Enhancement of upstream passage for American Eels at the St. Stephen Dam, SC

FINAL REPORT

South Carolina State Wildlife Grant SC-T-F13AF01207

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Introduction/Background

American eel (*Anguilla rostrata*) are catadromous fish that live in freshwater but spawn in the Atlantic Ocean. While in saltwater, the larvae go through a series of metamorphic transformations, then enter into the transparent "glass eel" stage. Glass eels then enter freshwater streams and begin long upstream migrations. As they grow, pigmentation increases and they are known as elvers; later juvenile stages are known as yellow or black eels. Eels occupy a significant and unique niche in Atlantic coastal rivers and associated tributaries.

Historically, the American eel was very abundant in East Coast streams, comprising more than 25 percent of the total fish biomass, occurring from the estuaries to the headwaters of coastal plain streams and at least as far inland as the fall line in larger watersheds, including the Savannah, Santee and Pee Dee river basins. Presently, American eel distribution and population size may be affected by dams and other impediments to migration, although the American eel is capable of traversing many obstacles that restrict migration and dispersal of other fishes.

The 2012 American eel stock assessment conducted by the Atlantic States Marine Fisheries Commission (ASMFC) concluded the American eel population is *depleted* in U.S. waters. The stock is at or near historically low levels. This is likely due to a combination of factors including habitat loss due to damming mainstem and tributary rivers. The recently released ASMFC Special Report #89 Research Priorities and Recommendations to Support Interjurisdictional Fisheries Management lists, under Habitat Priorities, the need to develop, investigate, and improve technologies for upstream and downstream American eel passage at various barriers for each life stage (ASMFC 2013). The report states dams that block or limit access of migratory fishes to historical habitats and prevent free movement both up- and downstream, have been indicated as major contributors to stock declines for all diadromous species and for effective management of the Atlantic Coast American eel population. It is of utmost importance to better understand the contribution of various riverine or regional sub-populations or population segments to the current and long-term productivity of the entire continental population (ASMFC 1985; ASMFC 1990; ASMFC 1999; ASMFC 2000; NMFS 1998). Additionally, it lists the need to monitor upstream and downstream movement of American eel at migratory barriers that are efficient at passing eels.

The current (2015) South Carolina State Wildlife Action Plan (SWAP) as well as the former (2005) Comprehensive Wildlife Conservation Strategy (CWCS) list the American eel as a species of highest priority stating that the American eel performs integral roles in the diverse habitats and ecosystems in which it resides during all portions of its complicated life cycle, and has faced impacts that have caused stock declines—sometimes dramatic—in at least some river basins, both in South Carolina and across their broader ranges. The species profile in the SWAP/CWCS for the American eel currently has no special status under state or federal regulations; however, a petition was filed in late 2004 and again in 2010 with the United States Fish and Wildlife Service (USFWS) in order to have the American eel listed as an endangered species.

The Santee River basin, at 17,000 square miles, is the second largest drainage area in the Eastern United States. The Lower Santee and Cooper rivers are the keystone corridors used by diadromous fish to access habitats in the Santee-Cooper Basin. The first blockages encountered by upriver migrating fish in these systems are the Santee-Cooper project dams (Santee/Wilson Dam on the Santee River, St. Stephen Dam on the Re-diversion Canal, and Pinopolis Dam on the Cooper River). These dams are located on the lower end of the Santee Basin coastal plain. As such, adequate passage beyond these dams is essential to diadromous fish restoration throughout the basin. Passage at these dams provides direct access to approximately 160,000 acres of impounded waters in Lakes Marion and Moultrie and 134 miles of tributary rivers extending to the vicinity of Columbia Dam on the Broad River and to Wateree Dam on the Wateree River. American eel populations within the Santee-Cooper watershed inland of Pinopolis, St. Stephen and Santee/Wilson Dams are likely well below numbers present prior to impoundment of the Santee-Cooper lakes in the 1940s. Historical records indicate presence of American eels in the Santee basin well inland of the fall line and into North Carolina (USFWS 2001).

Furthermore, the South Carolina Department of Natural Resources (SCDNR) Freshwater Fisheries Stream Team began a study in 2006 to monitor the status of South Carolina's streams. Personnel sampled between 150 and 200 streams each year throughout the state in order to track changes in habitat conditions and the numbers and types of species found in the streams. From collected data, densities of American eels were calculated for determined ecobasins (Figure 1). Densities of American eels above the Santee-Cooper River watershed were well below those in lower parts of the system, indicating passage at the Santee-Cooper System facilities could be an impediment to elver migration.

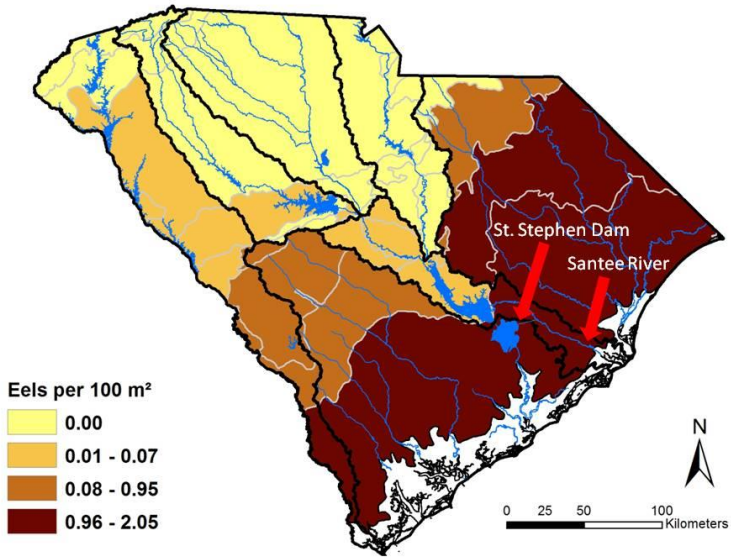

Figure 1. American eel densities per ecobasin.

A small study was conducted in April and June of 2012 to evaluate migrations of eels passed upstream of St. Stephen Dam, SC. SCDNR partnered with the USFWS, Duke Energy, and other NGOs to determine if tagged eels would be relocated in the Wateree River or would simply take

up residence in the reservoirs. A total of 3,377 elvers (young eels), collected in experimental eel ladders at St. Stephen Dam, were marked with rubber elastomer type tags inserted just under the skin and released just above St. Stephen Dam. With use of a special UV light, these tags could be identified during future captures (Figure 2).

On May 24, 2013 the first tag was recovered by Duke Energy personnel from an eel that was captured in a trap located at the Wateree Dam on the Wateree River. This site is ~142 river miles from the initial point of tagging. While the recapture rate was low, this experiment provided evidence for the possibility of eels navigating through the Santee Cooper reservoirs into tributary rivers.

Figure 2. American eel marked with rubber elastomer.

The Fish Lock at St. Stephen Dam on the Santee River Rediversion Canal, completed in 1985, was not designed to pass juvenile American eels (elvers). Beginning in 2003, SCDNR built and maintained two eel ladder sampling systems at the St. Stephen facility (Figure 3). They were used each year to collect migrating eels and assess temporal trends in upstream movement in relation to changing physical variables. However, they were constructed as experimental eel ladders and not intended to be permanent structures. One was constructed of aluminum electrical raceway trays and the other from corrugated polyethylene drainage pipe. During the last 10 years, these ladders have shown that elver American eel passage was feasible, passing ~17,000 in 2012 alone but, because of frequent equipment failure due to materials exceeding the life span of those used continuously in water, limited water flow, and bird predation, the preexisting experimental ramps needed to be replaced with a more permanent structure. In order to overcome these obstacles, a new permanent eel ladder was built in place of the existing temporary ladders. This permanent structure should be able to withstand the rigors of fluctuating flows from the dam and not require the amount of maintenance of the temporary ladders. Based

on the approved design, it should also be more efficient in capturing and assisting with upstream migration of elvers past the St. Stephen Dam.

Figure 3. Experimental eel ladders.

Materials and Methods

Specifications for the eel ladder at St. Stephen Dam include construction of two 6061 marine grade aluminum 10 in. wide C channels welded together to form a double channel 20 in. wide. Trough sections were constructed in 5ft flanged sections bolted together with a top cover to prevent predation of elvers. Trough sections are also supported by short, sturdy, marine-grade aluminum legs bolted to the dam surface using stainless steel wedge anchors. In order to continue to obtain biological information, the structure also includes an aluminum catch basin at upper end of the trough. It includes screened inflow and overflow outlets and has a locked cover to prevent any theft. The C channels have an attached Enkamat substrate in order to allow elvers to climb the ramp to the catch box, and an A/C powered submersible bilge pump provides a continuous flow to the ramp.

Results - *Detailed pictures are available in the Appendix*.

The fabrication of the eel ladder began in March 2014 with the award of the contract to Ramsey Manufacturing Co. (RMC) of Summerville, SC. However, spring 2014 rainfall amounts were above average in the Santee Cooper watershed resulting in unusually high water levels at St. Stephen Dam (Figure 4). Completion of this project was entirely dependent on adequate water levels to allow access to the work site. Water levels did not recede until mid-May at which time RMC was on-site recording needed measurements and elevation dimensions to order materials.

RMC was delayed in beginning the fabrication process because access to the site was not possible before mid-May.

SCDNR made a site visit to RMC in July to check on the progress of the fabrication and approve minor design modifications suggested by the fabricator. SCDNR took delivery of the completed eel ladder on August 26t, 2014. One week after delivery, SCDNR was notified by the Army Corp. of Engineers that maintenance on the St. Stephen Dam powerhouse would result in lower water levels, thus allowing the installation of the ramp. On September 5, 2014, installation of fabricated sections of the eel ladder was completed by personnel from SCDNR with aspects of plumbing and electrical work being completed four days later. The eel ladder began operation on September 11, 2014, with the first eel being collected four days later.

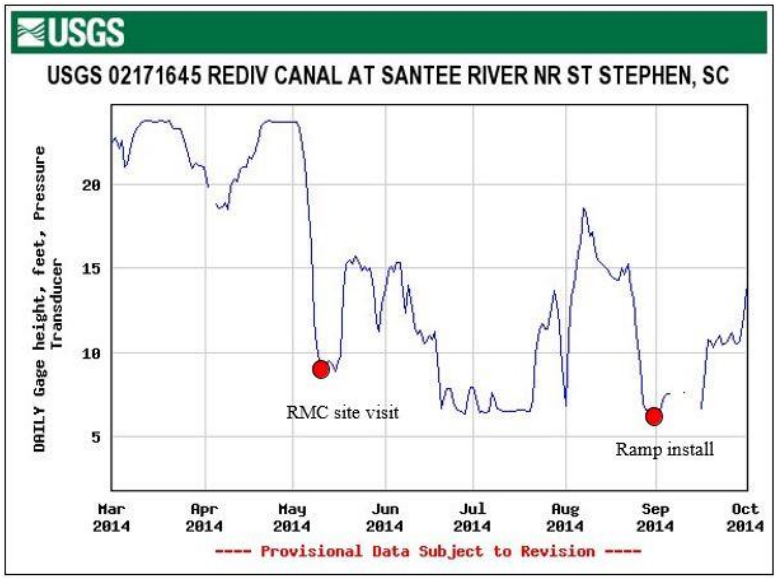

Figure 4. Water level at the Santee River Rediversion Canal.

To date (Sept. 2014-Oct. 2015) a total of 5,985 juvenile American eels have been collected at the new St. Stephen ramp. Thus far, 2015 has had the third largest catch since year-round eel ramp operations began (2010-2015) (Figure 5). The majority of eels were collected in spring, similar to previous years; however a spike in catch also occurred in October and is believed to be attributable to high flows related to record rainfall in early October (Figure 6). American eels collected in 2014-2015 ranged from 51 – 190 mm with the majority between 100 – 110mm. Length frequency distribution in 2015 was consistent with what was observed from 2013-2015 (Figure 7). Total length of eels collected in 2015 was very consistent regardless of month of the year, with an average length of ~100 mm, and was similar to length at month from 2011-2014 (Figure 8). The new ramp has demonstrated the ability to withstand the rigors of fluctuating flows from the dam and has not required the amount of maintenance of the previous temporary ladders. During October 2015, South Carolina experienced one of the most prolific rainfall events in the modern history of the United States. As a result of this rainfall, the state experienced a hypothesized 1,000-year flood event which impacted Santee River water levels and the ramp at the St. Stephens Dam which survived this event without damage (Figure 9).

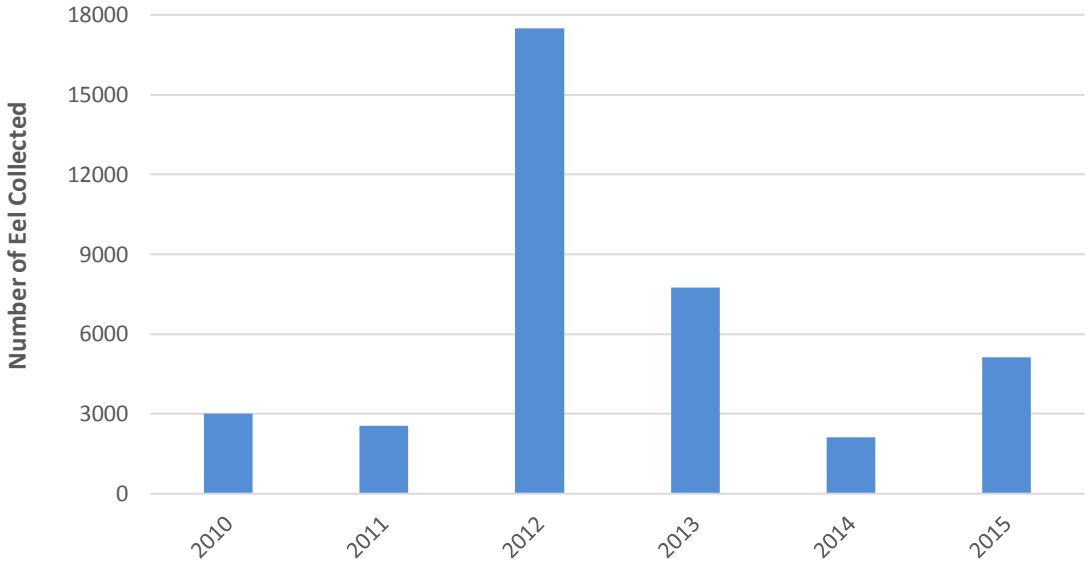

Figure 5. Data include collections from the St. Stephen experimental eel ramps 2010-2014 and the newly installed eel ladder in 2015.

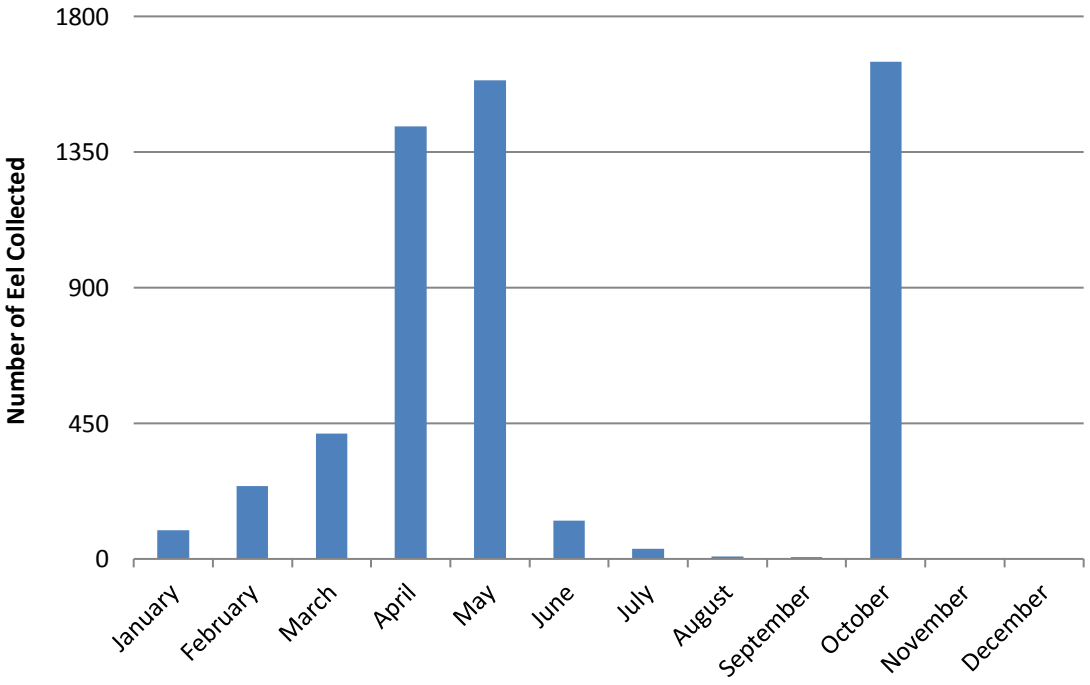

Figure 6. American eel catch by month 2015.

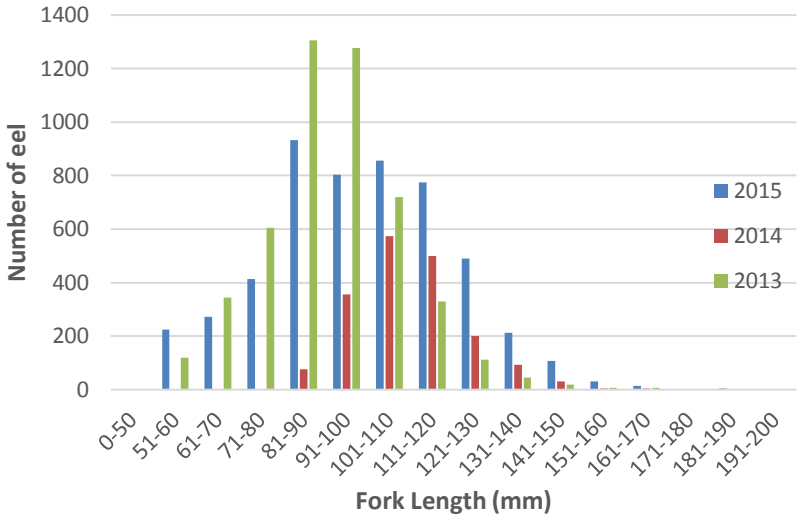

Figure 7. American eel length frequency distribution.

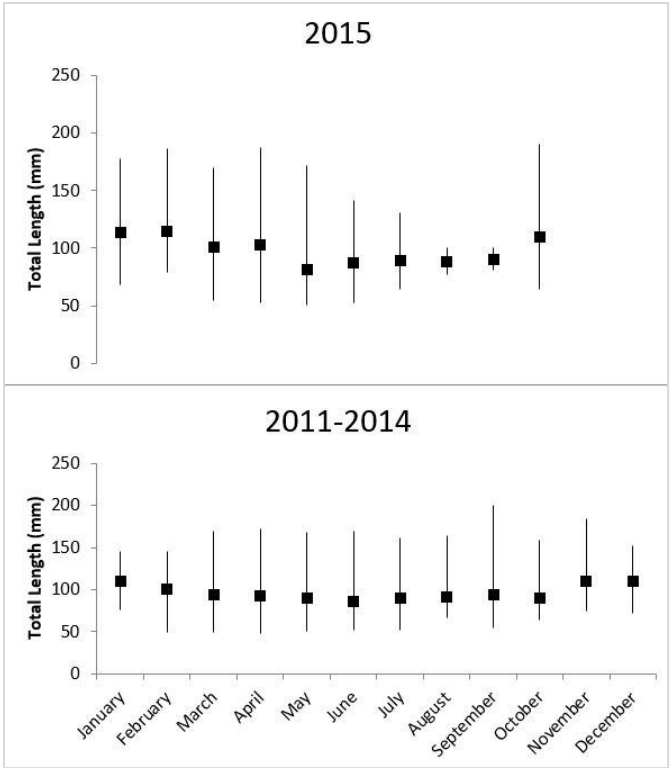

Figure 8. Total length (mm) of American eel by month of the year collected at St. Stephen Dam from 2011-2014. Vertical bars represent the size range (minimum: maximum) and boxes represent the average total length for a given month.

Figure 9. Ramp before (top) and during (bottom) 1,000-year flood event.

Conclusions

This permanent eel ladder increased access of migratory eels to historical habitats providing direct access to approximately 160,000 acres of impounded waters in Lakes Marion and Moultrie and 134 miles of tributary rivers important to eel maturation. This habitat is very important, if not essential, given the present status of the American eel population coast-wide. SCDNR personnel will continue to monitor upstream movement of American eels in the Santee Basin at this first upstream major migratory barrier. Data collected will include presence/absence, abundance, and biological information. Construction of this eel ladder was intended to replace ageing and sometimes unreliable ladders while also providing comparable capture methods. Based on 2015 data, this was achieved, capture rates were similar to past years, and the eel ladder withstood the effects of above normal flows. Continued sampling efforts will help to develop standardized protocols for monitoring eels at passage facilities and also help to evaluate

the potential impact of barriers to upstream migration and eel movement with respect to population and distribution effects.

Significant deviations:

RMC notified SCDNR that due to water levels at the St. Stephen Dam site, field measurements were not possible. This led to an unavoidable delay ordering materials until water levels returned to acceptable levels. As a result, RMC was not able to meet the 30 day delivery time to complete the job. In addition, in order to provide passage data and fulfill grant objectives, SCDNR applied for and was granted a one year no-cost-extension.

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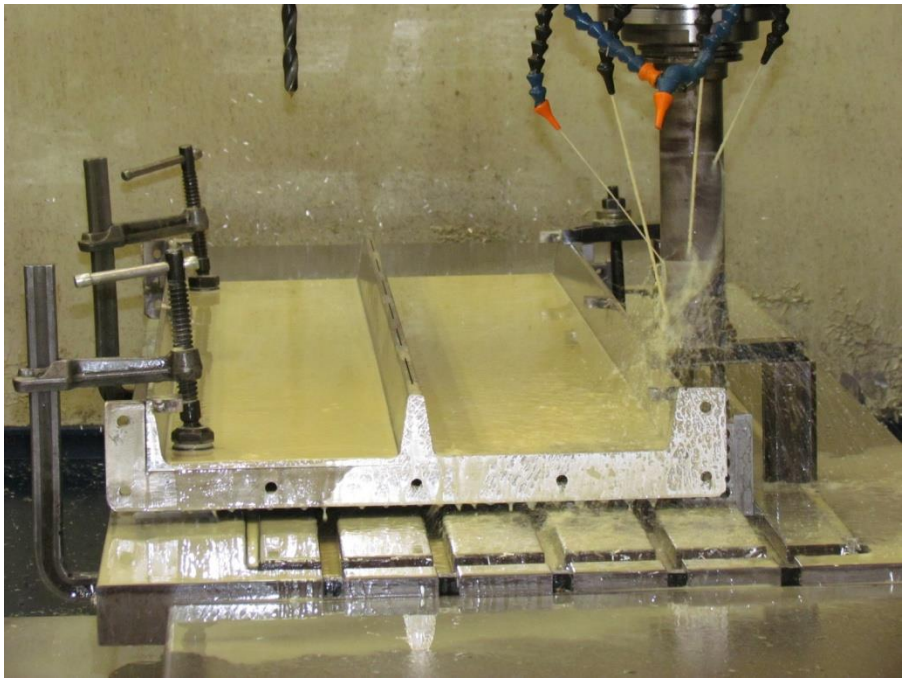
Appendix-Supplemental Pictures

Fabrication



RMC delivery of ramp sections

Installation

Completed Eel Ladder

Eel Collections