2008 Research Forum
Maine Atlantic Salmon and their Ecosystems
8-9 January 2008
D.P. Corbett Business Building
University of Maine, Orono

Program

Tuesday, January 8

8:00 a.m. *Registration, coffee*

8:30 a.m. **Welcome, announcements**
Sharon A. MacLean
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center

Session 1
Gail Wippelhauser, Moderator
Maine Department of Marine Resources
Bureau of Sea Run Fisheries and Habitat

8:40 a.m. **Coordinating local habitat restoration initiatives with Atlantic salmon habitat databases: How to make sure we're fixing the right stuff**
Kenneth Beland and Steven Koenig

9:00 a.m. **Driving tips from the Hatchery Review**
Joan G. Trial

9:20 a.m. **Managing Atlantic salmon in Ireland – a case study on the River Shannon**
Lorraine O'Donnell and Eamon Cusack

9:40 a.m. **Penobscot River Multi-Species Management Plan: Does multispecies mean ecosystem-based?**
Melissa Laser, Rory Saunders, Timothy Sheehan and Tara Trinko

10:00 a.m. **Effect of slimy sculpin on juvenile salmon survival and density dependence**
Darren M. Ward, Keith H. Nislow and Carol L. Folt

10:20 a.m. *Break*

Session 2
Tim Sheehan, Moderator
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center

10:40 a.m. **Large wood in Maine rivers and juvenile Atlantic salmon population densities and habitat use**
Gregory Mackey, Francis Magilligan, Keith Nislow, Burch Fisher, Jed Wright, Melissa Laser and Ernie Atkinson

11:00 a.m. **Effects of hydroelectric dams on survival and behavior of migrating Atlantic salmon smolts in the Penobscot River, Maine**
Christopher Holbrook, Joseph Zydlewski and Michael Kinnison

11:20 a.m **Habitat effects on resident brook trout persistence**
Benjamin Letcher, Keith Nislow, Jason Coombs, Matthew O'Donnell and Todd Dubreuil

11:40 a.m. **Managing the impacts of double-crested cormorant predation on endangered Atlantic salmon smolts**
James P. Hawkes, Rory Saunders and Adam Vashon

12:00 p.m. **Monitoring the infective pressure of *Lepeophtheirus salmonis* (Krøyer 1837) on wild salmonid populations in Scotland**
Cambell C. Pert, Katy Urquhart, Paul Cook, Una McCarthy, Alastair McBeath, Judy Simons, Sonia McBeath, Rachel Kilburn and **Ian R. Bricknell**

12:20 p.m. *Lunch*

Session 3
Christine Lipsky, Moderator
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center

1:20 p.m. **Planting Atlantic salmon eggs with a new hydraulic planter**
Paul M. Christman, Daniel McCaw and Jason Overlock

1:40 p.m. **Nutrient restoration using Atlantic salmon carcasses in Scottish Highland streams**
Keith H. Nislow, Brian P. Kennedy, John D. Armstrong and Keith H. Williams

2:00 p.m. **Observations of bedload sediment transport in Maine rivers: Implications for Atlantic salmon habitat restoration**
Noah P. Snyder, Michael R. Castele and Jed R. Wright

2:20 p.m. **Assessment of rotary screw trap environmental conditions and sampling effects on emigrating Atlantic salmon smolts**
Paul A. Music and James P. Hawkes

2:40 p.m. **Stable isotopic composition of otoliths in identification of hatchery origin of Atlantic salmon (*Salmo salar*) in Maine**
David Bean and Yongwen Gao

3:00 p.m. **Blue mussel (*Mytilus edulis*): a natural ISA vaccine factory?**
Cem Giray, Victoria Bowie, Wei Young-Lai and Brian Glebe

3:20 p.m. *Break and* **Poster Session**
Soderberg Lobby in Jenness Hall

Wednesday, January 9

8:00 a.m. *Coffee*

Session 4
Dan McCaw, Moderator
Maine Department of Marine Resources
Bureau of Sea Run Fisheries and Habitat

8:30 a.m. **Evidence for acidification as a causative factor in the decline of Atlantic salmon in eastern Maine**
Stephen D. McCormick, John T. Kelly, Michelle Monette and Trent Liebich

8:50 a.m. **Initial findings on multiple stressor effects in early life stage Atlantic salmon (*Salmo salar*): blueberry pesticides, acid, aluminum**
Adria A. Elskus and Crista Straub

9:10 a.m. **Evidence of water quality enhancement of Crooked River due to roadbed applications of crushed limestone adjacent to the stream**
Mark C. Whiting and Stephen Koenig

9:30 a.m. **Result of selective pressures measured by otolith characteristics of newly released, hatcheryraised Atlantic salmon fry**
Michael Bailey and Michael Kinnison

9:50 a.m. **Long-term seawater performance and scale circuli deposition of Atlantic salmon smolts**
Gayle Zydlewski, Joseph Zydlewski and Sheena Lashua

10:10 a.m. **Annual movement and migration patterns of Atlantic and shortnose sturgeons in the Penobscot River, ME**
Steven Fernandes, Gayle B. Zydlewski and Michael T. Kinnison

10:30 a.m. *Break*

Session 2
Michael Kinnison, Moderator
University of Maine
School of Biology and Ecology

10:50 a.m. **Upstream migration by *Salmo salar* hatchery fry in four Downeast streams**
Michael Loughlin

11:10 a.m. **Comparison of migratory urge and gill N^+, K^+-ATPase activity of Atlantic salmon (*Salmo salar*) smolts from Dennys River and Penobscot River stocks**
Randy Spencer, Joseph Zydlewski and Gayle Zydlewski

11:30 a.m. **Survival and life history variation of Atlantic salmon in Shorey Brook, Maine**
Michael Bailey and Michael Kinnison

11:50 a.m. **Feeding ecology of Atlantic salmon postsmolts in Penobscot Bay, Maine: Rearing origin matters**
Mark D. Renkawitz and Timothy F. Sheehan

12:10 p.m. **Sonic tracking of smolts from Canadian rivers across the Gulf of St. Lawrence to the Strait of Belle Isle**
Fred Whoriskey

12:30 p.m. **Closing**
John Kocik
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center

Poster Session
Jenness Hall, Soderberg Lobby

Diadromous Species Restoration Research Network (DSRRN): a new five-year collaborative effort
David Hart, Karen Wilson, Peter Vaux and **Adria Elskus**

Measuring sedimentation rates and land-use change in a dam-influenced lake delta: Narraguagus River, Maine
Alan Kasprak, Noah P. Snyder, Ilya V. Buynevich and Elizabeth A. Johnson

Water temperature changes in canopy-lined riparian habitat at four Distinct Population Segment utility crossings
Michael Loughlin

Survey of northwestern Atlantic fishes for salmonid viral pathogens
Sharon A. MacLean, Cem Giray and Stephen K. Ellis

Contaminant assessment of white suckers from eight rivers in the Gulf of Maine Distinct Population Segment for Atlantic salmon
Steven E. Mierzykowski

Depth, behavior and survival of emigrating Atlantic salmon (*Salmo salar*) postsmolts in Penobscot Bay, Maine
Mark D. Renkawitz, Timothy F. Sheehan and Graham S. Goulette

Comparison of channel morphology in two Atlantic coastal streams: Implications for Atlantic salmon habitat – preliminary results and analysis
Benjamin C. Wilkins and Noah P. Snyder

ABSTRACTS
ORAL PRESENTATIONS

Session 1 ***8:40 a.m.***

Coordinating local habitat restoration initiatives with Atlantic salmon habitat databases: ***How to make sure we're fixing the right stuff***

Kenneth Beland and Stephen Koenig
Project SHARE, Eastport, ME

Project SHARE (Salmon Habitat and River Enhancement) has been conducting an active program to assess and correct habitat degradation on private lands occurring in the five so-called 'Downeast Salmon Rivers" (Dennys, East Machias, Machias, Pleasant, and Narraguagus rivers). These five watersheds are included within the Gulf of Maine Distinct Population Segment designated by federal resource agencies. SHARE maintains a database containing more than 800 locations where potential habitat degradation has been documented, and documents measures to address issues identified during field surveys. Among many ongoing activities, SHARE is implementing a program to assess and correct habitat connectivity and fish passage deficiencies at stream crossings associated with the extensive logging road networks that occur in these watersheds. Improving the capacity to use these location data in conjunction with resource agency habitat and resource assessment datasets has become a priority for SHARE, in order to direct limited habitat restoration funds to areas most likely to improve habitat conditions for Atlantic salmon. Despite increasingly widespread use of an electronic database and GIS for information management, much progress remains to be made to realize seamless coordination of datasets originating from various sources. Frequently encountered barriers to data communication include: data confidentiality issues, incompatible data formats, inconsistent stream and town naming conventions, lack of unique record identifiers, and others. Ultimately, SHARE wishes to participate in coordinated habitat enhancement efforts that transcend single issue projects and address aquatic habitat quality and connectivity within focused areas having the greatest potential to benefit Atlantic salmon in Maine.

Session 1 ***9:00 a.m.***

Driving tips from the Hatchery Review

Joan G. Trial
Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Bangor, ME

The Hatchery Review team made a point about changing the drivers of recovery for the Maine program. Specific quotes include "*Hatchery supplementation should follow, not drive, recovery*" and "*Hatchery evaluation should not be viewed as research but as a core element of the Recovery Program. Accordingly, it is important to integrate scientific assessment advice into decisions regarding hatchery production and release schedules*." Past stocking requests have been for a number of fish of a given life stage. Except that fish meet New England Fish Health standards, managers were not explicit about fish quality, developmental maturity, or about matching development to stocking timing. Hatchery practices, history, and economics drove the product and delivery date. It is necessary to refine requests for hatchery products so that recovery goals drive hatchery production. The Bureau of Sea Run Fisheries and Habitat has started a process to facilitate a change. Teams for each life stage (fry to smolt) have been established to: 1) review the literature on survival of hatchery products related to measurable characteristics of "fish quality" and evaluate past stocking performance of current hatchery products in Maine; 2) determine which requests to the Craig Brook National Fish Hatchery or Green Lake National Fish Hatchery may be appropriate for quality of fish; 3) prepare a request and justification in a written "White Paper" that highlights changes from the current product and develop an evaluation of the product. The measurable quality traits likely will vary by life stage and be linked to rearing regime and hatchery practices. Effective management of hatchery products also involves understanding environmental variability, so target dates are year-specific not calendar-specific. Answers to questions that will help refine stocking timing will also be in the literature and in data from past program practices.

Session 1 ***9:20 a.m.***

Managing Atlantic salmon in Ireland – a case study on the River Shannon

Lorraine O'Donnell and Eamon Cusack
Shannon Regional Fisheries Board, Limerick, Ireland

The river Shannon is the largest river in Ireland measuring over 380 km long with a 70-km estuary and yet it doesn't have a sustainable stock of wild Atlantic salmon. Only two sub-catchments are currently reported as capable of sustaining an exploitable salmon population – the rivers Mulkear and Feale. In 2007, the Irish government decided to ban mixed stock fishing for Atlantic salmon. For Ireland as a whole, this meant no drift net fishing was permitted at sea, and cessation of any drift net fishing where mixed stocks were intercepted. In addition to the closure of commercial fisheries, rivers were either closed for salmon fishing or severe restrictions were placed on angling. The Shannon system is a mixed fishery holding large stocks of pike, perch, rudd, roach and bream. Ireland's largest hydroelectric power scheme operates a dam with a boran fish lift on a bypass channel at the upper tidal limit of the fishery. Various low head hydro schemes are also present in the catchment and are now being upgraded due to a switch to "greener" energy supplies. Water quality and habitat degradation continue to be major issues facing the protection of salmon in the juvenile stages. Fish counters have become an invaluable tool to fishery managers in accessing the status of the adult populations, and 2007 has seen dramatic increases in the numbers of salmon returning to our rivers. So what lies ahead now for the fishery manager with a limited capital budget? The Shannon Regional Fisheries Board are involved in many projects, such as: Development of a partnership model with the state agency, fishery owner and angling clubs; Creation of a committee and technical group, that includes the country's top scientists, to advise on strategies to restore salmon populations to the upper catchment; Participation in the steering group which is implementing the European Union Water Framework Directive (*2000/60/EC*); Rehabilitation of spawning and nursery streams through provision of technical assistance to various bodies including NGO's. One year on, we have made considerable progress, but a lot more is required. This won't happen overnight. Fishery managers need to plan for the long term, i.e., 5-10 years.

Reference:
Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

Session 1 ***9:40 a.m.***

Penobscot River Multi-Species Management Plan: Does multispecies mean ecosystem based?

Melissa Laser[1], Rory Saunders[2], Timothy Sheehan[3] and Tara Trinko[2]
[1]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME; [2]NOAA's National Marine Fisheries Service, Protected Resources Division, Orono, ME; [3]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA

The Penobscot River Restoration Project (PRRP) offers some unique opportunities to reconnect the native diadromous species with historic habitats and restore the concomitant ecological functions of the native diadromous suite. In particular, alewives are presently absent from the drainage with the exception of two tributaries of the Penobscot Estuary (Souadabscook Stream and the Orland River). While the PRRP will substantially improve passage conditions in the Penobscot Basin, it is in no way a "silver bullet." There are roughly 100 small dams and other fish passage barriers in the Penobscot Basin that will prevent some species from accessing historic habitats after the implementation of the PRRP. Thus, many other passage impediments will need to be addressed in order to realize the full potential of the PRRP. In order to begin to prioritize restoration efforts following implementation of the PRRP, the Maine Department of Marine Resources, Maine Department of Inland Fisheries and Wildlife, and NOAA's National Marine Fisheries Service have begun evaluating ways to prioritize restoration efforts. This effort, the Penobscot River Multi-Species Management Plan, includes four strategic goals: (1) coordinating management activities, (2) providing safe and effective upstream and downstream passage for diadromous and native freshwater fishes, (3) maintaining or improving abiotic (physical) and biotic habitat for diadromous and selected resident fishes, and (4) using adaptive ecosystem based management. An interagency Penobscot Fisheries Committee will develop an operational plan that details how these goals will be achieved as passage to habitat becomes available.

Session 1 ***10:00 a.m.***

The effect of slimy sculpin on juvenile salmon survival and density dependence

Darren M. Ward[1], Keith H. Nislow[2] and Carol L. Folt[1]
[1]Dartmouth College, Department of Biological Sciences, Hanover, NH; [2]U.S. Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA

The effects of slimy sculpin (*Cottus cognatus*) on survival of stocked Atlantic salmon (*Salmo salar*) in the Connecticut River basin were evaluated. In field sampling across salmon stocking sites, survival of salmon during the first summer declined with increased sculpin density, but salmon survival was not affected by any other fish species. Stomach sampling showed that sculpin preyed on newly stocked salmon fry. In 2005 and 2006, we conducted manipulative field experiments to determine how sculpin affect salmon density-dependent survival. Salmon fry were stocked at three population density treatments in three streams with sculpin and in three streams without sculpin (density treatments blocked within streams, 18 sites total). Mean salmon survival was three-fold higher in streams without sculpin (18±3%) than in streams with sculpin (6±2%). Furthermore, sculpin reversed the direction of density dependence for juvenile salmon survival. Salmon survival was highest at low stocking density in streams without sculpin, while salmon survival was highest at the highest stocking density in streams with sculpin. The results show that spatial variation in fish community characteristics influences salmon population dynamics and has important implications for management strategies such as determining optimal stocking densities.

Session 2 ***10:40 a.m.***

Large wood in Maine rivers and juvenile Atlantic salmon population densities and habitat use

Gregory Mackey[1], Francis Magilligan[2], Keith H. Nislow[3], Burch Fisher[2], Jed Wright[4], Melissa Laser[5] and Ernie Atkinson[1]
[1]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME; [2]Dartmouth College, Department of Geography, Hanover, NH; [3]U.S. Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; [4]U.S. Fish and Wildlife Service, Falmouth, ME; [5]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME

Maine streams have large wood loads far below predicted levels, and notably low compared to other parts of the United States. Although extensive research has been done on the relationship between Pacific salmonids and wood, relatively little is known about the role wood plays in influencing juvenile Atlantic salmon populations. Two hypotheses were tested in Old Stream, Maine, via snorkel survey in sites with naturally occurring high and low wood densities: 1) the density of juvenile Atlantic salmon was higher in sites that contained high as opposed to low loading of wood, and 2) where wood was available, juvenile salmon tended to be associated with it within a site. Results showed that age 1+ or older juveniles were at significantly higher densities in sites with high wood loading, but substrate coarseness was a more important factor. In addition, a significant proportion of both age 0+ and older juveniles were associated with wood in sites where it was available. However, this association also interacted with substrate coarseness and weed cover. These findings suggest that wood is an important habitat feature for juvenile Atlantic salmon, but cannot be viewed in isolation of other habitat factors. This work supports the need for greater understanding of the relationship between Atlantic salmon and wood in rivers.

Session 2 ***11:00 a.m.***

Effects of hydroelectric dams on survival and behavior of migrating Atlantic salmon smolts in the Penobscot River, Maine

Christopher Holbrook[1], Joseph Zydlewski[2] and Michael Kinnison[1]
[1]*University of Maine, Department of Biological Sciences, Orono, ME;* [2]*U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME*

Survival and behavior of migrating hatchery (n=493) and naturally reared (n=133) Atlantic salmon (*Salmo salar*) smolts were evaluated in 2005 and 2006 through the Penobscot River and estuary in Maine using acoustic telemetry. Mortality, movement rates, and use of a secondary migration path (the Stillwater Branch) were quantified. River sections containing three main stem dams (Howland, Milford and West Enfield dams) accounted for 43% and 60% of total losses for 2005 and 2006, respectively, though these sections accounted for only 16% and 6% of monitored reaches. Survivorship through sections with dams ranged from 95-100% and 71-100% in 2005 and 2006, respectively. Movement rates were significantly slower at dams compared to free-flowing reaches, and smolts arriving at dams during the day experienced longer delays than smolts arriving at night. Use of the Stillwater Branch by individual release groups 1) ranged from 0-26% and 0-19% in 2005 and 2006, respectively, 2) was significantly lower for groups released in a tributary compared to the main stem, and 3) was positively associated with river discharge. As part of the Penobscot River Restoration Project, the planned removal of two dams is expected to enhance passage through the main stem corridor for salmon and other migratory fish. However, this study demonstrates that the two dams scheduled for removal (Great Works and Veazie dams) had little effect on smolt survival and highlights the need to improve passage at the Milford, Howland and West Enfield dams, as well as at facilities in the Stillwater Branch, where more smolts are likely to pass after hydrosystem changes are implemented.

Session 2 ***11:20 a.m.***

Habitat effects on resident brook trout persistence

Benjamin Letcher[1], Keith Nislow[2], Jason Coombs[1,2], Matthew O'Donnell[1] and Todd Dubreuil[1]
[1]U.S. Geological Survey, Silvio O. Conte Anadromous Fish Research Center, Turners Falls, MA; [2]U.S. Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; [3]University of Massachusetts, Program in Organismic and Evolutionary Biology, Amherst, MA

To determine habitat effects on persistence of brook trout populations, the effects of habitat fragmentation among stream reaches and of habitat structure within a stream reach were estimated. Direct estimations were made of size-specific dispersal, growth, and survival of stream-dwelling brook trout in a stream network with connected, as well as naturally isolated, tributaries. Growth and survival differences were estimated between fish living in pools as compared to fish living in riffles. Multigeneration, individual-based data were used to develop and set parameters for a size class and location (or habitat)-based population projection model, allowing for testing effects of habitat structure on population dynamics at local (i.e., subpopulation) and of habitat fragmentation on local and system wide (i.e., meta-population) scales. Demographic rates which influence the persistence of isolated and fragmented populations were identified. In the naturally isolated tributary, persistence was associated with higher early juvenile survival (~45% greater), shorter generation time (one-half) and strong selection against large body size as compared to the open system, resulting in a stage distribution skewed towards younger, smaller fish. Simulating barriers to upstream migration into two currently connected tributary populations caused rapid (2- 6 generations) local extinction. These local extinctions in turn increased the likelihood of system wide extinction, as tributaries could no longer function as population sources. Within stream reaches, average yearly survival was 5% higher for fish in pools as compared to riffles, but was up to two-fold higher for large fish (>135 mm). In contrast, there was no difference in body growth for fish in pools compared to fish in riffles. Thus, variation in habitat structure will influence population persistence by influencing survival, but not body growth. For both analyses, large fish had disproportionately large effects on population persistence, suggesting that it will be particularly important to protect large fish from harvest in stressed systems (fragmented or low pool density).

Session 2 ***11:40 a.m.***

Managing the impacts of double-crested cormorant predation on endangered Atlantic salmon smolts

James P. Hawkes[1], Rory Saunders[2] and Adam Vashon[3]
[1]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; [2]NOAA's National Marine Fisheries Service, Protected Resources Division, Orono, ME; [3]U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Augusta, ME

Atlantic salmon (*Salmo salar*) smolts are exposed to intense predation pressure as they migrate from freshwater into estuarine and nearshore marine environments. During this period, double-crested cormorants (*Phalacrocorax auritus)* are a significant predator of Atlantic salmon smolts. To assess whether cormorant predation rates could be reduced, cormorant harassment activities were undertaken in 2004 and 2005 using various pyrotechnic, laser, and human/boat activities. These endeavors effectively displaced cormorants from feeding locations and effectively lowered predation on emigrating smolts in the Narraguagus River, Maine.

Session 2 ***12:00 p.m.***

Monitoring the infective pressure of *Lepeophtheirus salmonis* (Krøyer 1837) on wild salmonid populations in Scotland

Campbell C. Pert[1], Katy Urquhart[1], Paul Cook[1], Una McCarthy[1], Alastair McBeath[1], Judy Simons[1], Sonia McBeath[1], Rachel Kilburn[1] and **Ian R. Bricknell**[1,2]
[1]Fisheries Research Services, Marine Laboratory, Aberdeen, Scotland, UK; [2]University of Maine, School of Marine Sciences, Orono, ME

There is controversy concerning the distribution of salmon lice (*Lepeophtheirus salmonis*) within sea lochs. Some authors suggest there are low numbers of sea lice in the marine regions of a sea loch and that *L. salmonis* infection occurs under conditions of full salinity. Low numbers of lice then infect their host and gradually reach peak infection levels with time. A second model proposes that salmon lice gather at river mouths during the spring and early summer, and infect during a large single settlement event in low salinity waters. The aim of this research is to establish (i) where within the Loch Torridon system infestation with *L. salmonis* occurs, (ii) seasonal variation in infectious pressure, and (iii) whether copepodid, pre-adult or adult stages are responsible for infesting the host. Sentinel cages were located in Loch Shieldaig in a tidal exchange zone between Loch Torridon and the open sea, positioned to correspond to migration patterns of salmonids, tidal currents and to allow easy access. Fifty Atlantic salmon were introduced at each station for 7 days at monthly intervals, and environmental parameters, including plankton, temperature, salinity, and current speed and direction were recorded. After exposure to lice infectious pressure in the loch, the species and number of lice at each developmental stage were recorded. Data from Mar 2006 through Sep 2007 showed the majority of lice were at the copepodid stage. The mean number of lice per fish showed a continual increase throughout the study period even when the numbers of lice on adjacent salmon farms had been very low. There were low numbers of mobile *L. salmonis* stages within the loch from spring to early summer, which increased throughout the winter and following spring, with no winter decline in lice numbers as previously reported. Infection was initiated by copepodid and pre-adult stages. Adult salmon lice play a minor role in establishing infection. In addition, a survey of the *L. salmonis* burdens of returning sea trout (*S. trutta*) was conducted over three years (2005-2007), comparing the Scottish east and west coast populations. Over 350 returning sea trout were caught and sea lice burdens established. This is a direct comparison between the lice burdens of wild salmonids in an area with high farming activity (west coast) and low farming activity (east coast). In this part of the study, the highest lice burden was found on east coast fish (7.8 lice/fish) compared with only 3.3 lice/fish on the west coast of Scotland. This complex result suggests that the decline in sea trout on the west coast of Scotland may not be due to increased sea lice burdens. Instead, sea lice form part of a complex, multifactoral problem and the reasons behind the decline in Scottish west coast sea trout remains poorly understood.

Session 3 ***1:20 p.m.***

Planting Atlantic salmon eggs with a new hydraulic planter

Paul M. Christman, Daniel McCaw and Jason Overlock
Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME

In the past several years, Maine Department of Marine Resources has made several advances in utilizing green and eyed eggs for population enhancement of Atlantic salmon (*Salmo salar*). Green eggs have been found to be difficult to move due to handling shock. However, both green and eyed eggs have been successfully transported and buried in artificial redds in the Sandy and Sheepscot rivers. In the most recent study, efforts have been made to overcome the logistics of burying eggs in the gravel while minimizing mortality. In the 2006/2007 project eggs were buried using a newly developed hydraulic egg planter that utilizes a water stream to drill into the substrate and deposit eggs. Green and eyed eggs were buried using the new planter on the Sandy River and eyed eggs on the Sheepscot River. Fry trapping results indicate that the new planter successfully deposited eyed eggs and produced juveniles. Emergence rates were 43.6%, 33.8% and 10% for three artificial redds on the Sandy River and 10.4%, 1.3% and 0.53% for three artificial redds on the Sheepscot River. Green eggs did not develop on the Sandy River, most likely due to handling. Also, fry were trapped from three natural redds produced by released pre-spawn adults; emergence rates estimated from a range of fecundity were 8.9% -10.1%, 8.4% - 9.9% and 0%. Overall, the new planter worked very well given that juveniles were produced. Observations indicate that large enough numbers of eggs can be planted in a reasonable time frame to make it possible to use for watershed scale supplementation.

Session 3 ***1:40 p.m.***

Nutrient restoration using Atlantic salmon carcasses in Scottish Highland streams

Keith H. Nislow[1], Brian P. Kennedy[2], John D. Armstrong[3] and Keith H. Williams[3]
[1]U.S. Department of Agriculture, Forest Service, Northern Research Station, Amherst, MA; [2]University of Idaho, Moscow, ID; [3]Fisheries Research Service, Scottish Fisheries Service, Faskally, Pitlochry, Scotland, UK

It has long been known that an excess of nutrients can degrade freshwater ecosystems and fish habitat. However, in some situations human activities can reduce nutrients below expected levels and negatively affect fish production. In this study, nutrients (in the form of adult Atlantic salmon carcasses) were restored to salmon rearing streams in the Conon River basin, northeastern Scotland, in order to determine impacts on aquatic food webs and juvenile salmon production. Carcasses were extensively colonized by aquatic macroinvertebrates, and salmon-derived nutrients were readily incorporated into periphyton, macroinvertebrates, and juvenile salmon, in some cases at considerable distance from carcass addition locations. Juvenile salmon and macroinvertebrate biomass was significantly greater in carcass-addition site as compared to reference sites. These results suggest that nutrient limitation of production should be considered in habitat management plans, and that migratory salmon may play an important role in the nutrient dynamics of small oligotrophic streams.

Session 3 ***2:00 p.m.***

Observations of bedload sediment transport in Maine rivers: Implications for Atlantic salmon habitat restoration

Noah P. Snyder[1], Michael R. Castele[1] and Jed R. Wright[2]
[1]Boston College, Department of Geology and Geophysics, Chestnut Hill, MA; [2]U.S. Fish and Wildlife Service, Gulf of Maine Coastal Program, Falmouth, ME

Atlantic salmon spawning and rearing success partially depends on substrate habitat quality, which is influenced by grain size (median, D_{50} = 16-256 mm) and mobility. The ability of a given stream reach to transport coarse bedload controls whether it is embedded or armored. Historical land use changes in Maine may have altered channel geometry, resulting in changed frequency of substrate mobilizing events. Future adjustments in channel geometry and habitat quality (via natural stream processes or restoration projects) depend on erosion, transport and deposition of sediment. We present results from monitoring of coarse bedload transport using marked particles at one site on the Narraguagus River (December 2005-June 2007) and at three sites in the Sheepscot River watershed (July 2006-June 2007). All four sites are mapped as salmon spawning and/or rearing habitat, and we monitor two cross sections at each. The greatest observed bed reorganization occurred in winter/spring of 2006/2007, which included a significant flood event in April [recurrence interval (RI) ~9 yr on the Sheepscot River and ~5 yr on the Narraguagus River]. During this period, two of the three sites in the Sheepscot watershed exhibited significant particle mobility (40-75% of all marked particles), and the third had modest mobility (~15%). This contrast in mobility is likely due to differences in local channel morphology (slope, flow depth, width), and upstream sediment mobility and supply from eroding glacial deposits. The Narraguagus River reach had significant mobility during the winter-spring 2005-2006 period (~40%; including a RI ~2 yr flood) and the winter-spring 2006-2007 period (50-67%). We cannot separate the effects of ice rafting processes from those of floods, but the similarity in mobility during the two winters suggests that ice is likely an important influence on bedload transport processes. These results suggest that the frequency of bedload transport is reach specific, depending on factors including local channel geometry, upstream sediment supply and transport, and formation of frazil ice. This underscores the importance of conducting reach-scale studies of present channel conditions as a prerequisite for habitat restoration projects. This analysis holds the potential for refining watershed- and reach-based Atlantic salmon productivity models.

Session 3 ***2:20 p.m.***

Assessment of rotary screw trap environmental conditions and sampling effects on emigrating Atlantic salmon smolts

Paul A. Music and James P. Hawkes
NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME

Rotary Screw Traps (RSTs) are used to collect data on Atlantic salmon smolt production, migration timing, and run composition in several rivers in Maine. To better understand the possible environmental effects of using RSTs to sample smolts, water velocity and temperature conditions in RST live cars and rivers were monitored during the 2004 field season. Water temperature in the live cars ranged from 4.5°C to 20.8°C and was within 0.33°C of river water temperature 95% of the time. Water velocity in the live cars varied from 0 to 2.06 meters per second, and no stagnant water or excessive flows were recorded. Smolt mortalities in the RST live cars were extremely low (only 0.2% of the total catch) and were generally due to debris loading. The data indicated that environmental conditions inherent to RST live cars are unlikely to harm smolts. RSTs provide a low stress and safe environment for capturing Atlantic salmon smolts and other fishes, and most hazards are foreseeable and preventable. As such, RSTs should be considered a safe tool for sampling juvenile Atlantic salmon.

Session 3 ***2:40 p.m.***

Stable isotopic composition of otoliths in identification of hatchery origin of Atlantic salmon (*Salmo salar*) in Maine

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Stable isotope analyses of otoliths of Atlantic salmon (*Salmo salar*) were conducted in an attempt to develop a reference database on isotopic variability among various production hatcheries that support the Maine aquaculture industry and recovery of endangered Atlantic salmon populations. If successful, a diagnostic tool that can provide definitive information on identification of the hatchery origin could serve as a novel marking technique, and the chemical method may provide a low cost and more effective alternative to DNA analysis for mixed stocks. During the first phase of the study, 40-50 sagittal otoliths of juvenile Atlantic salmon were collected from each of the five Atlantic salmon production hatcheries in Maine and analyzed for stable isotope ratios ($^{18}O/^{16}O$ or $\delta^{18}O$, and $^{13}C/^{12}C$ or $\delta^{13}C$). By identifying stable isotopic variations of otoliths of Atlantic salmon from different hatchery settings, we were able to establish some isotopic criteria or standards to assign a likelihood that the origin of the cultured salmon was from a specific study hatchery. Combination of $\delta^{18}O$ and $\delta^{13}C$ values in otoliths showed that the five hatcheries can be clearly separated and chemically identified. The statistical results indicate that otolith samples can be correctly identified to a hatchery with higher than 88% correct classification for four hatcheries; one hatchery was slightly lower at 73% correctly classified. The data support the hypothesis that detectable differences between hatchery water sources can be detected within the otoliths of Atlantic salmon, and that isotopic separations among the five hatcheries appear to be well correlated with the different river systems or watersheds in which the hatcheries are located.

Session 3 ***3:00 p.m.***

Blue mussels (*Mytilus edulis*): A natural ISA vaccine factory?

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Bivalve shellfish are routinely used as indicator species for human viral and bacterial pathogens due to their ability to concentrate these agents from the surrounding waters. While they have also been implicated as potential reservoirs of aquatic animal pathogens, previous work investigating infectious salmon anemia virus (ISAV) bioaccumulation by blue mussels (*Mytilus edulis*), a common fouling organism at marine Atlantic salmon (*Salmo salar*) grow-out sites, indicated some unexpected outcomes; not only was ISAV not concentrated by *M. edulis*, but its viability was reduced below that expected from mere degradation in seawater. Since the ability of ISAV to cause cytopathic effect in cell culture was significantly reduced following filtration by *M. edulis*, we examined whether its ability to cause disease in *S. salar* was also negatively affected. Naïve salmon were exposed by immersion to a virulent strain of ISAV processed through *M. edulis* and the survivors were subsequently challenged by injection with ISAV. Results showed that positive control treatments exposed to virus not filtered by *M. edulis* suffered heavy mortalities. Conversely, fish initially exposed to ISAV filtered through *M. edulis* showed significantly lower mortalities during both the immersion exposure and the injection challenge with virulent virus. ISAV processed through *M. edulis* appears to lose virulence, but retain sufficient structural properties to produce immune protection in *S. salar* from subsequent exposure to the virus.

Session 4 ***8:30 a.m.***

Evidence for acidification as a causative factor in the decline of Atlantic salmon in eastern Maine

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Acid precipitation has caused chronic acidification and extirpations of Atlantic salmon in Norway and Nova Scotia. The moderate buffering capacity of rivers in eastern Maine prevents chronic acidification, but these rivers do experience episodic low pH events. It was previously thought that Atlantic salmon were sensitive only to long term (several weeks) exposure to low pH. However, our recent laboratory studies demonstrate that even short term (2-6 days) exposure of smolts to pH 5.3 results in loss of seawater tolerance, impaired ion regulatory ability in fresh water and mortality at inorganic Al levels of 11, 42 and 55 µg/L, respectively. Preliminary data on pH and inorganic aluminum levels in an ongoing survey in eastern Maine indicate that these levels occur in many sites in eastern Maine. Compromised ion regulation of smolts reared in streamside tanks occurred in the main stem of the Narraguagus and Pleasant rivers when pH dropped below 5.5. Further, data from Norway provide direct evidence that compromised ion regulatory ability of smolts results in reduced adult return rates. Together these results provide strong circumstantial evidence that episodic acidification has been a contributing factor to the decline of Atlantic salmon and that this effect continues today.

Session 4 ***8:50 a.m.***

Initial findings on multiple stressor effects in early life stage Atlantic salmon *(Salmo salar*): Blueberry pesticides, acid, aluminum

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Rivers in Maine 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 and Mills 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, alternative pesticides are being proposed to replace those currently used in Maine, and their effects on salmonids also are unknown. We hypothesized that combinations of acid/Al (AA) + pesticides would have stronger sublethal effects on early life stage salmon than either stressor alone. The study objectives were to determine whether pesticide-contaminated, AA 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 proposed alternative, 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. Survival, prey capture and immune function were evaluated. Pesticide treatment alone had no effect on survival relative to untreated controls, but AA treatments significantly reduced survival. Of the four multistressor (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 multistressor effect, drove this difference in mortality. High variability masked potential treatment effects on prey capture. Immune function assays were inconclusive. The results indicate 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, confounds interpretation of the data. Studies with additional endpoints and replicates are planned.

Reference:

Relyea RA, 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.

Session 4 ***9:10 a.m.***

Evidence of water quality enhancement of Crooked River due to roadbed applications of crushed limestone adjacent to the stream

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[2]*Project SHARE, Eastport, ME*

Episodic acidification of the Downeast salmon rivers during high stormwater flows has been an on going concern relative to the restoration of Atlantic salmon. Experimental limestone applications to add stream buffering capacity was identified as a high priority project by the Project SHARE (Salmon Habitat and River Enhancement) Research Committee. To date, we have not added limestone directly to rivers. However, Maine Dept. of Environmental Protection has determined that limestone can be added to terrestrial infrastructure (road surfaces, roadside ditches, bridge abutments, etc.) without water pollution discharge permits. In May of 2007, crushed limestone gravel was added to the 52 00 0 logging road on a 300 foot long slope on the north side of the bridge over the Crooked River, a second order stream and tributary to the Machias River. The stone was added to improve roadbed traction and to reduce erosion. During rainstorms, runoff has been observed to flow down the sloped roadway into the Crooked River, and the potential addition of carbonate buffering to the river was an anticipated benefit of using limestone. A comparison of before and after treatments above and below the bridge show that stream pH has been less extreme below the bridge after the treatment. During Hurricane Noel (beginning on November 3, 2007), the pH above the bridge went as low as 5.0; below the bridge the pH remained above 5.5. The data indicate that terrestrial limestone applications can affect the chemistry of stormwater runoff and can enhance buffering capacity of a second order stream.

Session 4 ***9:30 a.m.***

Result of selective pressures measured by otolith characteristics of newly released, hatchery raised Atlantic salmon fry

Michael Bailey and Michael Kinnison
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Atlantic salmon (*Salmo salar*) restoration efforts in Maine employ fry stocking as one of the primary population enhancement strategies. Some characters, such as large size or fast growth, are often thought to correlate with high survival in the wild. However, there are few data on the survival of newly stocked Atlantic salmon fry based on these characters. Hatchery rearing may reduce mortality in newly hatched fry, but natural selection may act strongly on stocked fry after they are released into the wild. These resulting survival patterns can be examined by reconstructing attributes of fry biology at stocking using characteristics of growth rings in otoliths. For this study, otoliths (sagittae) were compared from newly released fry with otoliths from stocked fry residing in the wild for 30 to 60 days. Developing a relationship between fry biology and otolith characteristics for newly hatched Atlantic salmon may well be an important tool for describing selective mortality at early life stages.

Session 4 ***9:50 a.m.***

Long term seawater performance and scale circuli deposition of Atlantic salmon smolts

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Penobscot strain Atlantic salmon were held in saltwater for up to four months to examine the relationship between growth and survival to gill Na^+, K^+-ATPase activity levels and determine scale circuli deposition rates. In May 2006, 940 salmon smolts from Green Lake National Fish Hatchery were analyzed for their freshwater gill Na^+, K^+-ATPase activity levels. Individuals were classified as having "low", "medium", or "high" levels based on the normal distribution of activities observed on the day of gill collection (10 May). All individuals were transferred isothermally to full strength seawater and maintained on photoperiod and temperature regimes similar to what they would normally experience during their migration from the Penobscot River to the Labrador Sea. Fish scales were taken and size (fork length and weight) was recorded on days 1, 3, 14, 44 and monthly for four months. Fish grew throughout the experiment, but fish size, growth rate, and gill Na^+, K^+-ATPase activity in saltwater did not differ among freshwater ATPase groups. Scale circuli spacing was greater when the salmon were in saltwater (than when in freshwater in the hatchery). It took approximately two weeks to deposit a single circulus in saltwater, compared to 11 days while in freshwater. Scale circuli deposition rates from this study can be used to approximate ages of adult Atlantic salmon returning to freshwater rivers. Based on this laboratory experiment, it is unlikely that small scale variation in gill Na^+, K^+-ATPase activity is predictive of long-term performance (measured as survival and growth) in seawater.

Session 4 ***10:10 a.m.***

Annual movement and migration patterns of Atlantic and shortnose sturgeons in the Penobscot River, ME

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The status of Atlantic and shortnose sturgeon populations in the Penobscot River of Maine are currently unknown yet vital to protection of these at risk species. In this study we have begun to assess abundance, distribution, and movements of adult and subadult Atlantic and shortnose sturgeons in this river system. In 2006 and 2007, we sampled for sturgeon using multifilament nylon gillnets set on the bottom of the river and estuary in likely habitat. We recorded the length, weight and morphometric measurements from all individuals and assessed their sex and reproductive status. All individuals were implanted with an external numeric tag and internal 124 kHz Passive Integrated Transponder tag, and a subset of individuals were tagged with ultrasonic transmitters to allow us to track the movement via active tracking and a large acoustic receiver array in the river and bay. In this presentation, we consider Atlantic and shortnose sturgeon movement patterns through the summer, fall, and winter of 2006 and the spring and summer of 2007. In particular, we discuss patterns of seasonal movements associated with foraging, overwintering, and spawning habitat use. Our results not only provide management agencies with a better idea of the status and ecology of Atlantic and shortnose sturgeon in a portion of their range that is understudied, but also highlight critical habitat and associated risks to sturgeon in this system.

Session 5 ***10:50 a.m.***

Upstream migration by *Salmo salar* hatchery fry in four Downeast streams

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Point stocking of Atlantic salmon fry is a routine fisheries practice. Numbers of fry stocked at points are calculated based on desired stocking densities. When point stocking fry on tributary streams from access roads and trails, frequently there are substantial lengths of inaccessible suitable habitat upriver of the access points. Information on upstream movement of fry is valuable to predict if habitat upriver of the crossing can be expected to be used by fry or parr. If upstream habitat is used by fry, then that habitat area should be used to calculate the estimated number of fry to be stocked. Upstream migration of fry is noted in Masu salmon fry (Nagata and Irvine 1997) and in Atlantic salmon parr (Erekinaro and Gibson 1997). Observations of Maine Bureau of Sea Run Fisheries and Habitat researchers suggest upstream migration of Atlantic salmon fry (Atkinson 2006, comm.) but are confounded by fry stockings 5.5 and 6.5 kilometers upriver, as well as by potential unobserved "wild" redds in the vicinity. Fry movement of *Salmo salar* downstream to 2,000 meters is documented (Atkinson 2006, comm.) and was used as an anticipated downstream movement distance. Two tributaries of the Machias and East Machias rivers were examined with a CPUE electrofishing technique. Transects equidistant above and below the stocking point were chosen and sampled up to a distance of 500 meters approximately 4 months post stocking. This preliminary study found evidence of upstream migration of fry to 100 meters at all locations and up to 500 meters above the stocking point at one location.

References:

Atkinson EA. (comm.) 2006. Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME. Observations on fry drift studies at Northern Stream. Atlantic Salmon Commission staff training, Little Lyford Pond Camps.

Erekinaro J, Gibson RJ. 1997. Interhabitat migration of juvenile Atlantic salmon in a Newfoundland river system, Canada. J. Fish Biol. 51(2):373-388.

Nagata M, Irvine JR. 1997. Differential dispersal patterns of male and female masu salmon fry. J. Fish Biol. 51(3): 601-606.

Session 5 ***11:10 a.m.***

Comparison of migratory urge and gill Na^+, K^+-ATPase activity of Atlantic salmon *(Salmo salar)* smolts from Dennys River and Penobscot River stocks

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Migratory urge and gill Na^+, K^+-ATPase activity of Penobscot River and Dennys River smolts were investigated simultaneously in a controlled hatchery environment. Smolts were tagged with Passive Integrated Transponders (PIT) and placed in behavioral evaluation tanks for a series of seven two-week long trials (n=30 new smolts*stock^{-1}*trial^{-1}) spanning the smolt migratory window (April-June). Nonlethal gill biopsies were collected from each smolt at the start and end of each trial to measure gill enzyme activity. Dennys River smolts had the same or higher mean Na^+, K^+-ATPase activity than Penobscot smolts on all sample dates. The seasonal pattern of increase, peak, and decline in enzyme activity of Dennys smolts were temporally and quantitatively similar to Penobscot smolts. The dates of onset, peak, and reduction of downstream (with tank flow) movements were independent of stock, but overall, Penobscot River smolts moved 15.5% more frequently. Smolt activity became increasingly diurnal during peak migration but most downstream movement (>59%) still occurred at night. Dennys smolts were slightly but significantly more nocturnal than Penobscot smolts during peak migration. Correlations between the frequency of downstream movement and gill Na^+, K^+-ATPase activity were absent or weak for Penobscot and Dennys smolts.

Session 5 ***11:30 a.m.***

Survival and life history variation of Atlantic salmon in Shorey Brook, Maine

Michael Bailey and Michael Kinnison
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From 2000 to 2006, individually marked juvenile Atlantic salmon (*Salmo salar*) were regularly monitored in Shorey Brook, a tributary of the Narraguagus River. Sampling included over 25 electrofishing samples from 37 sections (each 20m long) of Shorey Brook, and from smolt weirs and in-stream passive integrated transmitter (PIT) arrays. The use of these PIT arrays allowed us to account for fish leaving the system as smolts and non-smolt migrants, decreasing biases in mortality estimates. These arrays have also recorded three likely adult salmon returning to the stream (two confirmed adults, one unconfirmed). The software program MARK was used to estimate survival of four year classes during this study, relative to seasonality and life history attributes of the fish. Results indicate that parr in Shorey Brook have higher over winter survival, higher percentage precocious parr, and higher numbers of fall migrants than has been noted in other salmon streams in New England. These characteristics of parr life history can be missed by traditional survey approaches that occur only once per year, with substantial demographic consequences.

Session 5 ***11:50 a.m.***

Feeding ecology of Atlantic salmon postsmolts in Penobscot Bay, Maine: Rearing origin matters

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Maine's Penobscot River Atlantic salmon population remains at critically low abundance, despite intensive stocking of multiple life stages. High rates of mortality in the nearshore environment may be contributing to low adult return rates. NOAA Fisheries Service conducted post-smolt trawl surveys from 2001-2005 to investigate this hypothesis. Dietary analyses on post-smolt mortalities collected during this survey have yielded insights into the health and fitness of early marine phase postsmolts. Of the 253 stomach samples obtained, 4% were empty while 85% contained two prey types or less. A negative relationship was observed between stomach content weight and fish length. Fish that lived in the river longer (naturally-reared and parr-stocked fish) tended to be smaller and consumed more fish prey than fish that emigrated immediately post stocking (fish stocked as smolts). Fish reared naturally and those stocked as parr consumed 81% fish and 18% crustaceans (by weight), whereas stocked smolts consumed 48% fish and 42% crustaceans. Differences in the type and quantity of consumed prey may imply contrasting levels of fitness and be indicative of other behavioral differences that affect survival. These data improve our understanding of early marine phase dynamics among the different stocking groups and may aid in defining causal ecological mechanisms that influence marine survival.

Session 5 ***12:10 p.m.***

Sonic tracking of smolts from Canadian rivers across the Gulf of St. Lawrence to the Strait of Belle Isle

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Sonic telemetry was used to document concurrently the movements, and freshwater and estuary survival, of smolts from Canadian rivers over a 600 km north to south gradient. Some of the postsmolts were tracked subsequently across the Gulf of St. Lawrence to the Strait of Belle Isle, a distance of up to > 1,000 km from the initial release points. Survival patterns in freshwater and the estuary were consistent for individual rivers among years. Also, there were consistent differences in survival rates among rivers, but survival to the sea was not systematically higher in more northern sites. Movement rates across the Gulf of St. Lawrence were about 25 km/d. Fish from multiple rivers were detected in the Strait of Belle Isle on the same day, providing the first documented evidence in the ocean of shoals of salmon postsmolts originating from multiple rivers. The Strait appears to be an important migration pathway for smolts from southern Gulf of St. Lawrence rivers. However, no tagged smolts from the site on the Quebec North Shore were detected there. Water temperatures < 0°C were recorded in the Strait during the smolt migration period.

ABSTRACTS
POSTER PRESENTATIONS

Diadromous Species Restoration Research Network (DSRRN): A new five year collaborative effort

David Hart[1], Karen Wilson[2], Peter Vaux[1] and **Adria A. Elskus**[3]
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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, multispecies interactions in a restoration context, and the effects of multiple stressors on restoration results. DSRRN will work to coordinate the overlapping and interconnected research efforts of academic, government, tribe and watershed stakeholders, and provide administrative structure and support data management. This grant will support two scientific meetings to identify critical research areas in multispecies 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. Evaluations, member feedback, reports, quarterly meetings with core members, and other mechanisms will be used to assess progress and success. 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 research partnerships facilitated by the Research Coordination Network (RCN), 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. *Please help us begin this process by bringing your questions, your ideas and your vision to the network!*

Measuring sedimentation rates and land-use change in a dam-influenced lake delta: Narraguagus River, Maine

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Deposits of the Narraguagus River in coastal Maine were investigated to determine river sediment transport rates during the past ~150 years, a period of extensive timber harvest in the watershed. Such transport rates will provide a baseline for process based studies of interactions between substrate mobility and habitat characteristics. The study area was the inlet of Beddington Lake, which has undergone changes in its surface level due to the construction (circa 1850) and subsequent failure in 1951 of a dam installed at the lake outlet to facilitate log drives on the Narraguagus River. Based on historic (1946-1996) aerial photograph analysis, exposed river deposits from the period of elevated lake level were identified. In August 2007, these subaerial deposits were sampled using soil pits, hand auger cores, bailer-borings, and ground penetrating radar (GPR). In-channel pebble counts were performed at several locations at and upstream of the study area. Overall, sediment samples collected from the subaerial deposit show a fining trend downstream from the Narraguagus River mouth into Beddington Lake. Upstream sediment pits and cores in the deposit show a gravel layer at ~1 m depth. We hypothesize that this layer corresponds to river deposition prior to dam construction. Above this gravel layer was found a coarsening upward trend in individual soil pits and cores, from mud to coarse sand, which is representative of a prograding lake delta. This sediment package is, on average, 0.98 m thick, and we believe that its deposition occurred during the ~100 years that the dam was present on Beddington Lake. The calculated average vertical sedimentation rate, therefore, was 1.0 cm/yr at this proximal position in the lake delta during the time the dam was operational. Above this coarsening upward sequence, soil pits and cores have a topmost layer of fine sand and mud, with 0.22 m average thickness. Given that Beddington Lake has not been dammed since 1951, a current average vertical floodplain sedimentation rate of 0.4 cm/yr was calculated. Organic materials, dominated by wood chips and fragments of cut logs, can be found in the subaerial deposit. The concentration of these organics increases with depth, suggesting that logging activities in the Narraguagus River were most vigorous in the time soon after dam construction. Our ongoing research includes interpretation of GPR transects, textural sediment analyses, Wolman pebble count analyses, and mapping and correlation of the sediment pits and cores.

Water temperature changes in canopy-limited riparian habitat at four Distinct Population Segment utility crossings

Michael Loughlin
Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME

During 1999, a natural gas pipeline was installed across eastern Maine roughly following logging road 01-00-0 (the Stud Mill Road), widening the open corridor created by the road. This increased the corridor width from approximately 18 meters, for the logging road alone, to approximately 45 meters. Three of the four streams crossed the original road corridor in culverts or at a bridge. The forth crossing was wooded prior to the installation of the pipeline corridor. The corridor was widened from 45 meters to approximately 95 meters for an electric transmission line during the winter of 2005/2006. During summer 2005, automated synchronized temperature loggers were installed above and below four stream crossings, and temperatures recorded hourly were analyzed by regression analysis and the Student's t-test., Water temperatures at three locations were significantly higher downstream of the clearings. One exception was noted on the West Branch Machias River, where downstream temperature was significantly cooler than upstream. During summer 2006, temperature loggers were installed above, within and below the same four crossings, and temperatures recorded hourly were analyzed by regression analysis and the Student's t-test. Water temperatures at three locations were again significantly higher downstream of the clearings. Again an exception was noted on the West Branch Machias River, where downstream temperatures were significantly cooler than upstream.

Survey of Northwestern Atlantic fishes for salmonid viral pathogens

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Tissues from more than 3,600 fish of 20 different species were assayed in efforts to identify potential reservoirs of salmonid viral pathogens, with special interest in the infectious salmon anemia virus (ISAV). Fish were taken from rivers, streams, and coastal areas of Maine, from within or near net pens containing ISAV-infected salmon, and from the West Greenland commercial salmon fishery. Assays included viral culture on 3 cell lines (epithelioma papillosum cyprini; chinook salmon embryo-214; salmon head kidney or Atlantic salmon kidney) and reverse transcription-polymerase chain reaction specific for ISAV (ISAV-RT-PCR) or for salmon swimbladder sarcoma virus (SSSV-RT-PCR). ISAV-RT-PCR positive results were obtained from one fish taken from the Narraguagus River, Maine, of 931 (0.1%) alewife (*Alosa pseudoharengus*) sampled in total, and from one of 549 (0.2%) Atlantic salmon (*Salmo salar*) collected from the West Greenland commercial fishery. Twelve of 137 (9%) Atlantic salmon smolts used in streamside experiments tested positive for SSSV types 1 or 2 by SSSV- RT-PCR. A North American strain (IVa) of viral hemorrhagic septicemia virus (VHSV), most closely related to Pacific coast strains, was isolated from one of 260 (0.4%) herring (*Clupea harengus harengus*) taken from Maine coastal waters. Viruses were not detected in samples from 12 Atlantic salmon escapees or from fishes taken from within or near salmon net pens. Aside from SSSV, the results indicate that the prevalence of salmonid viruses in wild marine fish populations in Maine is quite low, leaving the source(s) of ISAV in cultured salmon in Maine still to be determined.

Contaminant assessment of white suckers from eight rivers in the Gulf of Maine Distinct Population Segment for Atlantic salmon

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White suckers (*Catostomus commersoni*) are a common sentinel species used in state, regional, and national biomonitoring programs to illustrate contaminant conditions and trends. White suckers were collected for tissue residue analyses between 2003 and 2006 to assess contamination in eight Gulf of Maine rivers where the endangered Atlantic salmon (*Salmo salar*) is considered a Distinct Population Segment (DPS) under the Endangered Species Act. Ninety whole-body white suckers collected from 27 locations among the eight rivers having DPS salmon were analyzed individually (n=25) or in multi-fish composites (n=22) for organochlorine compounds and trace elements. Of 22 organochlorine compounds included in the analytical scan, two were detected with regularity - polychlorinated biphenyls (PCBs) and p,p'-DDE. Total PCB was detected in all sucker samples from the Dennys River (mean 0.041 µg/g), two fish from the Pleasant River (0.007 µg/g, 0.018 µg/g), and four composite samples from the East Machias River (mean 0.005 µg/g). Total PCB in suckers from the DPS rivers were similar to levels reported in regional and national biomonitoring programs. Although Total PCB was detected in 25 samples, and suckers from the Dennys River had six-fold higher Total PCB concentrations than fish from two other DPS rivers, Total PCB concentrations in DPS river white suckers did not exceed suggested biological effect levels. DDE, a metabolite of the insecticide DDT, was found in 12 of 28 samples (median 0.003 µg/g) from the DPS rivers at levels 3 to 15 times lower than levels reported in regional and national biomonitoring programs, and two orders of magnitude below a suggested DDT tissue threshold-effect level of 0.60 µg/g. The mean mercury concentration for all white sucker samples (0.22 µg/g) from the DPS rivers was at the suggested tissue effect threshold level (0.20 µg/g). Mercury is frequently found in biota at elevated levels in New England. Relative to higher trophic level fish species such as smallmouth bass (*Micropterus salmoides*), elevated levels of mercury (> 0.50 to 1.00 µg/g) are not commonly found in white suckers in New England. Among the DPS rivers, the highest mercury levels were found in white suckers from the Machias River (0.69 µg/g) and to a lesser extent in the West Branch of the Sheepscot River (mean 0.35 µg/g). In white suckers from DPS-designated rivers, concentrations of 18 other trace elements appeared lower or similar to median values reported in Maine, regional, or national biomonitoring programs.

Depth, behavior and survival of emigrating Atlantic salmon (*Salmo salar*) postsmolts in Penobscot Bay, Maine

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Maine's Penobscot River Atlantic salmon population remains at low abundance despite intensive stocking. High nearshore mortality is hypothesized to contribute to low adult returns. To gain information on emigrating post-smolt dynamics, NOAA Fisheries Service conducted a post-smolt trawl survey in Penobscot Bay from 2001 to2005. The assumption that emigrating postsmolts were available for capture by a surface trawl was evaluated by implanting 26 salmon smolts with acoustic depth tags. Detection arrays monitored fish passage through 40 km of estuary and 45 km offshore through Penobscot Bay. Greater than 90% of the detections occurred in water depths of 4m or less, but depths up to 18m were recorded, suggesting that postsmolts spend most of the time near the surface but occasionally dive deeper. Emigration rates for successful migrants were rapid (approximately 1 km/h), and only 39% of the postsmolts were successfully detected by the outermost arrays. These results suggest that postsmolts experience high rates of nearshore mortality despite their short residence time. These data improve our understanding of nearshore dynamics and may aid in defining the causal mechanisms influencing early marine survival.

Comparison of channel morphology in two Atlantic coastal streams: Implications for Atlantic salmon habitat - preliminary results and analysis

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Bedload sediment mobility is important to Atlantic salmon (*Salmo salar*) spawning and rearing success. Channel beds that are not mobilized on a frequent basis will become armored or embedded over time, impeding the creation of redds and negatively influencing the likelihood of egg survival. Channel shape is an important factor affecting bedload sediment mobility within streams. It is believed that river channel morphology in Maine has been altered by land use practices, ultimately creating wider and shallower channels and lowering the stream competence. If correct, these changes may be partially responsible for the limited number of returning Atlantic salmon currently observed in Maine's rivers. To evaluate the magnitude of these changes, we are preparing a statistical comparison of channel morphology between two Atlantic coastal streams: the Narraguagus River in Downeast Maine and the Jacquet River in northern New Brunswick, Canada. Compared to the Narraguagus, the Jacquet River has relatively healthy returns of adult salmon and a differing land-use history. Both watersheds have roughly equal drainage areas (Narraguagus 588 km^2, Jacquet 510 km^2) and similar mean annual precipitation (1,244 and 1,200 mm, respectively). During the summer of 2007, we surveyed a 13.6 km section of the Narraguagus River with drainage area ranging from 129 to 247 km^2, and a 10.4 km reach of the Jacquet River with drainage area ranging from 94 to 265 km^2. Measurements were made of active and bankfull width, depth, and channel gradient at 100 meter intervals, and grain size counts were performed at 200 meter intervals. Preliminary results indicate significantly greater bankfull width to depth ratios on the Narraguagus River (29 ± 11) than in the Jacquet River (23 ± 9). This is indicative of lower basal sheer stress and reduced bedload sediment mobility.