FINAL PERFORMANCE REPORT
South Carolina State Wildlife Grant [T-24-R]
Fish Passage on the Broad River: an assessment of the benefits to freshwater mussels
October 1, 2006 – September 30, 2008

GRANT OBJECTIVES

To determine the benefits of newly constructed fish passage facilities to freshwater mussel populations on the Broad River

ACTIVITY OVERVIEW:

Tasks

I. Conduct searches for mussels to identify species present and determine the time of year during which mussels show evidence of reproduction.

Activity: Between March and October, 2007, we conducted searches for mussels in 60 locations on the main stem of the Broad River, its associated reservoirs, and the Upper Congaree River. Gravid individuals of several species were located during the spring and summer. Ten species were found below the Columbia dam, which first allowed fish to pass through during the spring of 2007. Above the dam, only four of these species were found. The habitat between the Columbia dam and Parr reservoir was excellent, and high densities of mussels were supported, suggesting that additional species might do well there if they historically occurred. Because there is no baseline data on mussels prior to the construction of the dam, it is unknown whether or not fish passage limits mussel distribution in this drainage. The habitat above Parr Reservoir was extremely degraded, due to erosion, sedimentation, and unstable substrates. Habitat restoration is recommended before the area should be considered before the reintroduction of mussels or the expansion of ranges through additional fish passage is established.
Significant deviations: none

II. Conduct fish host trials on glochidia of the mussel species found below Columbia dam but not above

Activity: Fish host trials were conducted for five mussel species, and three to six successful hosts were found for each of four of the mussel species. A sixth species, the creeper (*Strophitus undulatus*) found below the dam but not above, was not tested because only one individual was found during the study and it was not gravid. Furthermore, host testing was not considered necessary for this species, because several previous studies indicated that the creeper uses a wide variety of hosts, and that it is one of the rare mussels able to complete development without using a host. At least one successful host species for all mussels below the dam was observed moving through the fish ladder in 2007 and/or 2008.

Three species – blueback herring (*Alosa aestivalis*), gizzard shad (*Dorosoma cepedanium*), and white perch (*Morone americana*) – served as successful hosts for the Roanoke slabshell, *Elliptio roanokensis*. However, only one of the two white perch tested served as a host, indicating that it may be only marginally suitable as a host for this species. Juveniles remained attached to fish

from 10-16 days. Because blueback herring and gizzard shad are wide ranging migratory species, this mussel was the most likely to exhibit a limited range due to the obstruction of fish passage. However, if populations of other species were extirpated above the dam, they would not have been able to recolonize the area prior to the facilitation of fish passage.

The eastern pondmussel (*Ligumia nasuta*) used redbreast sunfish (*Lepomis auritus*) pumpkinseed sunfish (*Lepomis gibbosus*) redear sunfish (*Lepomis microlophus*) largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*). Redbreast and redear sunfish served as only marginally efficient hosts. Only one of two redear sunfish resulted in the successful transformation of any glochidia, and only four were able to complete development on that fish. Redbreast sunfish facilitated the transformation of one to 28 individuals (an average of 9) on each fish. Numbers of transforming individuals on other successful host species ranged from 44 to 344 per individual. Glochidia were attached to the fish from 11 to 24 days.

The eastern lampmussel (*Lampsilis radiata*) used largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) served as efficient hosts. The bluegill (*Lepomis macrochirus*) and striped bass (*Morone saxatilis*) produced only one and two juveniles respectively, and none of the other species tested facilitated transformation. Juveniles remained attached to the fish for 14-30 days.

The yellow lampmussel (*Lampsilis cariosa*), used smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and striped bass (*Morone saxatilis*). Each served as efficient hosts. Juveniles remained attached to fish 14-22 days.

Significant deviations: No gravid individuals of the Carolina slabshell, *Elliptio congaraea*, were found in 2007, so host trials for this mussel were conducted in the spring of 2008, using two individuals collected on April 17, 2008. Unfortunately, no successful hosts were found. Possible reasons for the failure to find hosts could be that the species is specialized to one or very few successful hosts and the actual hosts were not among the fish attempted, or that the mussels released their glochida in the lab before they were fully mature, even though they appeared to be mature at the time. A third possibility is that because individual fish vary in their degree of susceptibility to host infection based upon previous exposure to glochidial infestations, the individual fish involved in the trials may have become resistant to infestation prior to the trials. Attempts to locate additional gravid *E. congaraea* and repeat the trials were made in May and June of 2008, but no additional gravid individuals were found. As the species is quite rare and few other individuals were found, it is unclear whether the brooding period did not extend beyond April, or if by chance the only individuals located later were not gravid.

III. Determine the timing of glochidial release by mussels

Activity: Mussels were collected from 2 sites in the lower Broad and upper Congaree rivers, marked and their reproductive status noted as gravid or not gravid at approximately 2 week intervals between March 27 and June 25, 2008. Because the reproduction of mussels in the lower Congaree River appeared to be delayed relative to the reproduction in the Broad River, the monitoring period was extended at this site only until July 29, 2008.

The mussels in the Broad and Congaree Rivers exhibit two types of brooding patterns. Bradytictic brooders are gravid for an extended period beginning in the summer or fall and release their glochidia in the spring or early summer. Tachytictic brooders become gravid in the winter or spring and release their glochidia after a short period of time. Bradytictic brooders, *Lampsilis cariosa*, *Lampsilis radiata*, *Ligumia nasuta*, and *Villosa delumbis* breeding this year were gravid when first encountered and released glochidia a few at a time. Gravid individuals that had released part of a brood could be distinguished from those that held a full brood by patches of empty gills in between rows of brooding glochidia. *Ligumia nasuta* gradually released its glochidia from late April to late June. *Villosa delumbis* released its glochidia through the end of June. *Lampsilis radiata* was uncommon, with only 4 gravid individuals observed. One had partially released in March, but the other three did not release until late May through late June. *Lampsilis cariosa* released during June and July.

Tachytictic brooders *Elliptio angustata*, *E. congaraea*, and *E. roanokensis* were found gravid on March 27, the first date of reproductive assessment. Only three gravid *E. congaraea* were found on March 27 and April 17. Although the low sample size makes it difficult to assess the brooding patterns in this species, it appeared that the glochidia were released prior to May. *Elliptio angustata* and *E. roanokensis* had a very long brooding season, and the marking and recapturing of individuals revealed that some individuals could complete multiple broods within a season (at least 3 observed in *E. angustata*, and at least 2 in *E. roanokensis*). Gravid individuals of *E. roanokensis* were found through the conclusion of the study at both sites, but the majority had completed releasing by early June. *Elliptio angustata* had completed releasing by the end of June, and was still gravid in significant numbers until mid-June. *Elliptio complanata*, a common species found above and below the dam was not found gravid until early may, and released glochidia through the end of June. *Uniomerus carolinanus* was a tachytictic brooder found above and below the dam, and only one individual was found gravid on March 27. No gravid individuals of *Strophitus undulatus* were found.

Once the glochidia are released they must attach to an appropriate fish host within one to two weeks in order to complete development. Our host trials indicated that most mussels found in the area remain on the fish 10 to 30 days under laboratory conditions. This may not reflect the actual duration of time on a host under field conditions, as a number of environmental factors reflect development time, but is an approximation. Because many mussels were still releasing glochidia in June and a few were still releasing in July, a recommendation was made to keep the fish ladder at the Columbia dam open through August in typical years. South Carolina Electric and Gas Company agreed to do so during years that sufficient flow was available to do so without diverting too much water away from the Columbia canal. The canal allows the water to flow into an intake for municipal use by the City of Columbia. The current operation schedule of the fish ladder (late Feb. or Early March through late May) appears to accommodate the passage of most mussel species, but may be of little benefit to species such as *L. cariosa* and *L. radiata* which are of high conservation concern. Extending the fish ladder season is also expected to increase the volume of glochidia transported to additional suitable habitat for most species.

The reproductive output of mussels was greatly reduced in the upper Congaree River relative to the lower Broad. High mortality of mussels was also observed in the Congaree River. Although

the cause of these problems is not yet fully understood, possible reasons include the cooler water temperatures from water flowing from the Saluda river, lower nutrients, and water quality issues in the Saluda river, since the Saluda and the Broad come together to form the Congaree. The Congaree River site was chosen only because there is little habitat in the Broad River below the fish ladder. Adding the site allowed monitoring of a greater sample size and one additional mussel species. Although outside of the original scope of this project, the cause of these problems is being investigated and may prove to be critical in protecting these populations of several mussel species.

Significant deviations: none

Estimated Federal Cost (grant level): A total of $29,649.42 in federal funding was spent on this project.

Recommendations: Close this grant. The required tasks have been accomplished, and the objective met. Although many follow up questions exist, they are being pursued under an additional funding source.