U.S. Fish & Wildlife Service

Connecticut River Coordinator's Office

Restoring Migratory Fish to the Connecticut River Basin

About Us
Recreational Fishing
Work With Us
Fisheries Management
Habitat Restoration
Fish Production
Invasive Species
Data
Education
Contacts
Links
Site Map
Home

Migratory Fish Restoration Research Forum

Abstracts – 2005

Smolt migration and fall movement of juvenile Atlantic salmon in a restoration stream of the Connecticut River, USA

Stephen D. McCormick[1], Gayle Barbin Zydlewski, Kevin G. Whalen, Alex J. Haro, Darren T. Lerner, Michael F. O'Dea and Amy M. Moeckel.

[1]Conte Anadromous Fish Research Center, USGS/BRD, Turners Falls, MA 01376.

Advances in passive integrated transponder (PIT) tag technology offer the opportunity to locate and individually identify large numbers of fish without disrupting their natural habitat choice, activity, and behaviors. Using 23 mm TIRIS PIT tags that permit large read ranges (2 m), we have developed a method for passively monitoring downstream migration and movement of juvenile Atlantic salmon in the natural environment with only one initial handling. Estimates of detection efficiency using dummy tags and tagged hatchery smolts indicate that detection efficiency is >93%. Each autumn from 1998-2004, we have PIT tagged 302-460 fry-stocked parr (9-17 cm fork length; 1+- and 2+-year olds) from Smith Brook, VT (a tributary of the Connecticut River) and continuously monitored their downstream movement. Each fall there was a substantial downstream movement of parr (5-20% of fish tagged that fall), with relatively little movement in winter and summer. , whereas fish that remained were those less than 12 cm In spring 1998-2003, the smolt migration began in mid-March and ended in mid-May, with 90% occurring between April 20 and May 12. Most of the smolt migration occurred at night. From spring 1999-2003 the median date of migration varied by only 6 days over the 6 years, perhaps indicative of the photoperiodic control of smolt migration. Smolt migration in spring 2004 was earlier by 6 days than in any previous year, and although warmer than all other years was a nonlinear response to temperature. There was no apparent relationship of smolt migration to flow. There was a strong relationship between degree days in April and the median date of migration, whereas the relationship between first date of 10 oC and median date of migration

was weaker. There was a strong positive relationship between size at tagging in the fall and probability of smolting, with immature fish larger than 11.5 cm fork length having a probability of smolting nearly 100%. Estimates of winter survival for immature fish >11.5% varied substantially from year-to-year and were between 28-68%. Estimates of smolt recruitment for all fish (mature and immature fish) also varied from year-to-year and were between 19-42%.

Atlantic salmon smolt migration in the Connecticut River: mark/recapture population estimates and migratory behavior

Bob Stira, Northeast Generation Services, 301 Hammer Mill Road, Rocky Hill, CT 06067.

Since 1993, facilities at the Turners Falls (Cabot Station) and Holyoke hydroelectric projects have been used to estimate the number of Atlantic salmon smolts migrating from the upper Connecticut River basin, using mark/recapture techniques. Estimates for six of those years ranged from about 20,000 to 80,000 smolts, with confidence intervals ranging from about 23 to 53% of the estimates. During other years estimates were either not feasible (4 yr) or needed adjustment (2 yr) because of field conditions. The two adjusted estimates were about 37,000 (2001) and about 92,000 (1998). Smolt collections usually began in late April and continued through May. About 40% of marked smolts recaptured at Holyoke (51.8 km downstream of Cabot Station) arrived there within 24 h of release at Turners Falls, and about 70% arrived within 48 h; some arrived at Holyoke up to 7 d after release. There appeared to be a negative relationship between river flow volume and time elapsed between marking and recapture. Overall length frequency distribution peaked between 165 and 190 mm (TL), with a mean of about 184 mm.

A watershed-scale assessment of proportional representation and migration timing of smolts stocked in known regions above Cabot Station.

Ben Letcher[1], Kitty Griswold[1], Ken Gillette, Steve Gephard, Jay McMenemy, Mickey Novak, and Tim King. 1USGS, Conte Anadromous Fish Research Center, Turners Falls, MA 01376.

To date, it has been difficult to assess the relative production and migration timing of smolts from the many drainages in the Connecticut River basin because tagging large numbers of stocked fry has not been practical. Working with hatchery managers and personnel from the states of Vermont and Connecticut starting in 1997, we implemented a genetic marking program that allows assignment of large numbers of fry to stocking batches (locations). In 2002, 10 batches of fry were stocked into 10 drainages of the Connecticut River above the Turners Falls dam. In total, 1.8 million identifiable fry were stocked (41% of total stocked above Tuners Falls). We first tested whether a subset of fry from each stocking batch could be assigned uniquely to the correct batch. Then, in the spring of 2004, 1300 smolts were sampled at Cabot bypass at the Turners Falls dam. Of these, we have genotyped 600 to identify stocking batch (location). Our goal with this analysis was to determine 1) if smolts

collected had equal contribution from all stocking locations, 2) if smolts from the different stocking locations had equal migration timing and 3) if smolts from the different stocking locations had equal sizes.

Long-term changes in migration timing of adult Atlantic salmon at the southern edge of the North American species distribution: local adaptation or a coast-wide response to environmental change?

Francis Juanes[1], Steve Gephard, and Ken Beland. [1] Dept of Natural Resource Conservation, University of Massachusetts, Amherst, MA 01003-4210.

The Connecticut River historically represented the southernmost extent of the North American range of Atlantic salmon, but the native population was extirpated 200 years ago by dam construction. An extensive restoration effort has relied upon stock transfers from more northern rivers, especially the Penobscot River (Maine). Long-term success depends on the donor stocks adapting to the new river. Recent genetic work has shown differences between donor and derivative populations but life history traits have not been quantitatively compared. Here we focus on the timing of the adult migration. Based on data from other salmon stocks we expect that many native salmon migrated in March/April compared to May/June in more northerly stocks. We examined 23 years of migration timing data collected at two capture locations in the Connecticut drainage and found that both date of first capture and median capture date shifted significantly earlier by about 0.5 days/year. In order to conclude whether this is an adaptive change or a coast-wide effect we also quantified changes in migration timing of more northerly stocks (in Maine and Canada). We found a latitudinal pattern in the average returns dates as well as coherent patterns in the shifts towards earlier peak migration dates across the systems. These consistent shifts are correlated with long-term changes in temperature and flow, and may represent a response to global climate change.

Update on Disease Management Issues for the Restoration of Atlantic Salmon to the Connecticut River.

Trish Barbash, U.S. Fish and Wildlife Service, Lamar Fish Health Unit, PO Box 155, 400 Washington Avenue, Lamar, PA 16848.

The speaker will summarize recent pathogens of concern to Atlantic salmon restoration, with particular emphasis on *Aeromonas salmonicida* (furunculosis) and Infectious Salmon Anemia Virus (ISAv). Management strategies in place for prevention and control of disease in cultured, wild and captive stocks, as well as ramifications of disease to the restoration program will be discussed.

Physiological and behavioral effects of nonylphenol and 17ß-estradiol on larval survival and smolt development of Atlantic salmon, Salmo salar.

Darren T. Lerner[1] and Stephen D. McCormick[2]. [1]Organismic and Evolutionary Biology, University of Massachusetts, Amherst, MA USA, [2]USGS, Conte Anadromous Fish Research Center, Turners Falls, MA

01376.

Nonylphenol (NP) is widely found in effluents from sewage treatment plants and industrial sites due to its use in detergents, plastics, cleaning products, and pesticides. A direct consequence of this widespread use is its presence in rivers and estuarine systems. In this study, we examined the effects of estradiol (E2) and environmentally relevant concentrations of aqueous NP on larval survival and smolt development of Atlantic salmon. Larvae were exposed for three weeks to 10 or 100 ppb NP, 2 ppb E2, or vehicle. Animals were maintained at ambient conditions for one year and then assessed for endocrine, osmoregulatory, and behavioral disruption of smolt development. Fifty percent of larvae treated with 100 ppb NP succumbed to mortality, with less than 5% mortality in each of the other groups. Between one and two months post-treatment E2 and 10 ppb NP treatment resulted in mortality 4 to 5 times greater than controls, indicating a delayed mortality effect. These groups also exhibited decreased gill Na^+, K^+, -ATPase activity and salinity tolerance as smolts as well as a greater stress response when challenged with a handling stressor as evidenced by increases in plasma cortisol and decreases in plasma chloride in freshwater. Seawater preference of smolts exposed to E2 or 10 ppb NP as larvae was significantly reduced. These results indicate that E2 and environmentally relevant levels of aqueous NP can compromise smolt physiology and behavior and elicit stress hypersensitivity one-year following exposure. These impacts of early exposure suggest that NP and E2 can have long term, 'organizational' effects on life history events in Atlantic salmon.

Effect of hexazinone and atrazine on different life stages of Atlantic salmon.

Katherine Nieves-Puigdoller[1] and Stephen D. McCormick[2]. [1]Natural Resources Conservation and Organismic and Evolutionary Biology, University of Massachusetts, Amherst, MA 01003; [2]Conte Anadromous Fish Research Center, Turners Falls, MA, 01376.

Hexazinone and atrazine are highly mobile herbicides that are widely used along rivers in the United States. Exposure to these compounds can be potentially harmful to fish, including Atlantic salmon (*Salmo salar*), which have been recently listed as an endangered species. The objective of this study was to determine the effect of environmentally relevant concentrations of hexazinone and atrazine on larvae (soon after hatching) and smolts. Atlantic salmon larvae and smolts were exposed to 100 ppb hexazinone, 10 ppb and 100 ppb atrazine for 21 days. There was no effect of either contaminant on larval survival. Exposure to 100 ppb hexazinone, 10 and 100 ppb atrazine caused an increase in opercular movement in larvae, while only 100 ppb atrazine cause a significant weight loss. There were no mortalities in fresh water or after seawater challenge in smolts exposed to hexazinone or 10 ppb of atrazine, however 9.1% of the 100 ppb atrazine fish died. Hexazinone exposure had no effect on plasma levels of cortisol, chloride, and sodium in fresh water or after seawater challenge. Fresh water smolts exposed to 100 ppb atrazine had decreased plasma sodium and chloride ions and

increased cortisol. After seawater challenge, fish exposed to 100 ppb atrazine had a significant increase in hematocrit, plasma cortisol, sodium, and chloride. Hexazinone exposure resulted in decreased gill Na^+ K^+ ATPase activity, whereas atrazine had no effect. Growth rate for 2 months in seawater was not affected by prior hexazinone or atrazine exposure. We conclude that under the conditions imposed in this study, there was no effect of hexazinone on salinity tolerance of Atlantic salmon smolts. Hexazinone does appear to affect some features of larval respiration. Atrazine has a substantial impact on larval metabolism and causes ionoregulatory disturbance in smolts.

Methanol as a cryoprotectant for Atlantic salmon spermatozoa.

Wade A. Jodun[1], Kim King[1], Pat Farrell[1], William Wayman[2] and Greg Looney[2],[1]U. S. Fish and Wildlife Service; Northeast Fishery Center, P.O. Box 75, Lamar, PA 16848; U.S. Fish and Wildlife Service, [2]Warm Springs Technology Center, Warm Springs, Georgia 31830.

The effect of four extenders on the success of cryopreservation of Atlantic salmon *Salmo salar* sperm was tested. Extenders included: (1) Cloud extender (54.04 g/L glucose and 1.7 g/L KCl) with 5% dimethyl sulfoxide (DMSO), (2) Cloud extender with 5% DMSO supplemented with 13.3% egg yolk, (3) Cloud extender with 10% methanol (4) Cloud extender with 10% methanol supplemented with 13.3% egg yolk. Fertilization rates, expressed as the percentage of eyed embryos, ranged from 52.7 to 83.5 %. Sperm cryopreserved using Cloud with 10% methanol supplemented with 13.3% egg yolk yielded significantly higher ($F_{3, 19} = 31.4$, $P < 0.001$) fertilization rates (83.0%) than did sperm cryopreserved with the other three extenders. Our fertilization rates compare favorably to those observed for eggs from the same year class fertilized with fresh milt (81.4%) and reared at the White River National Fish Hatchery. The presence of egg yolk added to extenders incorporating 10% methanol provided additional protection to salmonid sperm during the freezing and thawing processes and resulted in an increase in survival from 72.9 to 83.5%. However, the cryoprotective effect of egg yolk may be specific to the individual formulation of extenders. In our trials, Cloud-5% DMSO without egg yolk yielded a 66.9% fertilization rate while Cloud-5% DMSO supplemented with 13.3% egg yolk, produced only 52.7% fertilization after cryopreservation. Our results indicate cryopreservation has the potential to be successfully used as a tool for Atlantic salmon management.

Factors influencing the timing of emigration of silver-phase American eels, Anguilla rostrata, in the Connecticut River at Holyoke, MA.

Bryan Apell, Chris Tomichek and Tim Sisk, Kleinschmidt Associates, 35 Pratt Street, Essex, CT 06426.

The Holyoke Hydroelectric Project Louver Bypass located in the canal system at river mile 80 in Holyoke Massachusetts was sampled almost every evening from October 1 through November 15, 2004, for emigrating silver-phase American eels, *Anguilla rostrata*. During the six weeks of

sampling , the number of eels that moved through the bypass sampler varied greatly among days, however, the eels consistently moved during the same time period within each day. The number of eels that passed through the bypass sampler was compared to the date, time of day, river flow, air and water temperature, precipitation, and moon-phase to determine if any relationships existed. These relationships were analyzed to determine which of these parameters best explained the timing of the eel movements in the Connecticut River at Holyoke, MA.

River Continuity: Reconnecting Critical Fish and Wildlife Habitat.
Brian Graber, MAEOEA Riverways Program, 251 Causeway Street, Suite 400, Boston, MA 02114.

The talk will describe the efforts of the Massachusetts River Continuity Partnership (a collaborative effort with University of Massachusetts-Extension and others) to develop protocols, standards, and techniques to identify and restore connectivity through stream crossings that are creating barriers to fish and wildlife passage. The Massachusetts Riverways Program is working to remediate ineffective stream crossings in priority streams through volunteer training, targeted technical assistance, and demonstration projects. Two stream crossing restoration projects are in progress in the Westfield watershed in brooks that are stocked with Atlantic salmon fry. On Tower Brook, the retrofit of a perched, high velocity flow culvert will include raising the tail-water pool and installing baffle structures and rock inside the culvert to eliminate perching and match flow velocities and substrate of the natural stream. Replacement of a failed double-box culvert on Bronson Brook will eliminate perching and improve flood protection for local property owners and municipal infrastructures.

American shad passage on the Connecticut River: what we've done, what we know, what to do?
Ted Castro-Santos, Alex Haro, and Tim Sullivan. USGS, Conte Anadromous Fish Research Center, Turners Falls, MA 01376.

Passage of American shad through the fishway complex at Turners Falls is poor (<1% in some years), and may be having a substantial limiting effect on the Connecticut River population as a whole. Data from five-years of monitoring with a large PIT antenna array indicate that although passage is particularly problematic at Cabot ladder, rates of entry are high: about half the fish lifted at Holyoke appear to be entering the ladder, many of these spending considerable time and energy attempting, but failing to ascend the fishway. Efforts to improve passage have been unsuccessful, although this may be in part due to river conditions that are not conducive to upstream movements Passage out of the canal through the Gatehouse fishway is also poor, however, and any improvement in passage at Cabot will need to be matched with improved passage out of the system. Unlike Cabot, the problem at Gatehouse appears to be poor attraction. Combined telemetry and hydraulic data suggest that a new entrance to the Gatehouse fishway may resolve this problem.

Linking hydrologic regime to summer growth of age-0 Atlantic

salmon.

K.H. Nislow[1], A J. Sepulveda[2], C.L. Folt[2] [1]USDA Forest Service Northeastern Research Station, Amherst, MA 01003; [2]Department of Biological Sciences, Dartmouth College, Hanover, NH 03755.

Significant reductions in growth of juvenile stream salmonids associated with low summer flow have been observed, but underlying mechanisms are poorly understood, and predictive power is limited. We conducted a stage-specific analysis of the relationship between summer flow and the growth of age-0 Atlantic salmon in two rearing sites in the Upper Connecticut River basin, New Hampshire, USA. We contrasted effects of variation in foraging habitat availability and temperature on individual age-0 salmon mass during a high- and two low-flow years and from high- and low-flow sites within years. Overall age-0 salmon mass was positively correlated with the availability of model-predicted favorable foraging locations and negatively correlated with density during the summer. Individual salmon mass, and the proportion of temperature-predicted maximum mass was lowest during the two low-flow years, and in lower in the upstream vs. downstream sections. Between-year variation in growth was not closely associated with temperature-model predictions. However, some of the difference between upstream and downstream sections appeared to be associated with lower summer temperatures in the upstream section. Our case study provides a framework for combining empirical and modeling approaches to quantify the potential impact of hydrologic change on fish growth and links variation in stream discharge to juvenile salmon performance across time and space.