern elliptio is widely distributed from the Apalachicola River Basin, throughout the Atlantic Slope, St. Lawrence, and within the Interior Basin to Lake Superior (Johnson 1970). On the Atlantic Slope (including North and South Carolina), this is a relatively common species found in the Mountains, Piedmont, and Coastal Plain.

Although considered a common species, eastern elliptio populations have been extirpated or have declined in many habitats throughout its range.

During the current survey, very limited evidence of an extant *Elliptio complanata* population was found. In nearly fourteen hours of total mussel survey time only one live individual was found and that was in the 99 Islands Tailrace.

Habitat Preferences – This species is found in a great diversity of lotic habitats and, occasionally, may be common in ponds and lakes. The best populations are associated with landscapes dominated by properly managed woodlands and waters of excellent quality.

Life History – Female eastern elliptio are gravid during the early spring through early summer each year. Nothing is known about potential fish hosts for the species in South Carolina.

Status – The eastern elliptio is not a protected species in South Carolina (i.e., state listed endangered, threatened, or special concern).

Carolina lance
***Elliptio angustata* (L. Lea, 1831)**



Description – Johnson (1970) synonymized *E. angustata* under *E. lanceolata*; however, *E. angustata* is now recognized as a distinct species by the scientific community. As with the other elliptios, *E. angustata* is highly variable in terms of length/height ratios, length/width ratios, and color. In general, *E. angustata* individuals are more than twice as long as tall (some over 3 times as long as tall), and they have straight to arcuate ventral margins.

Distribution – Based upon current taxonomic understandings, the Carolina lance occurs along the Atlantic Slope from the Altamaha River Basin in Georgia up through the Cape Fear River Basin in North Carolina. It is found in the Mountains, Piedmont, and Coastal Plain of North and South Carolina. This species has been extirpated from many habitats throughout its range.

During the current survey, limited evidence of extant *Elliptio angustata* populations was found. Only a single shell was found in both the Cherokee Falls Tailwater and the 99 Islands Reservoir and in the 99 Islands Tailrace a lone live specimen was collected.

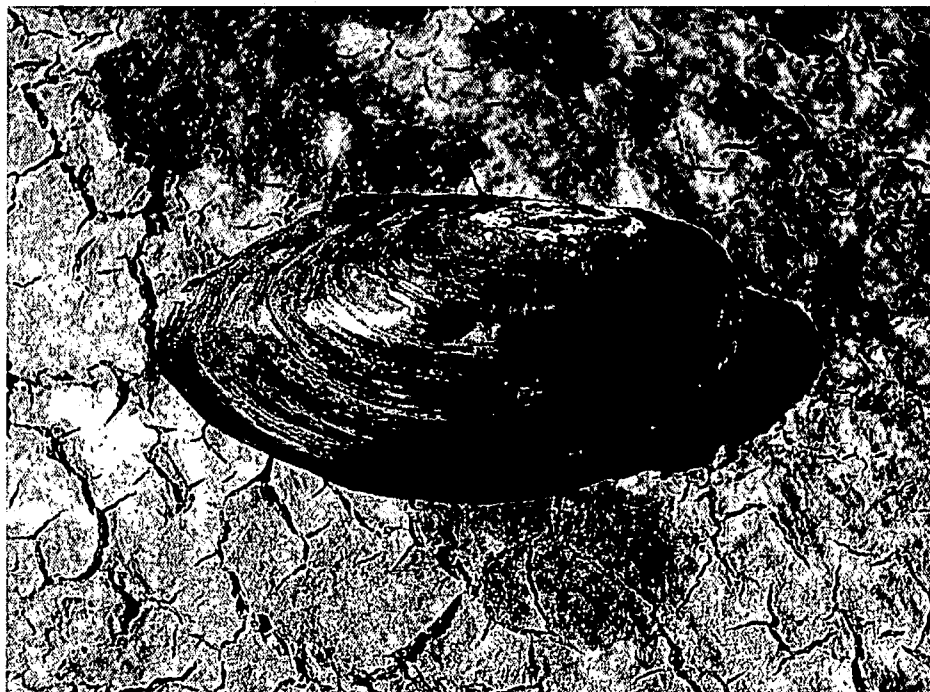
Habitat Preferences – This species is found in a great diversity of lotic habitats and is occasionally found in lakes or reservoirs.

Life History – Female Carolina lance are gravid during the early spring through early summer each year. Nothing is known about potential fish hosts for the species.

Status – The Carolina lance is not currently a protected species in South Carolina (i.e., state listed endangered, threatened, or special concern).

Paper pondshell

***Utterbackia imbecillis* (Say, 1829)**



Description – *U. imbecillis* is a thin shelled, toothless freshwater mussel. Umbos do not extend above the hinge line.

Distribution – The paper pondshell occurs throughout much of the Mississippi River Basin and along the Atlantic Slope up through the Gunpowder River Basin in Maryland (Johnson 1970). Although uncommon in many areas of the Piedmont and Coastal Plain of North and South Carolina, this species may become abundant in some lentic habitats, such as lakes and ponds.

During the current survey, evidence of an extant *Utterbackia imbecillis* population was found in the Sedimentation Basin. Additionally, this species was also found by Duke

Power personnel in shell collections from 2 containment ponds (now dry) on 5 January 2006.

Habitat Preferences – The paper pondshell is usually found in various lentic habitats, including ponds, lakes, and reservoirs and in lotic habitats in close proximity to such lentic habitats.

Life History – The paper pondshell is gravid from late summer of one year through the late spring or early summer of the following year. Numerous species of fish and possibly some amphibian species may serve as glochidial hosts (summary provided by Bogan 2002).

Status – The paper pondshell is a protected species in South Carolina; listed as a Species of Concern (http://www.dnr.sc.gov/pls/heritage/county_species.list?pcounty=all).

Eastern floater
***Pyganodon cataracta* (Say, 1817)**



Description – *P. cataracta* is a large, thin shelled, toothless freshwater mussel. Umbos extend well above the hinge line.

Distribution – The eastern floater occurs from the Alabama-Coosa River Basin then eastward to and up the Atlantic Slope and into the St. Lawrence River Basin and westward into the Interior Basin to Michigan (Johnson 1970). This common species is found in many Piedmont and Coastal Plain habitats of North and South Carolina.

During the current survey, evidence of a significant extant *P. cataracta* population was found in the Sedimentation Basin, with over 50 live specimens and assorted shells collected, and also several live specimens and several shells were found in the Low Flow

Reservoir. Additionally, this species was also found by Duke Power personnel in shell collections from 2 containment ponds (now dry) on 5 January 2006. They also found shells of the species within the Sedimentation Basin and Low Flow Reservoir on 21 February 2006.

Habitat Preferences – The eastern floater is found in various lentic habitats, including ponds, lakes, and reservoirs and in lotic habitats near ponds, lakes, and reservoirs.

Life History – The eastern floater is gravid from late summer of one year through the late spring or early summer of the following year. Several potential glochidial fish hosts have been identified, including bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and yellow perch (*Perca flavescens*) (Bogan and Alderman 2004).

Status – The eastern floater is not a protected species in South Carolina (i.e., state listed endangered, threatened, or special concern).

Discussion

Twelve freshwater mussel species are known from the Broad River Basin in North and South Carolina (Table 1). In addition to these species, other taxa are found in nearby waters of the greater Santee-Cooper River Basin, including the Carolina heelsplitter (*Lasmigona decorata*), brook floater (*Alasmidonta varicosa*), and Savannah lilliput (*Toxolasma pullus*). Although there appeared to be some good areas of mussel habitat, particularly above the project site (Cherokee Falls area) and below (99 Islands tailwater), mussels are scarce in these areas as well as in the reservoir proper. Even the eastern elliptio that is usually common in many river systems was represented by only a single live specimen in all of the field sampling. Given that the relatively tolerant species, eastern elliptio, appears rare within this area of the Broad River Subbasin, it is highly improbable that the sensitive species, such as Carolina heelsplitter, brook floater, and Savannah lilliput, exist within the project area.

Glossary

The following definitions represent a compilation from the NCWRC (2003) and Webster's Ninth New Collegiate Dictionary (1990)

anadromous fish: a salt water fish which migrates up freshwater rivers to spawn

anterior end: the shorter end of the shell as measured from the umbo to the margin. In a live animal, the foot extends from this end, and this end is usually embedded in the substrate.

arcuate: a condition also known as concave when referring to the ventral margin

bradytictic: species with females gravid for long periods, usually becoming gravid in late summer or early fall and remaining gravid through the spring or early summer

concave (ventral margin): a ventral margin curved toward the dorsal margin

convex (ventral margin): a ventral margin curved away from the dorsal margin

demibranchs: the major layers of a gill (i.e., two demibranchs to form 1 gill on each side of the mussel's body)

dendritic: branched

dimorphic: having 2 forms, as in male and female

dioecious: having 2 sexes

dorsal margin: the margin of the shell with the umbo, hinge, and ligament

ecophenotype: the form of a mussel species characteristic of a particular habitat

endangered: in reference to a population, likely to become eliminated from an area within the foreseeable future

excurrent aperture: an opening of the mantle at the posterior end of the mussel which expels water, wastes, glochidia or sperm; may be tube-like; above incurrent aperture

extant: in reference to a population, present as live individuals in a particular area

extinct: in reference to a species, no longer living on Earth

extirpated: in reference to a population, no longer present as live individuals in a particular area

fish host: a species of fish parasitized by the glochidia of a mussel species

foot: a muscular part of the body used for movement on or within the substrate; extends from antero-ventral shell area

glochidia: the parasitic life stage of a freshwater mussel

gravid: condition when glochidia or young mussels are present in the gills

hermaphrodite: a mussel individual with both male and female sex organs

hinge line: the dorsal edge where the two valves of a shell meet; connected by the hinge ligament

incurrent aperture: an opening of the mantle at the posterior end of the mussel which brings water and other resources into the body of the mussel; may be tube-like; below excurrent aperture

interdental projection: a "tooth" that juts out from the interdentum

interdentum: the area between the pseudocardinal and lateral teeth

lamellate: in reference to pseudocardinal teeth, thin and layered

lateral teeth: the long blade-like structures along the hinge line of each valve and closest to the posterior end of the shell

left valve: the shell half on the left side when the hinge is facing up and the anterior end is directed forward (away from you)

lentic: freshwater habitats with little or no flow

lotic: freshwater habitats with flow

marsupial gill: the condition of a female mussel's demibranchs when they are filled with glochidia

nacre: the inner surface of the shell

pallial line: a linear impression on the inner surface of the shell, parallel to the ventral margin, the line of attachment of the mantle muscles.

papillae: fingerlike sensory organs associated with the incurrent and excurrent apertures

periostracum: the external surface of the shell

plications: parallel ridges

posterior end: the longer end of the shell as measured from the umbo to the margin. In a live animal, the siphons extend from this end.

posterior ridge: a ridge along the external surface of the shell extending from the umbo to the postero-ventral margin.

pseudocardinal teeth: the compact, often triangular, tooth like structures along the hinge line of each valve and closest to the anterior end of the shell.

rare: in reference to a population, individuals uncommon within an area

rays: streaks or lines of color on the external surface of the shell.

right valve: the right half of the shell when the hinge is facing up and the anterior end is directed forward (away from you)

shell: the hard outer covering of the mussel.

special concern: a species which needs to be monitored

suprabranchial chamber: the dorsal portion of the gills

tachytictic: species with females gravid for short periods, usually late spring or early summer

teeth: the structures along the hinge line on the inner surface of the shell that serve to lock the two valves together when the animal closes its shell.

threatened: a population which is likely to become endangered as individuals become less common

umbo: the raised part at the dorsal margin of each valve, an external structure

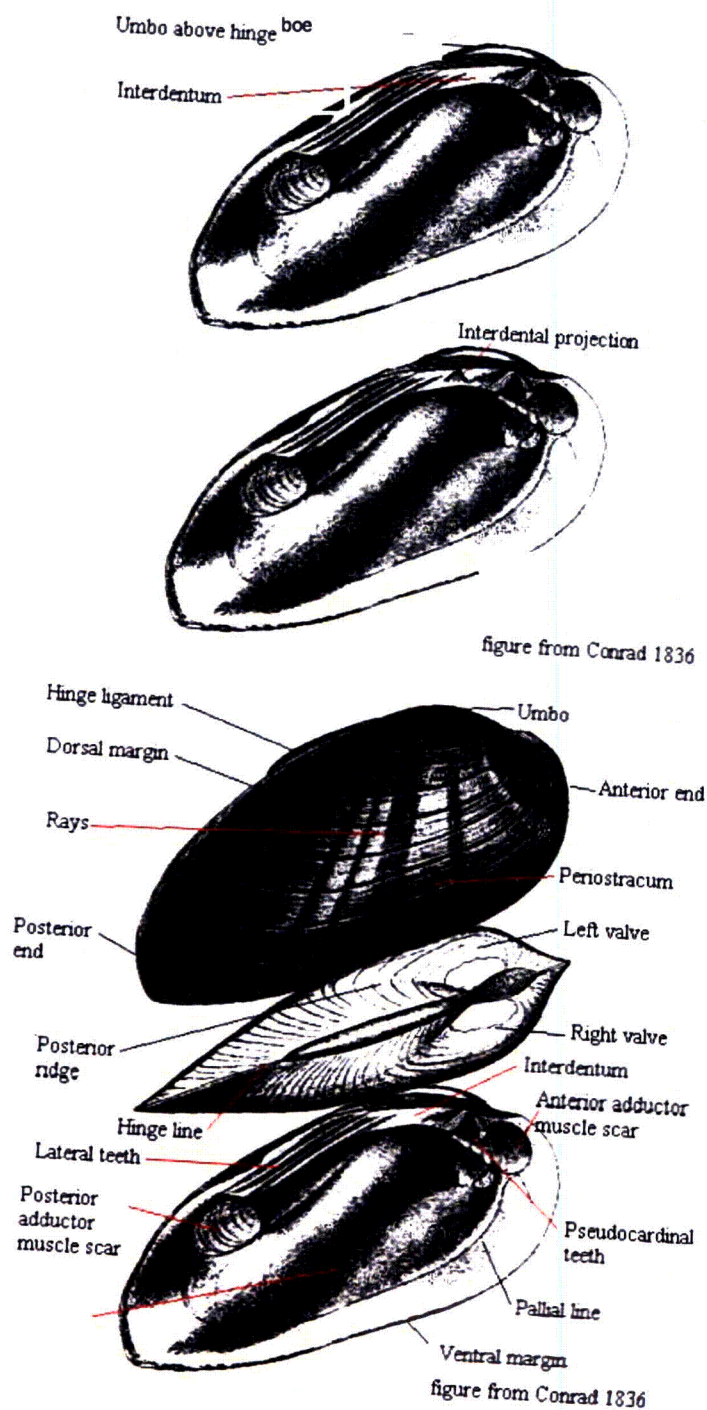
valves: one of the two halves of the shell

vestigial: a structure that is less fully developed compared with closely related forms

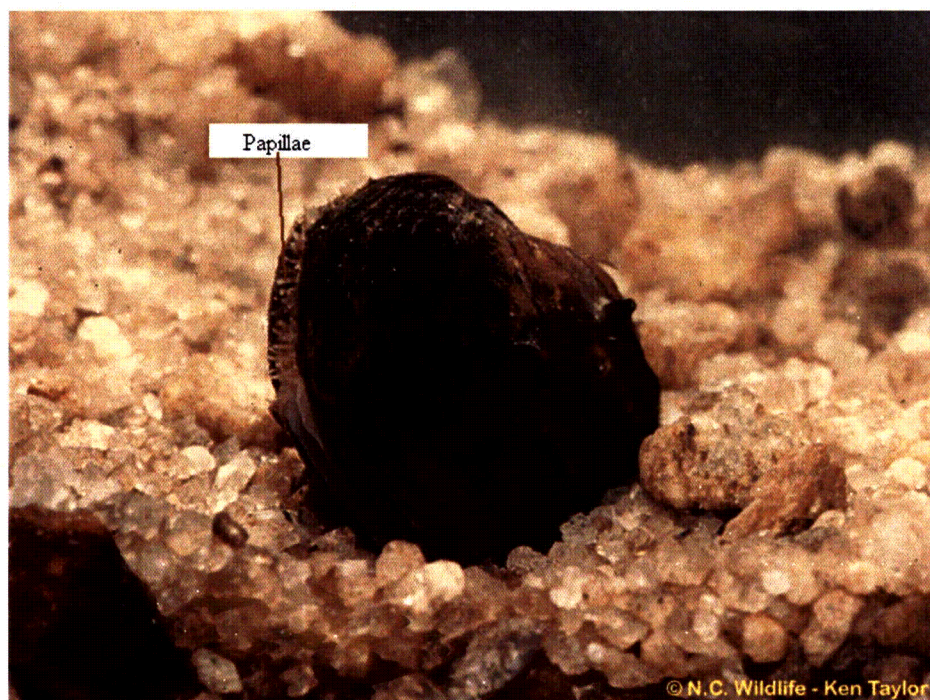
ventral margin: the bottom edge of the shell, opposite the hinge line

wing: an extended posterior-dorsal shell margin

Shell Morphology (from NCWRC 2003)



Select Soft Part Anatomy (from NCWRC 2003)



Acknowledgements

The following people have contributed significantly to this project: G.E. Vaughan, James J. Hall, J.D. Alderman, and J. West.

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Figure 1. Lee Nuclear Station study area.

Table 1. The freshwater mussels of the Broad River Basin

Species	In Broad R. Subbasin	Possibly Extirpated from Broad R. Subbasin	2006 Status (TNC, FWS)*
<i>Elliptio complanata</i>	X		G5
<i>E. roanokensis</i>	X		G3, FSC
<i>E. icterina</i>		X	G5
<i>E. angustata</i>	X		G4
<i>E. producta</i>	X		G3
<i>Pyganodon cataracta</i>	X		G5
<i>Utterbackia imbecillis</i>	X		G5
<i>Toxolasma pullus</i>		X	G1G2, FSC
<i>V. delumbis</i>	X		G4
<i>V. constricta</i>	X		G3, FSC
<i>V. vauhaniana</i>	X		G2, FSC
<i>Lampsilis cariosa</i>	X		G3G4, FSC

*** Species statuses according to NatureServe or U.S. Fish and Wildlife Service (FWS):**

NatureServe G Ranks:

G1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

G2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3 Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

G4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 Secure—Common; widespread and abundant.

FWS: Federal Species of Concern (FSC) as recommended by USFWS Asheville Field Office; E – federally listed endangered species

APPENDIX

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060608.1jma

BIOLOGISTS: John M. Alderman (snorkel)
Gene Vaughan (batiscope)
James J. Hall (batiscope)
Jeffrey West (batiscope)
Joseph D. Alderman (snorkel)

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Broad River, Cherokee Falls Tailwater, Cherokee County, South Carolina; 35.05826 N, 81.54284 W; see **Figure 1**.

SURVEY DATE: June 8, 2006

SITE COMMENTS: Effluent odor, nice substrate in places

HABITAT:

WATERBODY TYPE:	River
FLOW:	Run, riffle, slack
RELATIVE DEPTH:	Shallow
DEPTH (%<2 FEET):	50
SUBSTRATE:	Silt, sand, gravel, cobble, boulder, bedrock
COMPACTNESS:	Normal and compact
SAND/GRAVEL BARS:	Present
WOODY DEBRIS:	High
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	Moderate
TEMPORARY POOLS:	None observed
CHANNEL WIDTH:	100+ meters
BANK HEIGHT:	3.75+ meters

HABITAT (cont.):

BANK STABILITY:	Some erosion/undercutting
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	1
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	At least one
VISIBILITY:	Slightly turbid
WATER LEVEL:	Normal
WEATHER:	Sun-Cloud, Warm

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	Snorkel and batiscope
SURVEY TIME:	3.33 person hours

FRESHWATER MUSSELS:

Elliptio angustata – 1 shell

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060608.2jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Broad River, large wash over area, Cherokee County, South Carolina;
35.05685 N, 81.53938 W; see Figure 1.

SURVEY DATE: June 8, 2006

SITE COMMENTS: Thoroughly examined extremely large sand bar

HABITAT:

WATERBODY TYPE:	River
FLOW:	-
RELATIVE DEPTH:	-
DEPTH (%<2 FEET):	-
SUBSTRATE:	Silt, sand, gravel
COMPACTNESS:	Normal
SAND/GRAVEL BARS:	Present

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	Visual
SURVEY TIME:	1.25 person hours

FRESHWATER MUSSELS:

No evidence of unionids

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060608.3jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: 99 Island Reservoir, Cherokee County, South Carolina; 35.05613 N, 81.53352 W; see Figure 1.

SURVEY DATE: June 8, 2006

SITE COMMENTS: Back side of island with flow; much good potential *Toxolasma pullus* habitat; no crawls; also checked many sites in lake – no signs of *T. pullus* along shore

HABITAT:

WATERBODY TYPE:	Reservoir
FLOW:	Pool
RELATIVE DEPTH:	Very shallow (around large sand bar)
DEPTH (%<2 FEET):	100
SUBSTRATE:	Silt, sand, gravel
COMPACTNESS:	Normal
SAND/GRAVEL BARS:	Present
WOODY DEBRIS:	-
BEAVER ACTIVITY:	-
WINDTHROW:	-
TEMPORARY POOLS:	-
CHANNEL WIDTH:	~50 meters
BANK HEIGHT:	2+ meters
WATER LEVEL:	Normal
WEATHER:	Sunny, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	Visual
SURVEY TIME:	1.67 person hours

FRESHWATER MUSSELS:

Elliptio angustata – 1 old shell

OTHER TAXA:

Physa sp. -abundant
Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060608.4jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: 99 Island Tailrace, Cherokee County, South Carolina; 35.02950 N, 81.49119 W; see Figure 1.

SURVEY DATE: June 8, 2006

SITE COMMENTS: Slight effluent odor

HABITAT:

WATERBODY TYPE:	River
FLOW:	Run, riffle, slack
RELATIVE DEPTH:	Very shallow
DEPTH (%<2 FEET):	90
SUBSTRATE:	Silt, sand, gravel, cobble, boulder, bedrock
COMPACTNESS:	Normal
SAND/GRAVEL BARS:	Present
WOODY DEBRIS:	Low
BEAVER ACTIVITY:	None
WINDTHROW:	Low
TEMPORARY POOLS:	None
CHANNEL WIDTH:	200+ meters
BANK HEIGHT:	2+ meters

HABITAT (cont.):

BANK STABILITY:	Some erosion/undercutting
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	-
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	-
VISIBILITY:	Slightly turbid
WATER LEVEL:	Normal
WEATHER:	Sun-Cloud, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 snorkel, 2 batiscope, 1 visual
SURVEY TIME:	3.75 person hours

FRESHWATER MUSSELS:

Elliptio complanata – 1 live
Elliptio angustata – 1 live

OTHER TAXA:

Elimia catenaria
Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.1jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Sedimentation Basin, Cherokee County, South Carolina; 35.03287 N, 81.50385 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS:

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Moderate to deep
DEPTH (%<2 FEET):	10
SUBSTRATE:	Silt, sand, gravel, vegetation
COMPACTNESS:	Normal
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	Low
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	N/A
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY: Very stable
BUFFER WIDTH: -
RIPARIAN VEGETATION: Wooded, shrub-brush, grass
LAND USE: Rural
PERCENT COVER: 0
WOODLAND EXTENT: Not extensive
NATURAL LEVEES: -
VISIBILITY: Clear
WATER LEVEL: Normal
WEATHER: Sunny, warm

TECHNIQUES AND SURVEY TIME:

TECHNIQUES: 2 SCUBA, 1 batiscope, 2 safety
SURVEY TIME: 0.75 person hours

FRESHWATER MUSSELS:

Utterbackia imbecillis – 7 live (67, 67, 63, 69, 56, 66, 62 mm)
Pyganodon cataracta – 21 live (106, 97, 96, 119, 99, 78, 107, 102, 92, 88, 101, 99, 113, 84, 83, 101, 74, 97, 109, 99, 102); 5 shells

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.2jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Sedimentation Basin, Cherokee County, South Carolina; 35.03426 N, 81.50474 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Moderate to deep
DEPTH (%<2 FEET):	10
SUBSTRATE:	Silt, sand, detritus, vegetation
COMPACTNESS:	Normal and unconsolidated
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	High
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	-
RIPARIAN VEGETATION:	Wooded, shrub-brush, grass
LAND USE:	Rural
PERCENT COVER:	-
WOODLAND EXTENT:	-
NATURAL LEVEES:	-
VISIBILITY:	Clear
WATER LEVEL:	Normal
WEATHER:	Sunny, warm

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.5 person hours

FRESHWATER MUSSELS:

Pyganodon cataracta – 20 live (81, 95, 101, 89, 94, 97, 91, 97, 93, 90, 94, 92, 95, 86, 69, 90, 83, 94, 80, 72); 9 shells
Utterbackia imbecillis – 1 live (65 mm); 1 shell

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.3jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Sedimentation Basin, Cherokee County, South Carolina; 35.03264 N, 81.50510 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Moderate to Deep
DEPTH (%<2 FEET):	5
SUBSTRATE:	Silt, sand, gravel, vegetation
COMPACTNESS:	Normal and unconsolidated
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	Average
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	-
RIPARIAN VEGETATION:	Wooded, shrub-brush, grass
LAND USE:	Rural
PERCENT COVER:	-
WOODLAND EXTENT:	Not extensive
NATURAL LEVEES:	-
VISIBILITY:	Clear
WATER LEVEL:	Normal
WEATHER:	Sunny, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.65 person hours

FRESHWATER MUSSELS:

Pyganodon cataracta – 15 live (110, 91, 96, 100, 83, 92, 75, 55, 90, 82, 94, 94, 93, 101, 92 mm); 11 shells

OTHER TAXA:

Helisoma anceps
Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.4jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Low Flow Reservoir, Cherokee County, South Carolina; 35.03475 N,
81.52015 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Shallow to moderate
DEPTH (%<2 FEET):	10
SUBSTRATE:	Silt, sand, detritus
COMPACTNESS:	Normal
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	Average
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	-
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	-
VISIBILITY:	Clear
WATER LEVEL:	Normal
WEATHER:	Sunny, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.75 person hours

FRESHWATER MUSSELS:

Pyganodon cataracta – 2 live, 4 shells

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.5jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Low Flow Reservoir, Cherokee County, South Carolina; 35.03559 N, 81.52424 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Moderate
DEPTH (%<2 FEET):	5
SUBSTRATE:	Silt, sand, gravel
COMPACTNESS:	Normal and unconsolidated
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	Low
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	-
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	-
VISIBILITY:	Clear
WATER LEVEL:	Normal
WEATHER:	Sun-Cloud, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.5 person hours

FRESHWATER MUSSELS:

None

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.6jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Low Flow Reservoir, Cherokee County, South Carolina; 35.03951 N, 81.52267 W; see **Figure 1**.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Shallow
DEPTH (%<2 FEET):	10
SUBSTRATE:	Silt, sand, gravel
COMPACTNESS:	Normal and unconsolidated
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	Low
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	-
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	-
VISIBILITY:	Slightly turbid
WATER LEVEL:	Normal
WEATHER:	Sun-cloud, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.4 person hours

FRESHWATER MUSSELS:

None

OTHER TAXA:

Corbicula fluminea

PROJECT: Duke Power Company freshwater mussel survey of the Upper Broad River Basin, SC

STATION: 20060609.7jma

BIOLOGISTS: John M. Alderman
Gene Vaughan
James J. Hall
Jeffrey West
Joseph D. Alderman

N.C. WILDLIFE RESOURCES COMMISSION ES PERMIT: NC – 2006 ES 09

U.S. FISH AND WILDLIFE SERVICE ES PERMIT: TE065756-0

S.C. DEPARTMENT OF NATURAL RESOURCES AUTHORIZATION:
November 25, 2002

LOCATION: Auxiliary Holding Pond Cherokee County, South Carolina; 35.04187 N, 81.51230 W; see Figure 1.

SURVEY DATE: June 9, 2006

SITE COMMENTS: -

HABITAT:

WATERBODY TYPE:	Pond
FLOW:	Pool
RELATIVE DEPTH:	Moderate
DEPTH (%<2 FEET):	5
SUBSTRATE:	Clay, silt, sand, cobble, boulder
COMPACTNESS:	Normal and unconsolidated
SAND/GRAVEL BARS:	None
WOODY DEBRIS:	High
BEAVER ACTIVITY:	Evidence (gnawed sticks)
WINDTHROW:	None
TEMPORARY POOLS:	None
CHANNEL WIDTH:	-
BANK HEIGHT:	-

HABITAT (cont.):

BANK STABILITY:	Very stable
BUFFER WIDTH:	Wide
RIPARIAN VEGETATION:	Wooded, shrub-brush
LAND USE:	Natural, timber, rural
PERCENT COVER:	-
WOODLAND EXTENT:	Extensive
NATURAL LEVEES:	None
VISIBILITY:	Slightly turbid
WATER LEVEL:	Normal
WEATHER:	Sun-Cloud, hot

TECHNIQUES AND SURVEY TIME:

TECHNIQUES:	2 SCUBA, 1 snorkel, 2 safety
SURVEY TIME:	0.4 person hours

FRESHWATER MUSSELS:

None

OTHER TAXA:

Corbicula fluminea