Report as of FY2006 for 2006NY84B: "The Sawkill Eel Project: Eel restoration in a tributary to the Hudson River"

Publications

- Conference Proceedings:
  - Schmidt, R.E., C.OReilly, and D. Miller, 2006, Hudson River Tributaries: American Eels and the Estuary Connection. Presented at the Watershed Commons: People, Wildlife, and Water in the Hudson Valley, Hudson River Watershed Alliance Conference, Mohonk Mountain House, New Paltz, NY, 17 November 2006.
  - Schmidt, R.E., C. OReilly and D. Miller, 2007, Observations on American Eels at a Passage Facility on a Hudson River Tributary. Presented at New York State Chapter, Amerian Fisheries Society, Thayer Hotle, West Point, NY, 9 February 2007.

Report Follows

WRI/HREP Grants 2006NY84B

Saw Kill Eel Project Report

Participants

Principal investigators: Dr. Catherine O'Reilly (Bard College) and Dr. Robert Schmidt (Simon's Rock College of Bard)
Collaborator: Dan Miller (Hudson River National Estuarine Research Reserve)

Background

Populations of American eels have been declining for several reasons, including loss of habitat (Haro et al. 2000). American eel *(Anguilla rostrata)* is a catadromous fish that spawns in the Sargasso Sea (central Atlantic Ocean). After hatching, young eels migrate thousands of miles to coastal estuaries and continue their migrations upstream into tributaries and inland ponds and lakes where they grow and mature for up to ten years or more before returning to the Sargasso Sea to spawn and die. Population declines have been so extensive that the American eel has been considered for listing as threatened or endangered. In the Hudson River estuary, access to upstream habitat is severely restricted by numerous small dams that act as barriers to many miles of viable habitat upstream. These dams typically restrict eel habitat to the lower reaches of the tributaries to the Hudson River, leading to high densities, decreased growth rates, and potentially lower recruitment in these reaches.

Eel ladders could provide passageways over these barriers and effectively increase the amount of available habitat. Access to this upstream habitat could increase eel growth rates, fecundity, and ultimately eel recruitment. By establishing a demonstration eel passage facility on the dam on the Saw Kill at Bard College, we hope to show that eels will use such a facility, that the facility will increase the numbers of eels upstream, and that these facilities are relatively cheap to install, monitor, and maintain. Currently, there are no migratory fish passage devices on dams in tributaries to the Hudson River Estuary. Given the large number of dams, and their potential collective impact on eel populations, there may be great potential for eel habitat restoration by providing passage over these historic dams.

As a tributary to the Hudson River, the Saw Kill has undoubtedly supported large eels populations historically throughout its reach. The Saw Kill watershed is 26.6 square miles and land use within the watershed is primarily forested (51.1%), with some agricultural (25.8%) and minimal urban (16.5%) areas. The landscape near the mouth is basically unimpacted secondary forest with some old growth, as the stream is the property boundary between Bard College campus and the historical Montgomery Place estate. The high densities of eels in the lower reach of this tributary (13,000 – 16,900 eels/ha, compared to 2 – 34 yellow eels/ha in the Hudson River) suggest that this relatively protected and undisturbed creek is prime habitat, which is supported by the large annual run of young-of-the-year American eels (elvers) for the Saw Kill (up to 10,000 (NYS DEC 2005)). Other accessible northeastern rivers support eel densities up to 3,000 eels/ha (Oliviera and McCleave 2000, Morrison and Secor 2004). Upstream of a small

dam on Bard College campus, eel densities are significantly lower (170-554 eels/ha). These upstream densities are still lower than those found in other northeastern rivers with eel passages (800- 2200 eels/ha (Oliviera and McCleave 2000)), indicating that this upstream habitat could easily support higher densities if it were more accessible. Although eels are adapted for getting around barriers (as evidenced by their presence upstream of the dam) it is clear from the large difference in densities that the dam represents a substantial barrier.

Approach

We installed a trap-and-transfer eel ladder at the dam on Bard College campus. The goal was to design and install an inexpensive eel ladder that could be easily maintained and monitored. In addition to being less expensive, a trap-and-transfer system allowed us to collect information on the numbers, sizes, and movement patterns of eels using the ladder. Eels using this type of ladder would become trapped in a large container at the top of the fish passage device and then need to be manually transferred from the container to the water upstream of the dam, so data collection could be done when the transfer occurred. The collaboration between Bard College and Simon's Rock College of Bard allowed students to actively participate in the research program and helped ensure frequent monitoring.

The eel ladder was designed and installed by Alden Research Laboratory, Inc. (Holden, MA). Greg Allen and Brian McMahon of Alden Research Laboratory, Inc. visited the site February 16 and returned April 16, 2006 to install the ladder. The ladder framework was constructed of aluminum for durability and attached to rocks near the edge of the water below the dam (but was not attached to the dam itself). Alden Research Laboratory, Inc. designed a pressure-driven siphon system to keep upstream water flowing through the ladder. Some improvements were made to the system throughout the summer to help simplify maintenance and operation and reduce the likelihood of escapement from the ladder or container.

The ladder was checked twice each week. Eels were removed from the container and placed into a bucket where they were anesthetized with clove oil, counted, and measured. All eels longer than 16 cm were tagged with a 1 mm coded wire tag (CWT) at the head of the dorsal fin. Trapped eels were also checked to see if they contained a CWT from previous electroshocking and tagging below the dam. Eels were allowed to recover in a bucket of stream water before they were released above the dam.

Students were trained to handle, measure, and tag the eels during the spring, under the supervision of Dr. O'Reilly. During the summer, two other students were trained and worked with Dr. Schmidt.

The eel ladder was completely removed from the stream in late December and stored over the winter.

Results and outcomes

Number and size of eels

From May 15 through September 18, 2006, 132 eels used the ladder. We expect that this number is an underestimate of the total number of eels who would use the ladder. There was evidence that eels could escape from the container at the beginning of the summer. The ladder and container were subsequently modified to reduce the likelihood of escape.

Eels ranged in length from 7.4 to 50.3 cm, with a modal length of 10-15 cm (Fig 1). Of these eels, 42 were larger than 17 cm and were tagged at the beginning of the dorsal fin. The modal length indicates that the ladder was used primarily by younger eels (2-3 years old). This is probably due to competition for food and habitat because eel densities are very high (13,000 – 16,900 eels/ha) downstream of the dam.

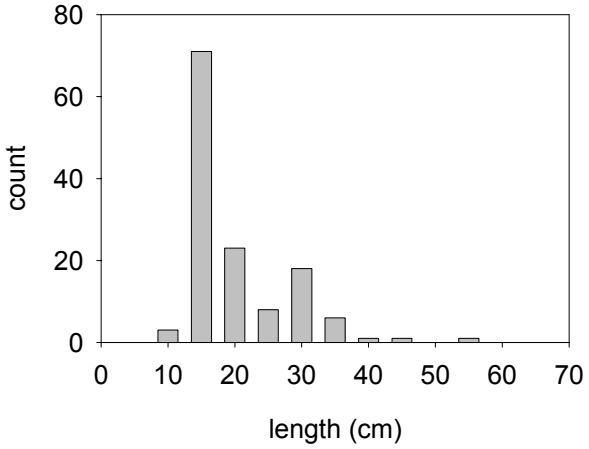

Figure 1. Length-frequency plot of eels using the ladder.

Eel movement patterns

Water temperature during this period was 12 ºC in May through 18 ºC in October. There were several periods of high water level throughout the summer.

Statistically, multiple regression indicated that eel movement was correlated with water temperature ($p<.06$) and depth ($p<.04$). However, it is not clear whether the relationship with temperature is driven by smaller scale patterns or is just an indication of the overall seasonal pattern of warmer water in the summer (Fig 2). Eel movement was not related to mean, minimum, or maximum air temperature. Water depth is associated with discharge, and varies over time depending upon precipitation (Fig 3). There was a very weak but significant relationship between cooler water temperatures and greater depth ($r^2=0.12$, $p=0.4$). When moon phase was included, ANOVA indicated that eel movement was not significantly related to water temperature, but was significantly related to depth ($p<.03$) and darkness of the moon phase ($p<.06$) (Fig 4).

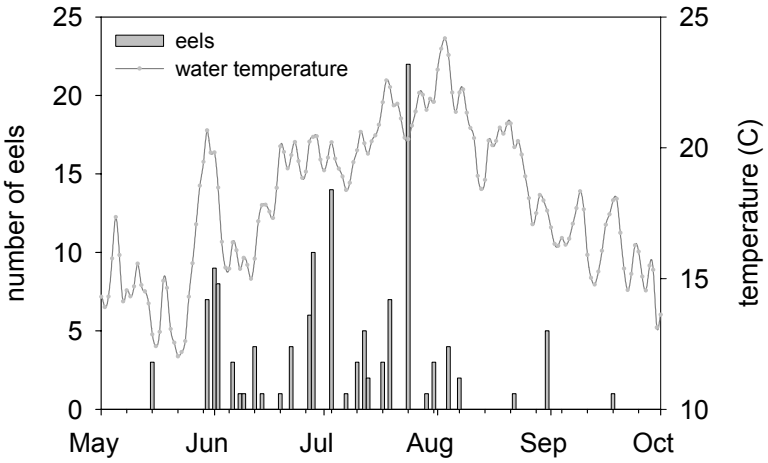

Figure 2. Water temperature and the number of eels using of the ladder.

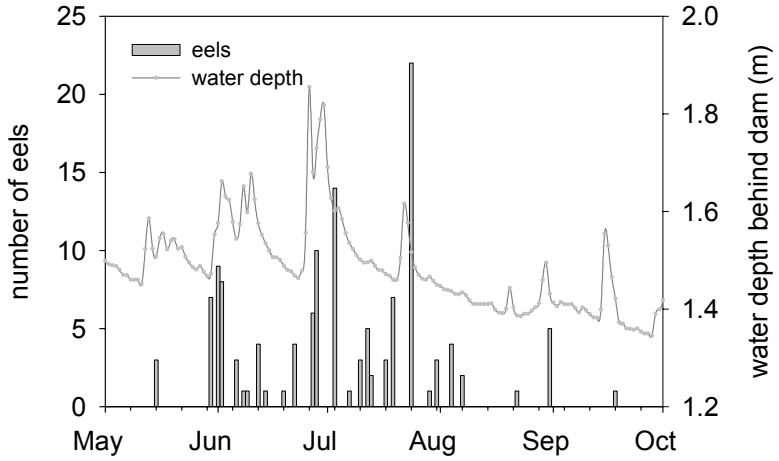

Figure 3. Water depth behind the dam (as an indicator of discharge) and the number of eels using of the ladder.

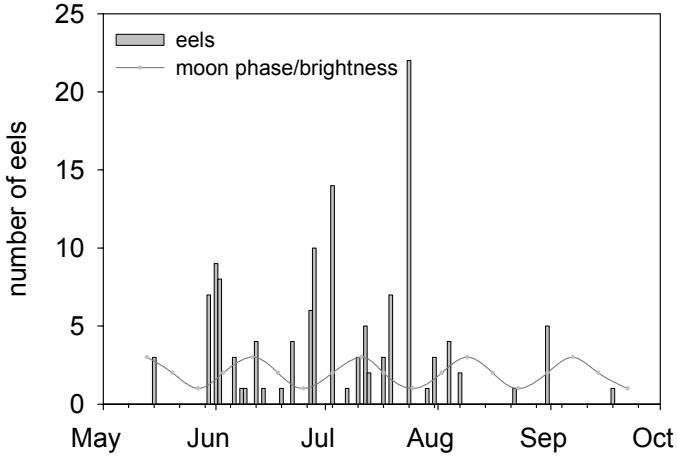

Figure 4. Moon phase (as an indictor of night time brightness) and the number of eels using of the ladder.

Our data have some interesting findings regarding eel movement patterns. Although temperature alone does not provide detail about sub-seasonal movement patterns, temperature probably drives the initiation of movement in the spring and cessation of movement in the fall. There is some evidence that eel movement may be greater during or just after high discharge events. With respect to greater movement during the darker moon phases, it is not clear whether this reflects eel activity and upstream movement patterns in general or just eel movement in the relatively more exposed environment of the ladder. More data is clearly needed to determine the driving factors behind eel movement patterns.

Student involvement

Several students participated in this project. Students participated in electroshocking several reaches of the Saw Kill below the dam and tagging these eels. Students were also trained in the maintenance and monitoring of the eel ladder. Student teams were responsible for checking, maintaining, and monitoring the eel ladder during the academic year, reporting to Dr. O'Reilly after each check. In the summer, students from Simon's Rock College of Bard worked with Dr. Schmidt at the site.

Mer Mietzelfeld, biology major, junior, Bard College
Noah McKenna, biology major, sophomore, Bard College
Andras Huttl, biology major, junior, Bard College
Meredith French, studio art major, freshman, Bard College
Victoria Gono, bioengineering major, freshman, Simon's Rock College of Bard
Mallory Eckstut, biology major, senior, Simon's Rock College of Bard

Presentations, outreach, and media exposure

The research was presented at two conferences:

> Schmidt, R.E., C. O'Reilly, and D. Miller. 2006. Hudson River Tributaries: American Eels and the Estuary Connection. Presented at The Watershed Commons: People, Wildlife, and Water in the Hudson Valley, Hudson River Watershed Alliance Conference, Mohonk Mountain House, 17 November 2006.
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> Schmidt, R.E., C. O'Reilly, and D. Miller. 2007. Observations on American eel at a Passage Facility on a Hudson River Tributary. Presented at New York State Chapter, American Fisheries Society, Thayer Hotel, West Point, 9 February 2007.

Several family groups and science classes from both Bard and Simon's Rock were exposed to the eel project on the Saw Kill. Observers were able to watch electrofishing, measurement, and tagging of eels, and were given an explanation of how the eel ladder worked. For classes, students were able to participate in these activities.

The Saw Kill Eel Project was reported in the *Poughkeepsie Journal* (April), *Kingston Freeman* (June 11), *Green Times* (Summer 2006), and *Wildlife Conservation* (October 2006).

Further funding and future work

We have secured future funding for the monitoring of this ladder through Chuck Neider of the Hudson River National Estuarine Research Reserve (HRNERR) (pending continued federal appropriation for HRNERR). The eel ladder was reinstalled in early May of this year and regular monitoring has begun. Dan Miller also secured additional funding through the Hudson River Estuary Program to install one new eel ladder along the Hudson River each year.

Summary of accomplishments

We demonstrated that the eel ladder is effectively used by eels as they attempt to move upstream of the dam. The cost of installation, monitoring, and maintenance are relatively low using this trap-and-transfer system. Our research program involved a large number of undergraduate students, and the data provides the first information about eel movement patterns. Our research was presented at two conferences and received media coverage.

Literature cited

Haro, A., W. Richkus, K. Whalen, A. Hoar, W.D. Busch, S. Lary, T. Brush, and D. Dixon. 2000. Population decline of the American eel: Implications for research and management. *Fisheries* 25:7-16.

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Morrison, W.E. and D.H. Secor. 2004. Abundance of yellow-phase American eels in the Hudson River estuary. *Transactions of the American Fisheries Society* 133 (4): 896-910.

Oliviera, K., and J. D. McCleave. 2000. Variation in population and life history traits of the American eel, *Anguilla rostrata*, in four rivers in Maine. *Environmental Biology of Fishes* 59: 141-151.