From the Mountains to the Sea:

Ecosystems in Action

34th Annual Meeting
Atlantic International Chapter
September 21 – 23, 2008
Digby Pines Inn, Nova Scotia

Agenda

Sunday, September 21st

3:00 pm - 7:00 pm	**Registration**
5:30 pm - 6:30 pm	**Student Sub-unit Development Meeting**

Sunday Evening Session (and Mixer)	**Chair: Joan Trial**
7:10 pm - 7:30 pm	**Paul Christman** - Planting Atlantic Salmon Eggs With A New Hydraulic Planter
7:30 pm - 7:50 pm	**Ernie Atkinson** - 2008 Dennys River Alewife Trapping Activities on the Dennys River, Maine
7:50 pm - 8:10 pm	**Joan Trial** - Managing Expectations
8:10 pm - 10:00 pm	Mixer and BBQ

Monday, September 22nd

7:30 am - 10:00 am	**REGISTRATION**
7:00 am - 8:00 am	**BREAKFAST**
8:15 am - 8:30 am	**WELCOME AND INTRODUCTIONS**
8:30 am - 8:50 am	**Key Note Speaker: Jennifer Graham -** Reconnecting the Coast: Collaborative Action for Nova Scotia's Coasts and Watersheds

Diadromous Fisheries Management	**Chair: Jon Carr**
8:50 am - 9:10 am	**W.M. von Zharen** - International Legal Regimes in Ecosystem Management of Ocean Fisheries
9:10 am - 9:30 am	**Karen Wilson -** Diadromous Species Restoration Research Network (DSRRN): A New Five-year Collaborative Effort
9:30 am - 9:50 am	**Eva Walker -** Restoration of Ridge Brook: A Restoration Success Story in the Making?
9:50 am - 10:10 am	**Dylan Weese** - Fish population recovery following collapse: do maladapted immigrants contribute?
10:10 am - 10:40 am	**BREAK and Posters**

10:40 am - 11:00 am	**Martha Jones -** Bad company: invasive swim bladder nematode found in American eels in Cape Breton, Nova Scotia
11:00 am - 11:20am	**Christina C. Pater** - Diel Movement Patterns of Estuarine Fishes in an Eelgrass Habitat
11:20 am - 11:40 am	**Jonathan Carr** - Migration of silver American eels past a hydroelectric dam and through a coastal zone.
11:40 am - 12:00 pm	**Tara Trinko** - The use of GIS based modeling to establish basin specific fisheries goals and prioritize restoration efforts in the Penobscot River Basin (Maine, USA).
12:15 pm - 1:15 pm	**LUNCH**

Restoring Critical Connections from the Mountains to the Sea	**Chair: Katrina Mueller**
1:20 pm - 1:40 pm	**Katrina Mueller** - A Focus Area Approach to Restoring Coldwater Salmonid Habitat in Eastern Maine
1:40 pm - 2:00 pm	**Scott Craig** - Assessing the Efficacy of Fish Presence and Species Composition at GIS-Derived Stream-Road Crossings in Low Gradient Headwater Streams in Downeast Maine
2:00 pm - 2:20 pm	**Steve Koenig** - Log Drive Dams: A legacy of remnant hydraulic checks
2:20 pm - 2:40 pm	**John Bagnall** - Downstream Atlantic Salmon Passage Project - Tobique River, NB
2:40 pm - 3:10 pm	**BREAK and Posters**
3:10 pm - 3:30 pm	**Mark Whiting** - The potential for terrestrial limestone or in-stream clam shell applications to buffer salmon streams from acid rain effects.
3:30 pm - 3:50 pm	**Trent Liebich** - Water chemistry and its associated impacts on the physiology and survival of Atlantic Salmon (Salmo salar) smolts in eastern Maine, USA
3:50 pm – 4:10 pm	**Adria Elskus** - Multiple stressor effects in early life stage Atlantic salmon (Salmo salar): blueberry pesticides, acid, aluminum
4:10 pm - 4:15 pm	**Wrap up Monday**
4:15 pm - 5:00 pm	Break and time to move to whale watch
5:00 pm - 8:00 pm	**Whale Watching Excursion**
6:30 pm – 10:00 pm	**DINNER** (dinner will still be available after the whale watch tour)

POSTER PRESENTATIONS

Jason LeBlanc – Nesting Success of Small Mouth Bass (*Micropterus dolomieui*) in Nova Scotia: Preliminary Assessment of Factors Affecting Nest Success

MacMillan, J.L. and R.J. Madden - Biological characteristics and population status of anadromous brook trout (Salvelinus fontinalis), 66 years after an initial study, in Moser River, Nova Scotia, Canada.

Mark Hamilton - Nova Scotia's Learn to Fish Program (L2F)

Tuesday, September 23rd

7:00 am - 8:00 am	**BREAKFAST**
8:00 am - 10:00 am	**BUSINESS MEETING**
9:50 am - 10:20 am	**BREAK and Posters**
Fishery Management and Enhancement Strategies	**Chair: Paul Christman**
10:20 am - 10:40 am	**Joan Trial** - Adaptive management: linking Atlantic salmon and habitat
10:40 am - 11:00 am	**Charles Ayer** - Myths and Realities of Trout Regulations
11:00 am - 11:20 am	**Paul Christman** - Differential Survival of Streamside Incubated and Hatchery Incubated Atlantic Salmon to the Smolt Stage
11:20 am - 11:40 am	**Jason LeBlanc** - The history of freshwater fish introductions in Nova Scotia: balancing prevention and promotion
11:40 am - 12:00 am	**RAFFLE AND FISHING CONTEST AWARDS AND WRAP UP**
12:00 pm - 1:30 pm	**Lunch**
	Note: Ferry to Saint John departs at 4:30 p.m.

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List of Abstracts

Presentations:

International Legal Regimes in Ecosystem Management of Ocean Fisheries

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Various principles for stewardship of the ocean's fisheries are embodied in a prodigious number of international, regional, and nation-state regimes. These regimes have proved to be ineffective in slowing the clear-cutting of the world's oceans and restoring the rich fabric of the global and coastal marine environment. This article explores the reasons for this ineffectiveness and suggests that the primary problem is that no regime focuses on the ocean's fisheries as an interconnected biotic circle. Instead, the regimes typically represent a disjointed, piecemeal, and/or single-species approach concentrating on players as if they were autonomous and isolated. Part I begins by highlighting the importance of the ocean fisheries followed by examples of complex, multiple anthropogenic stressors that disturb the ecosystem, e.g., by-catch of non-targeted fish, invasive species from ballast water and other vectors, pesticide run-off, atmospheric deposition and vessel operational pollution, erosion and habitat destruction from coastal construction, over-fishing, and economic subsidies. The section then canvasses the plethora of international legal regimes aimed at stewarding fisheries. Part II explores general management theories and codes and proposes adaptive management based on an eco-market strategy as a basis for effectuating a commitment to ecosystem stewardship of ocean fisheries pragmatic strategy for individual organizations and businesses. It postulates that once this basis is formed, the possibility of creating an effective global initiative for an ecosystem approach to ocean fisheries management is greatly enhanced. Global models are offered with requirements for implementing a worldwide initiative: To return fishing ecosystems to stability and health requires an international policy re-tooling predicated on the principle that the marine ecosystem for fisheries is interconnected and interdependent and, as such, requires switching from a single-species stewardship approach to a holistic one that considers the role of all stakeholders.

Diadromous Species Restoration Research Network (DSRRN): A New Five-year Collaborative Effort

D. Hart[1], **K. Wilson[2]**, P. Vaux[1], and A.A. Elskus[3]
[1]*Mitchell Center for Environmental & Watershed Research, University of Maine, Orono, ME 04469*
[2]*Aquatic Systems Group, University of Southern Maine, Portland, ME 04101*
[3]*U.S. Geological Survey, S.O. Conte Anadromous Fish Research Lab, University of Maine, Orono, ME 04469*

Diadromous fish populations are undergoing steady declines in the US leading to threatened and endangered listings. The central goal of the Diadromous Species Restoration Research Network (DSRRN) is to leverage, expand, and integrate the diverse array of research and management activities focused on the restoration of diadromous fish species in ways that improve ecological understanding and enhance restoration outcomes. The strength of the DSRRN is its connection to and integration with the Penobscot River Restoration Project (Maine), the most ambitious restoration effort ever proposed for a watershed of this size. Within this context unparalleled opportunities exist to study questions fundamental to diadromous fish ecology and restoration, including: the role of diadromous fish in marine-freshwater linkages, the interdependency of co-evolved diadromous species, multi-species interactions in a restoration context, and the effects of multiple stressors on restoration results. DSRRN will work to coordinate the overlapping/ interconnected research efforts of academic, government, tribe and watershed stakeholders, provide administrative structure, and support data management. This grant will support two scientific meetings to identify critical research areas in multi-species restoration (Year 1) and synthesize outcomes (Year 5), and three interactive workshops targeting critical research topics (Years 2, 3 and 4). We anticipate at least one synthesis paper per workshop and several master's theses focused around workshop topics and diadromous species.

The issue of diadromous fish restoration is complex and it is only through a broad collaborative approach drawing on data and knowledge from other systems, worldwide, that progress may be achieved and mis-steps minimized. Through RCN-facilitated research partnerships that place mission-driven restoration efforts in an integrated science context, key basic and applied research needs can be identified that might otherwise be overlooked. By actively engaging stakeholders, the RCN will facilitate public understanding of the critical role that science plays in guiding ecological restoration.

Restoration of Ridge Brook: A Restoration Success Story in the Making?

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The restoration of a section of Ridge Brook, New Brunswick was undertaken by Parish Geomorphic for a local watershed group to improve fish habitat, in particular that of Atlantic salmon. Often pre-restoration measures of fish populations are not undertaken for these types of projects. The restoration of Ridge Brook is an exception to this rule. Population assessment had occurred at a degraded section of the brook for several years pre restoration and yielded 3- 4 species in low numbers. Post restoration 11 species were found in overwhelming numbers. This success not only confirmed the value or habitat restorations, but has raised interesting questions about the re-colonizing community post-restoration. This presentation covers the techniques used in the restoration, the pre and post construction fish population survey and the outcomes of the project.

Fish population recovery following collapse: do maladapted immigrants contribute?

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Natural and anthropogenic disturbance may often decimate local populations of fishes. Two sources theoretically exist for subsequent population growth and recovery, the drastically depleted population of locally adapted individuals or a pool of immigrants from surrounding populations. The rescue effect predicts that immigrants may serve to sustain populations subjected to harsh conditions. However, if immigrants are maladapted, their contribution may be limited, positive, or detrimental with regard to population growth. Populations of Trinidadian guppies are locally adapted to alternative predation regimes within coastal river systems where migration is biased from low-predation (upstream) into high-predation (downstream) populations. Recently, heavy floods decimated the locally adapted high-predation sections of the Marianne River, whereas low predation populations remained largely intact; presenting us with an opportunity to evaluate the demographic consequences of selection on experimentally introduced migrants during population recovery. We used mark-recapture and genotyping approaches in natural, and experimentally enclosed (no predation), populations to evaluate differential selection acting on migrant and resident guppies in the high-predation habitat. Population genetic assignment tests quantified the relative demographic contributions of these ecotypes to subsequent recruitment and population growth of the experimental population. Our finding suggest very strong selection against immigrants that helps preserve mean population fitness, but also likely slows the rate of population recovery relative to ecological expectations.

Bad company: invasive swim bladder nematode found in American eels in Cape Breton, Nova Scotia

Martha Jones, Cheryl Wall, Lydia Rockwell, David Cone, and Rod Bradford

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Affiliations: Cheryl Wall, Saint Mary's University and Cape Breton University
Lydia Rockwell, Saint Mary's University and Cape Breton University
David Cone, Saint Mary's University
Rod Bradford, Department of Fisheries and Oceans, BIO

In the summer of 2007, American eels, *Anguilla rostrata*, from 2 localities on Cape Breton Island were found to be infected with the swim bladder nematode *Anguillicoloides crassus*. Infection of the swim bladder by *A. crassus* may cause thickening, disruption, or even rupture of the bladder wall, increased anal redness, secondary bacterial infections, decreased host energy level, and it has been speculated that it may interfere with eel migration to spawning grounds in the Sargasso Sea. In 2007, more than half of the yellow eels sampled in the Mira River (6 of 10), and 1 eel (of 5) from Sydney Harbour were infected. Parasite intensity ranged from 1 to 11 nematodes per eel. The occurrence of *A. crassus* at these 2 localities prompted a more extensive survey in 2008 on the distribution of this exotic parasite in eel populations throughout Cape Breton Island. Preliminary results from three survey locations in eastern Cape Breton are not encouraging. Parasite prevalence was 50% in Big Lorraine (n = 6), 76% in Mira River (n = 13), and 100% at Morrison's Beach (n = 9). The mean intensity of nematodes per infected eel at the 3 sites also differed: 1.2 ± 0.7 (mean ± s.e.), 2.5 ± 0.8, and 6.6 ± 2.2 at Big Lorraine, Mira River and Morrison's Beach, respectively. The number of nematodes per infected eel ranged from 2-4 nematodes per eel in Big Lorraine, 1-8 in Mira River, and 1-18 in Morrison's Beach. Numerous organizations are urgently working together to better understand the impact of *A. crassus* on eel populations in Cape Breton; and a large-scale collaborative effort is underway to assess the present status of the parasite in the Maritime Provinces.

Diel Movement Patterns of Estuarine Fishes in an Eelgrass Habitat

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Estuaries are highly productive coastal regions that provide important habitat for a wide variety of plant and animal species. In particular, eelgrass (*Zostera marina*) L. is a crucial component of the estuarine ecosystem providing nursery areas, foraging grounds and offer protection for many commercial and non-commercial fish species. In recent years there have been reports of large declines of eelgrass within estuaries across the Atlantic region. The objectives of this study were to assess the diel and tidal changes of the nearshore estuarine fish community within eelgrass beds to better understand their role in fish community dynamics. Using a 10m beach seine, two regions of an eelgrass bed were sampled every 4h throughout a 24h period twice each in June, July and August during a neap tide event. All captured fish were sorted, identified, counted and released. Preliminary results show notable differences in the diel movement patterns of some estuarine fish species.

Migration of silver American eels past a hydroelectric dam and through a coastal zone.

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We sonically tagged 25 silver American eels to document their passage success at the Magaguadavic Rivers recently reconstructed hydroelectric facility, and to explore the environmental correlates of surviving eel movements through the coastal zone to the Bay of Fundy. Downstream movements of many eels were delayed at the dam and tagged fish moved extensively in the reservoir, presumably searching for an exit. All 19 eels that entered the turbines died. Six eels survived by passing the dam either via a fish bypass chute (4), by spilling over the dam (1), or through a fish ladder for upstream migrating fish (1). Coastal zone movements of 20 control eels released below the dam, and of the six survivors, were linked to environmental parameters (tides, luminosity). The efficiency of the downstream fish bypass at this site might be improved by altering water management strategies.

The use of GIS based modeling to establish basin specific fisheries goals and prioritize restoration efforts in the Penobscot River Basin (Maine, USA).

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The Penobscot River Restoration Project (PRRP) is a multimillion dollar endeavor that aims to restore self sustaining populations of native sea-run fish through the removal of two mainstem dams and improved fish passage at numerous other dams on the Penobscot River. While many diadromous species will benefit from the PRRP directly, other species such as endangered Atlantic salmon (Salmo salar), alewife (Alosa pseudoharengus), and American shad (Alosa sapidissima) may require additional habitat improvements (barrier removal, fishways, etc.) or stocking. Thus, additional active restoration measures may be required to realize the full potential of the PRRP. Due to the high profile and high cost of the project (as well as the number of State, Federal and non governmental organizations involved), there is a need to prioritize restoration efforts in the basin to increase the probability of project success. To help facilitate this goal, we created an ecologically-based GIS tool to help establish restoration goals and to identify and prioritize restoration opportunities (stocking options, barrier removal, and fishway improvements). Initial data inputs for the model include spawning habitat for a number of focal species, a habitat weighting variable, and passage barriers (location and passage state). The outputs of the model are

ecologically-based targets for the focal species and prioritized lists of restoration projects based on their biological merits. These outputs will help ensure that achievable goals are established, and that funding and restoration efforts are applied in the most appropriate manner.

A Focus Area Approach to Restoring Coldwater Salmonid Habitat in Eastern Maine

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Through the efforts of concerned landowners, salmon anglers, businesses and various government agencies, Project SHARE (Salmon Habitat and River Enhancement) was founded in 1994 as a forum to cooperatively protect and enhance coldwater salmonid habitat. Since its inception, SHARE has carried out extensive and focused restoration efforts in the Downeast Region of Maine, particularly the Machias River watershed and corridor. Current impediments to habitat connectivity and stream function, as well as opportunities to restore coldwater refugia and rearing habitat within this current focus area have been identified in collaboration with state and federal agencies and other partners. Specific sites have been prioritized for restoration based proximity to mapped salmon habitat and location within sub-watersheds that currently support native brook trout populations and are high ranking in terms of habitat quality and future security from anthropogenic threats. To date, SHARE has carried out cooperative on-the-ground projects informed by those assessments that have 1) corrected stream crossings currently hindering movement of resident native brook trout and blocking Atlantic salmon parr from accessing historically-available rearing habitat and coldwater refugia, 2) restored connectivity in tributaries to mainstems containing mapped Atlantic salmon habitat, 3) reestablished bank-full, natural bottom channels at each crossing to restore natural gradient and flow, temperature and sediment regimes, 4) promoted innovative and cost-effective solutions for the landowner related to decreasing road maintenance costs while at the same time improving aquatic habitat for Maine's unique salmonids. Specific accomplishments to date include the decommissioning (pulling) and replacement of over 30 undersized and perched culverts with open bottom arched culverts, installation of a 125 ft bridge for ATV use over high quality spawning habitat on a DPS river, and, most recently, documentation and removal of historic and remnant log drive structures causing hydrologic checks and warming above restored sites. Pilot projects are underway to enhance pH related water chemistry with terrestrial additions of limestone and instream additions of clam shells.

Assessing the Efficacy of Fish Presence and Species Composition at GIS-Derived Stream Road Crossings in Low Gradient Headwater Streams in Downeast Maine

S. Craig[1], I. Lowery[2]
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The status and distribution of Brook trout is of particular concern in Maine, where high road densities have been shown to disrupt movements of small bodied fish. Identifying headwater habitats, distributions, and interactions with other species is therefore critical for the long-term management of this stenothermic cool water species. Since managers routinely utilize GIS stream-road layers to locate sampling locations, and to assess potential threats, understanding the potential pitfalls of these data layers is crucial to accurately monitor and manage headwater trout populations.

We assessed the efficacy of using GIS-derived stream-road crossings as a means to determine actual fish presence in two Machias River sub-basins. Locations of actual stream-road crossings in this study were determined by conducting comprehensive road surveys. Fish presence-absence, as well as species composition, was determined by one-pass electro-fishing surveys, where approximately 100 m of habitat was surveyed above and below each crossing during summer base flows in 2007-08. Stream-road crossings with watersheds >15.5 km^2 were excluded from the species distribution comparisons because of sampling inefficiencies associated with electro-fishing deeper-wider streams and trout's summer preference for colder headwater streams.

Fish presence was determined at 87 crossings- Old Stream (43) and W.B. Machias (44), while GIS-derived stream-road crossings indicated only 50 crossings with observed fish presence - Old Stream (25) and W.B. Machias (25). GIS-derived crossings thus underestimated actual fish observations by 43%. Additionally, GIS-derived crossings accounted for only 33% (27 of 82) of sites that had Brook trout observed.

When assessing the accuracy of GIS stream-road layers, we found that the road layer was accurate at 81% (70) of fish bearing crossings, but the hydrological layer was correct at only 52% (45).

Our results suggest that the National Hydrography Dataset layer (01050002) is grossly insufficient to identify Brook trout habitats in low gradient headwater streams in Downeast Maine watersheds.

Log Drive Dams: A legacy of remnant hydraulic checks

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In Maine, dams were and continue to be a major impediment to Atlantic salmon migration and recovery. However, few dams remain on Downeast DPS rivers and those located on mainstems have some form of fish passage. As part of our focused watershed assessments in Eastern Maine, Project SHARE has been documenting the locations of historic log drive dam sites in the Machias River watershed. With the end of the log drive era (circa 1970) the remaining dams on the mainstem of the Machias River were removed. Upon closer inspection, however, it appears that habitat impacts remain long after dam removal. A review of mapped Atlantic salmon habitat indicates that reaches immediately upstream of historic dam locations do not possess stream attributes suitable for spawning or parr rearing. Aerial photography reveals the presence of over-widen channels and historic reservoirs upstream of documented dam sites. Site specific assessments include longitudinal stream profiles and transects, pebble counts, temperature monitoring, electrofishing, and collection of aquatic macroinvertebrates. Longitudinal profiles reveal the presence of hydraulic checks where dams were not completely removed to the natural stream bottom. As a result of over-widening and decreased current velocity caused by remnant dams, benthic structure upstream of the dam site consists of accumulated fine sediment. Preliminary results suggest that while historic dam sites do not present a barrier to fish passage, habitat alterations remain long after the dam was breached. Pilot projects are underway to determine the impact of removing the remnant hydraulic check and restoring the original longitudinal profile.

Downstream Atlantic Salmon Passage Project - Tobique River, NB

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The St. John River was formerly the number three anadromous Atlantic salmon producer in New Brunswick behind the Miramichi and the Restigouche. Increased high seas mortalities and the effects of hydropower development have cumulatively resulted in an approximate 90% reduction in the returning salmon numbers to the upper St. John River. Coded wire tag studies in the 1990s demonstrated that approximately 50% of the smolts produced in the major upper river died before they reached the head-of-tide near Fredericton. In the early 00s there were not enough returning wild salmon returns to successfully operate the Mactaquac hatchery, which was in 1967 constructed to mitigate hydropower effects. The Department of Fisheries and Oceans instead now captures wild juvenile salmon in the major up-river spawning tributary, The Tobique River, raises them to mature adults in the hatchery and releases them to the river to spawn naturally. The goal is to produce 40% of the required smolts from the Tobique or ~120,000 of them using this strategy. One problem with this system is that all of the smolts must then pass three power dams during their downstream migration.

Since the early 1990s downstream smolt passage has been promoted by a committee of the NB Salmon Council. In 2005, AMEC in conjunction with Ben Rizzo of the Conte Institute prepared a conceptual design for a facility to be placed on the Tobique Narrows Dam, which is located at the confluence of the Tobique River with the St. John River. A collection gallery design was selected from a menu of three options which also included a fish fence with transport and a guidewall that would direct the smolts to a top-opening spillway gate opening in the dam. All of the options included an option to collect the fish and to actively transport them downstream of all three downstream dams.

The potential for terrestrial limestone or in-stream clam shell applications to buffer salmon streams from acid rain effects.

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Maine's eastern salmon rivers (i.e., the Narraguagus R, Pleasant R, Machias R, East Machias R, and Dennys R) are affected by acidic episodes due to acid rain. State and Federal recovery plans have made acid rain mitigation a priority, yet very little has been done so far. In the spring of 2007, Project SHARE, a coalition of government agencies, private landowners, and grass-roots watershed associations, put limestone gravel on logging roads to improve the road surface for truck traffic, fix existing erosion problems at stream crossings, and to provide a source of calcium and buffering capacity to nearby streams. Results show that terrestrial applications do provide a small amount of acid rain protection, ranging 0-0.5 pH units, depending on rain and stream conditions. However, in order to protect young salmon from low pH, low calcium, and high aluminum concentrations, we need to begin in-stream applications. Preliminary results show that clam shells loose 0.5 to 1% of their weight per day in streams that range from pH 5-6 during baseflow conditions. The shells are rapidly colonized by aquatic insects and apparently do not cause stream embeddedness. We are planning larger scale studies that will test the idea that shells can dissolve fast enough to provide adequate buffering capacity to protect endangered fish populations.

Water chemistry and its associated impacts on the physiology and survival of Atlantic Salmon (*Salmo salar*) smolts in eastern Maine, USA

Trent Liebich, Steve McCormick, Dan Kircheis, Ken Johnson, Ron Regal, and Tom Hrabik

We conducted a streamside rearing study in eastern Maine from 2004-2006 that investigated the physiological effects of episodic acid and aluminum fluctuations on Atlantic salmon (*Salmo salar*) smolts. Rivers in Eastern Maine are typically characterized as having episodes of pH declines associated with rain and snowmelt events, and varying levels of aluminum and dissolved organic carbon (DOC). During the normal spring migration period Atlantic salmon smolts were exposed to ambient river conditions at 9 sites in 4 eastern Maine watersheds for three and six day intervals. After the exposure periods, smolts were assessed for plasma chloride, plasma glucose, gill aluminum, and gill Na^+, K^+ ATPase levels in relation to ambient water chemistry. During the study period pH at most locations was below 6.0 in 2005 but typically remained above 6.0 in 2004 and 2006. Throughout the study DOC levels varied greatly between sites; ranging from 1.9-15 mg/L. Our results indicate a strong correlation between stream pH and both plasma chloride and glucose levels in salmon blood. Additionally, our results suggest an increasingly negative physiological response of Atlantic salmon smolts to pH as it declines below 5.9. Varying pH thresholds for this negative response occurred between pH 5.5 and pH 5.9 depending upon the physiological parameter observed. Although there were no mortalities during episodes of pH below 5.9 in streams with DOC greater than 4.2 mg/L, a loss of plasma ions indicates potentially compromised seawater tolerance of smolts. In East Bear Brook, a stream with DOC below 1.9 mg/L and pH < 5.9, mortalities of smolts occurred in freshwater and the remaining live smolts exhibited gill aluminum concentrations commonly exceeding 500 µg/L, plasma glucose often higher than 20 millimoles, and plasma chloride levels frequently below 100 millimoles. Our results indicate that whenever an acidification event in which pH drops below 5.9 coincides with smolt migration in eastern Maine rivers, there is likely to be physiological compromise. This physiological compromise may reduce smolt survival as they transition from freshwater to the marine environment. In rivers and streams with very low DOC, the threshold for negative physiological effects and mortality likely occurs at a higher pH and/or shorter exposure period than in rivers with higher DOC.

Multiple stressor effects in early life stage Atlantic salmon *(Salmo salar)*: blueberry pesticides, acid, aluminum

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Maine rivers experience a broad range of stressors, including acidity, aluminum (Al), endocrine-disrupting chemicals, organochlorines and pesticides, some of which may be present simultaneously. Exposure to multiple stressors can have effects on organisms that cannot be predicted from exposure to individual stressors alone (*Relyea et al.*

2001). Blueberry pesticides, acidic water and Al combinations are present in some Downeast rivers, but their potential effects on resident Atlantic salmon (*Salmo salar*) are unknown. Additionally, selected pesticides are being proposed to supplement those currently used in Maine, but their effects on salmonids are unknown. We hypothesized that combinations of acid/Al (AA) + pesticides would have stronger sub-lethal effects on early life stage salmon than either stressor alone. Our objectives were to determine whether pesticide-contaminated, acid/Al rivers pose a greater threat to salmon than pesticide-contaminated rivers alone, and to provide data on the potential effects of candidate pesticides on sensitive early-life stages before these pesticides come into use. We exposed F2 Penobscot River Atlantic salmon swim up fry to the current use herbicide formulation, Velpar™ (active ingredient hexazinone), or its supplement, Callisto™ (active ingredient mesotrione), at environmentally realistic concentrations (0.75 ppb a.i.) and at concentrations ten fold higher (7.5 ppb a.i.), in the presence and absence of high acidity (pH = 3.9 - 5.2) and elevated inorganic (toxic) aluminum (254-724 ppb). To better mimic real world conditions in which dissolved organic carbon significantly affects the availability of toxic aluminum, dosing solutions were made up in Machias River water (DOC = 7.2 mg/L). Fish were exposed for 5 days in a flow-through system at 14°C. We evaluated survival and prey capture; immune function assays were inconclusive. Pesticide treatment alone had no effect on survival relative to untreated controls, but AA treatments significantly reduced survival. Of the four multiple-stressor (pesticide +AA) groups, three sustained mortalities significantly higher than those of the AA control. However, it is likely that the dramatic drop in pH on day 2 (pH 3.8-4.3 across all acid/Al treatments), rather than a multiple-stressor effect, drove this difference in mortality. High variability masked potential treatment effects on prey-capture. We conclude that blueberry pesticide effects on prey capture and survival may increase in the presence of acid/Al, but high variability among replicates, and the dramatic drop in pH on day 2, confound interpretation of the data. Life-cycle exposure studies using buffered and un-buffered river water are planned.

Relyea, R.A., Mills, N., 2001. Predator-induced stress makes the pesticide carbaryl more deadly to gray treefrog tadpoles (*Hyla versicolor*). Proc. Nat. Acad. Sci. USA **98**: 2491-2496.

Adaptive management linking Atlantic salmon and habitat

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Adaptive management is a systematic process for continually improving management in complex systems by learning from research and operational programs. Stocking river-specific fry in the spring has been the primary method used for restoring Atlantic salmon populations in much of Maine. By assessing juvenile populations and habitat, we are attempting to understand the factors that influence the resulting populations where fry are stocked. Research indicates that stocked fry move quickly to the river bottom upon stocking and then volitionally disperse downstream at night. Research and operational assessments document that dispersal by the end of the summer can extend up to 1.5 km downstream and 0.5 km upstream, depending on habitat interspersion and the presence of physical barriers. Salmon seemed to select habitat based on physical quality and presence of competitors. A meta-analysis demonstrated that stream size serves as a surrogate for a suite of environmental conditions affecting juvenile carrying capacity. In part this suite includes; habitat complexity, substrate embeddedness, competitors (e.g. smallmouth bass), temperature, and hydrologic conditions. Relative stream productivity, which can be gleaned from bedrock type, water quality (e.g. pH, ANC), leaf processing rates, and conductivity, is integral to assessing carrying capacity. Based on these insights, we have identified and assisted in opening fish access to small streams; allocated fry from low productivity mainstem habitat to productive, previously and newly accessible, mid-sized and smaller streams; added wood to streams to increase complexity, change sediment storage, and reduce embeddedness; point stocked fry to allow natural dispersal and habitat selection; and adjusted fry stocking rates based on juvenile production. We will continue monitoring and analyses in conjunction with operational level habitat modifications and stocking strategy changes to ensure that recovery of Maine salmon populations is adaptive.

Differential Survival of Streamside Incubated and Hatchery Incubated Atlantic Salmon to the Smolt Stage

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In the past five we have used streamside incubation as a novel low-cost technique to supplement endangered Atlantic salmon populations. One benefit of streamside incubation may be improved overall performance over hatchery-reared fry. To test this hypothesis we compared the survival of one year class of streamside incubated hatchery-reared fry. Equal numbers of fry from streamside incubators and from Craig Brook National Fish Hatchery were stocked in the West Branch of the Sheepscot River. Fish were sampled in the fall at age 0+, 1+ and in the spring at the smolt stage and assigned to origin using DNA fingerprint. Even though fry were released at equal numbers, by the 0+parr life stage the streamside incubated group was three times as numerous as the hatchery group. The numbers for each group at each of the three sampling events were 37 hatchery and 114 streamside incubated 0+parr, 24 hatchery and 66 streamside incubated 1+parr and 35 hatchery and 90 streamside incubated smolts. The survival advantage in the first year carried all the way through to the smolt stage suggesting that streamside incubation may be an effective management option to increase production of naturally-reared smolts.

The history of freshwater fish introductions in Nova Scotia: balancing prevention and promotion

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The freshwater recreational fishery of Nova Scotia has developed on a historical preference for salmonid species such as speckled trout (Salvelinus fontinalis) and Atlantic salmon (Salmo salar). The introductions of freshwater fish, both indigenous and non-indigenous, has a long history in Nova Scotia motivated primarily to develop recreational fishing opportunities and augment existing fisheries for native species. Rainbow trout (Onchorynkiss mykiss) were first introduced in 1899, brown trout (Salmo trutta) in 1924 and lake whitefish (Coregonus clupeaformis) from 1878 to 1908 in 31 lakes preceding later introductions of lake trout (Salvelinus namaycush) that took place from 1892 to 1963. Intentional releases of smallmouth bass (Micropterus dolomieu) occurred starting in 1942 while illegal introductions of chain pickerel (Esox niger) began in 1945. Atlantic salmon, speckled trout, brown trout and rainbow trout continue to be enhanced through popular hatchery programs. In order of preference, 3 of the top 5 species and 43.2 % of angling effort is directed towards introduced species. The ecological risk associated with introductions differs among species and targeted educational programs have been developed both nationally and provincially and are often directed to specific watersheds where introductions of undesirable species are of particular concern. These programs focus on increasing public awareness of the potential impacts of illegal introductions and prevention of further occurrences. Conversely, where introductions of brown trout, smallmouth bass and chain pickerel have resulted in established populations or where continued introductions of rainbow trout have sustained fisheries, there are important economic benefits of maintaining a diversified recreational fishery. However, within the context of the current sportfishery of the province, there remains a perception of risk associated with introductions of certain species (particularly non-salmonids) and a difficulty balancing public perception of ecological risk, measurable or not, with sportfish promotion and economic benefit.

Posters:

Nova Scotia's Learn to Fish Program (L2F) Recreational

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Sportfishing has declined in Canada. Western provinces have addressed this issue by developing programs for youth. Nova Scotia has taken initiative to increase sportfishing by introducing a youth fishing program. Learn to Fish (L2F) was launched in 2006 in Halifax and was designed to promote the sportfishery. L2F is aimed at youth to provide them with the education and skills to enjoy sportfishing. The classroom presentation includes local sportfish, habitat, and fishing basics. The outdoor lesson is a hands-on fishing session. Workshops are held in schools, community groups and camps. Teachers found the material complementary to topics in curriculum and reinforced healthy, outdoor living. L2F recruits the next generation of stewards of aquatic resources by teaching safe angling skills. L2Fs objective is to introduce youth to sportfishing in a fun, safe environment with mentors that can teach basic angling. L2Fs goal is to ensure youth have a positive sportfishing experience.

NESTING SUCCESS OF SMALLMOUTH BASS (MICROPTERUS DOLOMIEUI) IN NOVA SCOTIA: PRELIMINARY ASSESSMENT OF FACTORS AFFECTING NEST SUCCESS RATES

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Smallmouth bass were first introduced in Nova Scotia in 1942, are now established in more than 200 lakes and contribute substantially to the sport fishery. Nest success rates were assessed in 7 lakes (567 nests). All nests were assessed for habitat features such as substrate, cover, depth and distance from shore and categorized by stage whereby class A = newly excavated nest, class B = eggs present, class C = newly hatched black fry present, class D = swim up fry present, class F1 = a nest abandoned after previously being assessed as class A and class F2 = a nest abandoned after previously being assessed as class B or C. Class D or successful nests ranged from 16 to 70% in a given lake (mean = 32.8%). Total nest starts increased with temperature but was variable among lakes and in the same lake from year to year. Preferred substrate was dominated by cobble, gravel or a cobble-gravel combination, accounting for 94% of all substrate types. Nest cover also varied from lake to lake and was dominated by large woody debris such as logs and boulders. Success rates were low in other substrate types (silt, detritus, rock, or vegetation), 0-25%. Nest depth (0.1 1.6 m, P

Biological characteristics and population status of anadromous brook trout (Salvelinus fontinalis), 66 years after an initial study, in Moser River, Nova Scotia, Canada.

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Brook trout (Salvelinus fontinalis) are the most popular native sport fish in Nova Scotia. The annual catch of brook trout has declined since the early 1980s and may reflect a change in the brook trout resource. Nova Scotia's relatively short river systems are believed to facilitate anadromy in many brook trout populations and these trout are important to the sport fishery.

Moser River is located (N 44 58 34.9 W 62 15 11.6) on the Eastern Shore in Halifax County, Nova Scotia. Live release traps were used to assess brook trout population parameters in the same locations as in the historical studies conducted on the Moser River by White (1940 and 1941). Wilder (1952) described growth and age of the anadromous trout population from Moser River. In general the pattern of movement of anadromous brook trout was similar in 2006 compared to White (1940 and 1941), as downstream migration to the sea occurred in May and most of the upstream migration to freshwater occurred in July. However, a greater proportion of upstream migrating brook trout were detected in June in 2006 compared to June of 1939 to 1941. Anadromous

populations in southern regions of the distribution of brook trout migrate earlier to and from salt water.

The level of precipitation in June 2006 was well above the 40 year mean and the resultant high water conditions created difficulties in maintaining live traps in the main river site. The number of migrating trout counted from the 2006 Mill Brook site was compared to fish counts from 1939 to 1941. The number of brook trout trapped per day in Mill Brook, a major tributary of Moser River, suggests that the number of anadromous brook trout had declined in 2006 compared to 1939 to 1941. The mean number of brook trout caught per day in July was 5.7 ±5.8 (mean, SD) in 1939, 11.5 ±8.5 (mean, SD) in 1940, 21 ±13.1 (mean, SD) in 1941, and 1.8 ±1.9 (mean, SD) in 2006. The size structure of brook trout with a fork length longer than 200 mm indicated that the proportion of large trout in the 2006 population was less than historical levels. The proportion of large (fork length >300 mm) brook trout captured migrating upstream in July was 26% in 1940 (N=114), and 27% in 1941 (N=149), and 3% in 2006 (N=2). In 2006, fork length of anadromous brook trout was 198 mm ±25 (mean, SD) at two years of age and 259 mm ±34 (mean, SD) at three years of age and was similar to mean fork length at age data from 1939 to 1943. The oldest brook trout aged was four years from 2006 and was six years from 1939 to 1943. A maximum age of four years, for the 2006 study, was consistent with the results from other recent studies on anadromous brook trout populations in Nova Scotia.

Paleolimnological techniques and direct YSI meter measures indicate that water acidity increased and acid neutralizing capacity decreased in the Moser River. In 2006, mean pH was 5.5 (0.2, SD) in Mill Brook and in the main river. In 1939, pH was 6.1 in Mill Brook and 6.7 in the main river. Diatom-inferred pH from a paleolimnological assessment of Mill Lake, located upstream of the Mill Brook trapping site, indicated an increase in acidity by a decline of 0.7 pH units from about 6.8 in the 1930s. Diatom-inferred Gran-alkalinity changed from a pre impact range of 4.1 - 7.2 mg/L to a present day 0.6 mg/L (Ginn, Personal communication). Water temperature was warmer in 1939 compared to water temperature in 1940, 1941 and 2006. Hunstman (1945) recorded mortality of salmon trout in Moser River and St Mary's River during warm low flow conditions in August. Mean monthly air temperature records indicate that August of 1939 was one of the warmest on record for Nova Scotia (Environment Canada). Warming has occurred over the past 150 years in the Halifax region and water temperatures in Moser River were warmer in 2006 compared to 1940 and 1941 and the frequency of warm summer temperatures in Nova Scotia have increased since 1980.

Habitat changes are believed to have reduced trout production in many regions. Environmental conditions and exploitation may have influenced the size and age structure of the Moser River anadromous brook trout population. The short duration of our study and issues related to high flow conditions warrants additional study to fully assess the current status of the anadromous brook trout population in Moser River.