Third Maine Atlantic Salmon Technical Advisory Committee
Research Forum
10 January 2006
D.P. Corbett Business Building
University of Maine, Orono

Program

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

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

Session 1
Christine Lipsky, Moderator
NOAA's National Marine Fisheries Service

8:40 a.m. **Seasonal patterns in the relative importance of organic acids and sulfates in episodic acidification of the Downeast salmon rivers**
Mark C. Whiting

9:00 a.m. **Assessment of water chemistry in Downeast Maine rivers and effects on Atlantic salmon smolts**
Daniel Kircheis, Stephen McCormick, Richard Dill, Trent Liebich, and Kenneth Johnson

9:20 a.m. **Comparison of responses of Atlantic salmon parr and smolts to acid/aluminum exposure and detection of gill aluminum accumulation using nonlethal gill biopsy**
Michelle Y. Monette and Stephen D. McCormick

9:40 a.m. **Thresholds of acid and aluminum impacts on survival and physiology of Atlantic salmon smolts**
Stephen D. McCormick, Michelle Y. Monette, and Amanda Keyes

10:00 a.m. **Smolt rearing origins from scales: Scale readers vs. computers**
Ruth Haas-Castro, Christine Lipsky, and Edward Hastings

10:20 a.m *Break and Poster session*

Session 2
Sharon MacLean, Moderator
NOAA's National Marine Fisheries Service

10:40 a.m. **Waterborne transmission of ISAV in marine waters: Studies from the Quoddy region of Maine and New Brunswick**
Stephen K. Ellis and Lori Gustafson

11:00 a.m. ***Mytilus edulis* investigated as a bioaccumulater of infectious salmon anemia virus**
Victoria A. Bowie, Keith A. Brockway and Cem Giray

11:20 a.m. **Descaling impairs osmoregulation in seawater challenged Atlantic salmon smolts**
Gayle Zydlewski, Joseph Zydlewski and G. Russell Danner

11:40 a.m. **Heritable adaptive trait variation in Maine's endangered Atlantic salmon (*Salmo salar*) – what's the next step?**
Nathan Wilke, Michael Kinnison and Timothy King

12:00 p.m. **Postsmolt survival and growth of five Atlantic salmon stocks in seawater**
William R. Wolters

12:20 p.m. *Lunch*

Session 3
Richard Dill, Moderator
Maine Atlantic Salmon Commission

1:20 p.m. **Penobscot River salmon smolts: Movements, survival, and path choice during a flood year**
Christopher M. Holbrook, Joseph Zydlewski and Michael T. Kinnison

1:40 p.m. **Movements of pre-spawn Atlantic salmon in Penobscot Bay and River: A pilot study using acoustic telemetry**
Christopher M. Holbrook, Joseph Zydlewski and Michael T. Kinnison

2:00 p.m. **Movements and fate of sonically tagged, experimentally "escaped" farmed Atlantic salmon from the border area between Maine and New Brunswick of east coast North America**
Fred Whoriskey, Paul Brooking, Gino Doucette, Steve Tinker and Jonathan Carr

2:20 p.m. **The development and use of fish assemblage assessment tools for determining the ecological benefits of dam removal and diadromous fish restoration in Maine rivers**
Christopher O. Yoder and Brandon H. Kulik

2:40 p.m. **Incubation capacity of streamside incubators**
Paul Christman, Kevin Dunham and Daniel McCaw

3:00 p.m. *Break and* **Poster Session**

Session 4
Joan Trial, Moderator
Maine Atlantic Salmon Commission

3:20 pm. **Inferring selective mortality in hatchery raised Atlantic salmon (*Salmo salar*) fry**
Michael Bailey and Michael Kinnison

3:40 p.m. **Review of captive adult salmon as a restoration approach in Maine**
Gregory Mackey, Timothy Sheehan and Randy Spencer

4:00 p.m. **Research prioritization lists: Quit meeting and start reading**
John Kocik and Joan Trial

4:20 p.m. **Maine Atlantic salmon recovery and restoration priorities**
Melissa Laser, Willa Nehlsen and Mark Minton

4:40 p.m. **Closing**
Rory Saunders
NOAA's National Marine Fisheries Service

Posters/Exhibits Session
D.P. Corbett Atrium

Designing road-stream crossings to accommodate aquatic organism passage
Jason Czapiga

The Student Conservation Association
Abraham R. Gates and Douglas Smithwood

In situ feeding behavior of Atlantic salmon juveniles at warm water temperatures: Are salmon in Maine adapted to warm water temperatures?
Alexandra Rohrer and Gregory Mackey

Atlantic salmon, smallmouth bass, and restored habitat in Kenduskeag Stream, Maine
Peter Ruksznis and Joan Trial

ABSTRACTS
ORAL PRESENTATIONS

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

Seasonal patterns in the relative importance of organic acids and sulfate in episodic acidification of the Downeast salmon rivers

Mark C. Whiting
Maine Dept of Environmental Protection, Bangor, ME

From 1999 to 2002, volunteers collected water samples from the Downeast salmon rivers for analysis at the George J. Mitchell Center for Environmental and Watershed Research, University of Maine. Assays included pH, alkalinity, major cations, anions, conductivity, and dissolved organic carbon (DOC). In 1999, all samples were taken during baseflow conditions. From 2000 through 2002, both baseflow and stormwater samples were collected. The timing of low pH events coincides with high riverflows that occur from October through May. The causes of low pH include dilution of alkalinity by storms, natural organic acidity (DOC), and anthropogenic sources of sulfate and nitrate. These observed patterns in pH were compared with patterns in the major acidic anions (DOC, sulfate and nitrate) in different rivers, flow conditions, and months. This report discusses the relative importance of different acidity sources. Under normal flow conditions, DOC plays a dominant role in determining pH. However, during low pH events, sulfate plays an important role in all the rivers and a dominant role in Tunk Stream and the Narraguagus and Pleasant rivers. DOC plays the most obvious and dominant role in the Dennys River, with a strong fall maximum in November. Often both sulfate and DOC were important (Machias, East Machias, and Dennys rivers). Nitrate and sulfate peak at the same times, but the relative contribution of nitrate is small. In conclusion, the relative importance of sulfate and DOC will vary by river basin or subbasin, time of year, and storm event. Low pH events in Downeast rivers are driven by complicated interactions between weather, hydraulic pathways through or over soils, wetland inputs, and by precipitation chemistry.

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

Assessment of water chemistry in Downeast Maine rivers and effects on Atlantic salmon smolts

Daniel Kircheis[1], Stephen McCormick[2], Richard Dill[3], Trent Liebich[4] and Kenneth Johnson[5]
[1]NOAA, Northeast Regional Office, Orono, ME; [2]U.S. Geological Survey, Silvio O. Conte Anadromous Fish Research Center, Turners Fall, MA; [3]Maine Atlantic Salmon Commission, Bangor, ME; [4]University of Minnesota, Duluth, MN; [5]University of Maine, George J. Mitchell Center for Environmental and Watershed Research, Orono, ME

Episodic low pH and high aluminum associated with anthropogenic acidification has been identified by the Maine Atlantic Salmon Technical Advisory Committee as a possible threat to Atlantic salmon (*Salmo salar*) recovery in the Gulf of Maine distinct population segment (DPS). Low pH and high aluminum can impair a smolt's ability to successfully migrate and sometimes results in direct mortality (Lacroix and Townsend 1987; Staurnes et al. 1996; Magee et al. 2003). The level to which pH and aluminum impact smolts depends on other water chemistry conditions, particularly acid neutralizing capacity (ANC) and dissolved organic carbon (DOC). In 2003, we began investigating water chemistry effects on Atlantic salmon smolts by 1) documenting spatial and temporal patterns of episodic low pH and high aluminum across DPS watersheds, and 2) monitoring the physiological response of Atlantic salmon to these conditions using streamside exposure studies. Preliminary findings indicate that smolts in Downeast rivers exhibit signs of stress, indicated by elevated plasma glucose and depressed plasma chloride levels, when river pH falls below 5.6. Among the Dennys, Machias, East Machias, Pleasant and Narraguagus rivers, the Pleasant River is the only main stem documented to experience pH episodes below 5.6 during the spring smolt migration. Nine tributaries are documented to have had at least one occurrence of pH less than 5.6. Many more rivers and tributaries experience pH episodes below 5.6 in the autumn, though less is known about the effects (immediate or cumulative) on eggs or parr. Even though gill aluminum concentrations were low in the 2004 and 2005 streamside studies, more work is needed to determine to what extent aluminum in the Downeast rivers may be impacting smolt survival.

References:

Lacroix GL and Townsend DR. 1987. Responses of juvenile Atlantic salmon (*Salmo salar*) to episodic increases in acidity of Nova Scotia rivers. Can. J. Fish. Aquat. Sci. 44:1475–1484.

Staurnes M, Hansen LP, Fugelli K, Haraldstad O. 1996. Short-term exposure to acid water impairs osmoregulation, seawater tolerance, and subsequent marine survival of smolts of Atlantic salmon (*Salmo salar*). Can. J. Fish. Aquat. Sci. 53:1695–1704.

Magee JA, Obedzinski M, McCormick SD, Kocik JF. 2003. Effects of episodic acidification on Atlantic salmon (*Salmo salar*) smolts. Can. J. Fish. Aquat. Sci. 60:214–221.

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

A comparison of responses of Atlantic salmon parr and smolts to acid/aluminum exposure and detection of gill aluminum accumulation using nonlethal gill biopsy

Michelle Y. Monette[1] and Stephen D. McCormick[2]
[1]*University of Massachusetts, Organismic and Evolutionary Biology Program, Amherst, MA;* [2]*U.S. Geological Survey, Silvio O. Conte Anadromous Fish Research Center, Turners Falls, MA*

Acid rain coupled with increased aluminum (Al) is a potential cause of Atlantic salmon decline in many North American rivers including those of eastern Maine. Smolts appear to be the most sensitive of the salmon life stages to acid/Al (AA); however, the mechanisms underlying increased sensitivity are unknown. Our objectives were to 1) validate nonlethal, gill biopsy for measuring gill Al, 2) confirm that smolts are more sensitive to AA than parr, and 3) identify mechanisms underlying increased sensitivity. Parr and smolts were exposed to control and AA conditions in both the lab and the field, and were sampled after two and six days. In both test environments, AA caused a dose-dependent elevation of gill Al. Gill Al measured by the gill arch method did not differ from gill Al measured by nonlethal gill biopsy. In the lab and field, gill Al in both life stages increased > 7-fold after two days. After 6 days, parr gill Al was 2-fold greater than smolts. In lab exposures, plasma chloride of AA smolts decreased 11%, and glucose increased 3-fold after six days; however, chloride and glucose in parr were unaffected. Gill Na^+, K^+-ATPase activity (NKA) of both lifestages was unaffected. In the field, plasma chloride decreased 8.3% in AA parr and 27% in smolts after two days. Chloride in parr continued to decline but partially recovered in smolts. Plasma glucose increased > 2-fold in AA parr and smolts after two days. Gill NKA decreased 45% in AA parr and smolts after six days. We demonstrate that measurement of gill Al using nonlethal gill biopsy provides a valid indicator of AA exposure. We confirm that smolt ionoregulatory ability is more sensitive to AA than that of parr, however, neither decreased gill NKA nor elevated gill Al appear to be mechanisms of increased sensitivity.

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

Thresholds of acid and aluminum impacts on survival and physiology of Atlantic salmon smolts

Stephen D. McCormick[1,2], MichelleY. Monette[2], Amanda Keyes[1] and Keith Nislow[2,3]
[1]*U.S. Geological Survey, Silvio O. Conte Anadromous Fish Research Center, Turners Falls, MA;* [2]*University of Massachusetts, Organismic and Evolutionary Biology Program, Amherst, MA;* [3]*U.S. Forest Service, University of Massachusetts, Amherst, MA*

Previous work has established that smolts are more sensitive to acid and aluminum than most other life stages of Atlantic salmon. Recent work also indicates that relatively short-term exposure (several days) to acid and aluminum can cause mortality and reduce salinity tolerance. We conducted laboratory and field studies to determine the levels of acid and aluminum that affect survival, salinity tolerance, and stress in Atlantic salmon smolts. In the laboratory, fish were exposed to three levels of pH (6.0, 5.6, 5.2) and four levels of aluminum (0, 40, 80, 175 µg/l) for two days. All smolts died at low pH and high aluminum, and intermediate levels of acid and aluminum resulted in moderate mortality, loss of salinity tolerance, loss of plasma ions in fresh water and increased stress. Cage studies in southern Vermont streams indicated that similar thresholds of impact occur in natural stream waters over a three to six day period. The results indicate that an interaction of aluminum and low pH causes mortality and loss of salinity tolerance in Atlantic salmon smolts.

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

Smolt rearing origins from scales: Scale readers vs. computers

Ruth Haas-Castro[1], Christine Lipsky[2] and Edward Hastings[2]
[1]NOAA, Northeast Fisheries Science Center, Woods Hole, MA; [2]NOAA, Northeast Fisheries Science Center, Orono, ME

Identification of the source of Atlantic salmon that survive to advanced life stages (smolts and adults) must be accomplished to evaluate the effectiveness of stocking strategies. In Maine's Penobscot and Dennys rivers, smolt production occurs as a result of natural spawning and also by fry, parr, and smolt stocking. Using scales sampled from smolts collected by a rotary screw trap in the Pleasant River tributary of the Penobscot River, we conducted a scale reading study to determine the degree to which biologists can visually distinguish (with the aid of only a microscope) between scales from naturally and hatchery reared smolts. Hatchery reared smolts had been clipped on the ventral fin and stocked as parr 20 months or eight months prior to capture. No smolts had been stocked in the Pleasant River. Three experienced scale readers assigned age and origin (Parr20, Parr8, or naturally reared) to 177 scale samples. Readers accurately classified the stocking group of Parr8 in 75-94% of the cases. Accuracy for Parr20 was much lower, 10-53%, but the misclassification was mostly into the Parr8 category rather than into the naturally-reared category. A second study objective was to investigate the utility of computer-assisted scale pattern analyses in reliably determining smolt rearing origins. We derived a linear discriminant function (LDF) from measurements of scale growth variables (radius, circuli numbers and spacings, etc.). The LDF correct classification rate was 85% for Parr8 and 86% for Parr20. Scale feature measurements from Dennys River smolts were also analyzed using linear discriminant functions to distinguish among the above groups as well as smolt stocked fish. LDF correct classification rates were all above 90%. Quantifiable differences exist in the growth characteristics of parr-stocked and smolt-stocked individuals that can be reliably inferred not only through scale pattern analysis, but also visually by experienced scale readers.

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

Waterborne transmission of ISAV in marine waters: Studies from the Quoddy region of Maine and New Brunswick

Stephen K. Ellis and Lori Gustafson
U.S. Department of Agriculture, Animal Plant Health Inspection Service-Veterinary Services, Eastport, ME

Passive dispersal of virus by water is considered a probable means of distribution of Infectious Salmon Anemia in marine waters. The relevance of this means of transmission in the field has been presumed, but not clearly demonstrated; however, the implications to disease management and zonation strategies in the bi-national Quoddy region of Maine and New Brunswick are significant. Historical context and laboratory evidence is presented that led the authors to develop and implement an epidemiologic field study to try to identify the impacts of tidal flow on the distribution of ISA virus in the Passamaquoddy Bay and adjacent waters. The relationship between circulation patterns and the spatial and temporal incidence of ISA in the 2002 production year class of Atlantic salmon is evaluated. Findings, management implications, and ongoing concerns are discussed.

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

Mytilus edulis investigated as a bioaccumulator of infectious salmon anemia virus

Victoria A. Bowie, Keith A. Brockway and Cem Giray
Micro Technologies, Inc., Richmond, ME

Infectious salmon anemia virus (ISAV) has seriously affected the Atlantic salmon aquaculture industry in North America. Pathogen surveillance and disease management programs have been established in Canada and the USA to curb its effects. A key need for these programs has been the early detection of the pathogen before it can cause infections in aquaculture salmon. Research is currently being conducted to determine whether seawater, oceanographic parameters or other components can be used for the early detection of the virus or impending infections, but with limited results. Shellfish have been employed in environmental testing for human viral agents such as rotavirus and hepatitis A, and have also been implicated as potential reservoirs of aquatic pathogens. Blue mussels (*Mytilus edulis*) make up a substantial portion of the fouling organisms found on equipment such as nets and pontoons at marine Atlantic salmon (*Salmo salar*) grow-out sites. These filter feeders pump large volumes of seawater through them as they grow on net pen structures and may potentially retain ISAV. In this study we examined the ability of *M. edulis* to concentrate ISAV and its potential use as an indicator organism for the early detection of ISAV. Methods were developed and optimized for the extraction and detection by RT-PCR of viral RNA from *M. edulis* tissues, and laboratory bioaccumulation trials were conducted to determine if *M. edulis* could concentrate ISAV from seawater and at a level that could be useful as indicator organisms in the field. Results indicated that ISAV was not concentrated to any significant level by *M. edulis* and that, instead, the filtration activity of *M. edulis* reduced the viability of ISAV beyond that expected from degradation in seawater.

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

Descaling impairs osmoregulation in seawater challenged Atlantic salmon smolts

Gayle Zydlewski[1], Joseph Zydlewski[2] and G. Russell Danner[3]
[1]University of Maine, School of Marine Sciences, Orono, ME; [2]U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME; [3]Maine Department of Inland Fisheries and Wildlife, Augusta, ME

Descaling is a commonly observed injury in Atlantic salmon smolts migrating in watersheds that have dams with poor downstream passage. These injuries are particularly observed towards the end of the migratory season. The effect of this type of injury on the ability to osmoregulate upon seawater entry was investigated using hatchery smolts. A series of seawater transfers was conducted three times to reflect "early", "middle" and "late" periods of migration (April 25, May 11 and May 31). Before each transfer, 120 fish were anesthetized and measured (length and weight). Half served as controls and received no injury. The other half received a descaling injury of 20 % of the body surface. Immediately after recovery, 15 control and 15 treatment fish were subjected to a 35 ppt seawater challenge. After 24 h blood was collected (for plasma osmolality, hematocrit, and on day 7 septic bacterial load) and gill biopsies taken to measure gill Na^+,K^+-ATPase activity. Three additional seawater challenges were carried out at 1, 3, and 7 days after the initial sampling. Gill Na^+,K^+-ATPase activity levels indicate that the time series spanned the period from early smolting (increasing activity) to desmolting (decreasing activity). In each group, descaled fish showed greater osmotic perturbation than control fish. Control fish stabilized within 7 days for early and middle series; however, descaled fish failed to recover in this time frame. For the "late" fish, plasma osmolality was elevated in both groups; descaled fish did not differ from controls at days 3 and 7. No clear pattern of septic bacterial load and treatment was apparent. The evidence suggests that descaling impairs osmoregulatory performance during smolting and full recovery does not occur within 7 days. Therefore, descaled smolts entering seawater within 7 days of the injury may have compromised long-term survival.

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

Heritable adaptive trait variation in Maine's endangered Atlantic salmon (*Salmo salar*) – what's the next step?

Nathan Wilke[1], Michael Kinnison[1] and Tim King[2]
[1]University of Maine, Department of Biological Sciences, Orono, ME; [2]U.S. Geological Survey, Leetown Science Center, Kearneysville,, WV

One of the primary concerns surrounding population declines in species at risk is the loss of potentially adaptive trait variation and its implications for fitness and population persistence. Variation at molecular markers has at times been used as an indicator for potential loss of adaptive trait variation. However, theoretical predictions for the fate of quantitative trait variation under population decline are variable and empirical associations between molecular and adaptive trait variation have often proved elusive. Until now, microsatellite variation has been the primary data assessed for genetic variation in populations of Maine Atlantic salmon (*Salmo salar*). In this study we compare patterns of heritable, adaptive trait variation in six populations of Maine Atlantic salmon that have experienced recent population declines. The populations have been listed under the U.S. Endangered Species Act, and are currently managed at the Craig Brook National Fish Hatchery. All of these populations are closely related and most were reared to maturity under similar captive conditions, allowing us to better control for some of the confounding effects that may have limited other studies.

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

Postsmolt survival and growth of five Atlantic salmon stocks in seawater

William R. Wolters
U.S. Department of Agriculture, National Cold Water Marine Aquaculture Center, University of Maine, Orono, ME

Atlantic salmon aquaculture is one of the most successful global aquaculture enterprises, and farmed salmon has wide acceptance as a main food item by American consumers. Maine has the ideal location and unique opportunity to further increase salmon production and be the leader in coldwater marine finfish aquaculture. However, environmental issues, mandatory stocking of 100 percent native North American salmon, and disease have impacted economic viability of the U.S. salmon industry. In response, the Agricultural Research Service (ARS) established the National Cold Water Marine Aquaculture Center (NCWMAC) in Orono and Franklin, Maine. Initial research is aimed at developing a comprehensive Atlantic salmon breeding program from native North American fish stocks and release of genetically improved salmon lines to commercial producers. In the first two years of the breeding program, individual families were obtained from two St. John River sources, the Penobscot River, the Gaspé Peninsula, and landlocked salmon stocks in Maine. Eyed eggs were disinfected upon arrival and incubated in separate hatching jars. Yolk-sac fry were transferred into individual 0.1-m^3 tanks receiving 8 L/min of oxygen-saturated, biofiltered, recirculated freshwater. Approximately 30 days after initiation of feeding, fish densities were equalized to 250 fish per tank. Fish were fed 5% of the tank's total biomass daily and evaluated for growth over a 30-day period. Thirty fish from each family were tagged with Passive Integrated Transponder tags and stocked communally into replicated 10-m^3 tanks receiving 400 L/min of recirculating freshwater. One month prior to stocking into sea cages for performance evaluations, serum chloride levels and gill Na^+, K^+-ATPase activity were measured on subsamples from all stocks in freshwater and the subsequent seawater challenge. Analysis of variance was used to determine differences between stocks. Fish were weighed prior to stocking into sea cages for growth evaluations. Smolts were stocked into sea cages in June 2005 and are being evaluated for growth, survival, and sexual maturity under commercial culture situations. Fish will be sampled prior to the first winter in the cage for intermediate (6-month) growth measurements. Analysis of data on survival and growth will be presented.

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

Penobscot River salmon smolts: Movements, survival, and path choice during a flood year

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

The Penobscot River supports the largest run of Atlantic salmon in the United States; however, populations in this and neighboring systems have recently experienced precipitous declines. Restoration efforts have included extensive hatchery supplementation, and the majority of returning adults are believed to be the product of hatchery smolt stocking. In this study, we use acoustic telemetry to describe movements of both hatchery and naturally reared smolts in order to quantify path choice, transit times and loss to the system (mortality). These factors are related to smolt condition, supplementation practices, and the impacts of hydroelectric facilities. A total of 335 smolts were surgically implanted with acoustic transmitters and released at four locations in the Penobscot River and tributaries in the spring of 2005. Hatchery smolts were released in the Mattawamkeag River (n=40), the Penobscot River, Howland (n=150), and the Pleasant River, Milo (n=85) in mid-late April. Wild smolts (n=60) were captured during emigration, tagged, and released in the Penobscot River below Weldon Dam in late May. Tagged smolts were detected by an array of acoustic receivers spanning more than 150 km of the Penobscot River and its estuary. Peak discharge (107,000 cfs) during the study period was above the 90th percentile for the last 102 years of data, resulting in variable reach detection efficiencies. Nonetheless, preliminary results suggest that the majority of losses occurred in upper reaches, with small losses in the vicinity of dams. On average, hatchery smolts took 21 (SE ±.0.49) days to reach the estuary, whereas later migrating wild smolts took 3.5 (SE ±.0.22) days. These results indicate that survival to the estuary varied by rearing, stocking location and release date.

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

Movements of pre-spawn Atlantic salmon in Penobscot Bay and River: A pilot study using acoustic telemetry

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

Previous research has revealed extensive information on the freshwater stages of Atlantic salmon life history in the Gulf of Maine Distinct Population Segment, but the behavior of pre-spawn adults, particularly in the marine and estuarine environments, remains unclear. Migrating adults may incur significant mortality or delay at dams or through other sections of the river, representing critical impediments to restoration. In this study, we assessed the feasibility of acoustic telemetry as a method to describe patterns of upstream movement and migratory success over more than 200 km of the Penobscot Bay and River. Ten two-sea-winter (2SW) adult male salmon of hatchery origin were surgically implanted with acoustic transmitters; five of these were released in Penobscot Bay (near Rockland) and five were released above Veazie Dam (in Orono). An array of acoustic telemetry receivers provided detailed information on movement rates and path choice, including depth at detection. Detection efficiencies were robust, with minimal missed detections. Although all salmon were released in late June, only three had passed the Milford Dam (approx. 14 km upstream of Veazie Dam) by late October. These data suggest that dams are a severe impediment to migrating salmon. We recommend the use of acoustic telemetry in future assessments of migrating Atlantic salmon in the Penobscot River.

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

Movements and fate of sonically tagged, experimentally "escaped" farmed Atlantic salmon from the border area between Maine and New Brunswick of east coast North America

Fred Whoriskey[1,2], Paul Brooking[1], Gino Doucette[1], Steve Tinker[1] and Jonathan Carr[1]
[1]Atlantic Salmon Federation, St. Andrews, NB, Canada; [2]Huntsman Marine Science Centre, St. Andrews, NB, Canada

Farmed Atlantic salmon were sonically tagged then experimentally "escaped" from a cage site in Cobscook Bay, Maine, USA, to document movement patterns and fates of the fish. Fish were liberated in either the winter or spring. Cobscook Bay and the surrounding Bay of Fundy region are dominated by intense tidal currents, and tagged salmon dispersed away from the cage sites within a few hours post-release. There were high mortalities of the fish within Cobscook Bay and the surrounding coastal region (56% of winter release fish; 84% of the spring group) probably due to seal predation. Surviving fish exited the coastal zone to the Bay of Fundy primarily by following the dominant tidal currents in the region through Canadian waters. No sonically tagged fishes were detected during the autumn spawning season in any of 40 monitored Atlantic salmon rivers draining to the Bay of Fundy.

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

The development and use of fish assemblage assessment tools for determining the ecological benefits of dam removal and diadromous fish restoration in Maine rivers

Christopher O. Yoder[1] and Brian H. Kulik[2]
[1]Midwest Biodiversity Institute, Columbus, OH; [2]Kleinschmidt Associates, Pittsfield, ME

We are developing indices of fish assemblage condition based on the concepts of the Index of Biotic Integrity (IBI) as proposed by Karr et al. (1986) and modified by others for large rivers. The approach is flexible as the baseline data required for an IBI can be used for other resource assessment and management purposes including assessing the restoration of diadromous fishes and the ecological effects of altering habitat and habitat connectivity. The principal field sampling goal is to produce estimates of relative abundance for species amenable to efficient capture and for large numbers of sites located along extended reaches of large rivers on an annual basis. During 2001 and 2002, we began exploratory work in Maine on a fish assemblage assessment tool by constructing and testing a sampling device, and sampling 100 miles of the Kennebec River to ascertain changes in the fish assemblage of the main stem following removal of the Edwards Dam. Conventional analysis of the data showed marked differences in assemblage composition, density, and biomass between the newly re-created free flowing river and upstream impoundments. We sampled the Penobscot River main stem and selected tributaries in 2004, and in 2005, included the St. John, Allagash, Aroostook, and St. Croix rivers. Strong differences were found in various assemblage parameters and species relative abundance between major habitat types (riverine, impounded, tidal) and along the lengths of each river (cold to warm water). Important tasks that remain to be completed include delineation of reference conditions, determining the correspondence of the assemblage assessment to un-sampled species, and refining the definition of biological metrics that are applicable to Maine's large rivers. We will detail progress to date and describe a long term strategy for IBI development and its application to other New England rivers.

Reference:

Karr JR, Fausch KD, Angermier PL, Yant PR, Schlosser IJ. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Nat. Hist. Surv., Spec. Pub. 5. 28pp.

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

Incubation capacity of streamside incubators

Paul Christman, Kevin Dunham, and Daniel McCaw
Maine Atlantic Salmon Commission, Sidney, ME

The egg incubation capacity of decommissioned refrigerators as streamside incubators was tested in 2004. Two incubators were designed to allow incoming water to flow under a false floor and up through eight layers of poultry nesting material 127cm long and 74cm wide. Incubators were deployed in February and connected to a gravity fed waterpipe laid in a small tributary of the Sandy River. Each incubator received 42 L/minute of stream water. Eggs were loaded at a different density in each incubator. One incubator received 40,000 eyed eggs yielding a density of 0.55 eggs/cm^2 and one received 90,000 eyed eggs yielding a density of 1.25 eggs/cm^2. Incubators and temperature were monitored until egg development reached approximately 95%. All fry were removed, counted, and weighed. Observations and counts indicate the high-density incubator had over 60% mortality and the low-density incubator had less than 10% mortality. The results indicate safe egg densities may be 0.55 eggs/cm^2 for a refrigerator-sized incubator. It was also noted that temperature fluctuated due to a warm spring season which could have exacerbated mortality. Newly designed re-circulation systems and filter chambers will be discussed.

Session 4 ***3:20 p.m.***

Inferring selective mortality in hatchery raised Atlantic salmon (*Salmo salar*) fry

Michael Bailey and Michael Kinnison
University of Maine, Department of Biological Sciences, Orono, ME

Atlantic salmon (*Salmo salar*) restoration efforts in Maine employ fry stocking as one of the primary population enhancement strategies. The earliest periods of fry development are thought to represent the greatest phases of mortality in most fishes, including salmonids. In the wild, larger size, faster growth, or more advanced developmental state during these periods are often hypothesized to convey better survival; however, there is little data on the actual survival of newly emerged Atlantic salmon fry based on these characters. Hatchery rearing may reduce mortality up to stocking in hatched fry; however, it may also disrupt the natural match between fry characteristics and the features of their natal habitats, causing natural selection to act strongly on stocked fry in the wild. This, in turn, may have important implications for later aspects of the life history and productivity of fry-stocked fish. We have designed, and are now implementing, a series of experiments to assess patterns of size, growth and development related survival patterns for fry spending between 30 and 60 days in the wild. Our approaches all rely on reconstruction of attributes of fry at stocking using characters of growth rings in otoliths. Developing relationships between fry biology and otolith characters has been challenging. Nonetheless, we believe these experiments will provide important insights into the features of fry best suited for restoration efforts.

Session 4 ***3:40 p.m.***

Review of captive adult salmon as a restoration approach in Maine

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Maine Atlantic salmon stocks remain at extremely low levels. Although captive broodstock programs for six populations have been in place and extensive stocking of fry, parr and smolts has occurred, the populations remain at critically low levels. In addition to stocking juvenile life history stages, sexually mature adult salmon have been stocked on several occasions over the last ten years. The fish stocked have differed markedly in rearing history, with juveniles derived from the wild or domestic sources and adult fish reared to maturity in marine net pens or freshwater hatcheries. Monitoring of the reproductive effort and success of these fish indicates that they generally achieved relatively little reproductive output, with some exceptions (additional genetic analyses pending). Nevertheless, use of stocked adult salmon as natural spawners remains a tenable restoration method. Although this approach affords managers less control over the number of eggs successfully reared to fry (or older life history stages) and the spatial distribution of the offspring in the rivers, the fry that do emerge are derived from natural spawning (mate choice, competition for mates or spawning locations, choice of spawning location, etc.) and natural incubation and emergence conditions. These factors are lacking in our current hatchery fry production method. Whether these factors are important to the success of individual fish, and by extension, to the restoration of these populations, must be evaluated. Finally, we present some considerations for adult stocking that may improve the likelihood of success.

Session 4 ***4:00 p.m.***

Research prioritization lists: Quit meeting….and start reading

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Are "personalized prioritization lists" of the factors affecting Atlantic salmon survival and recovery necessary to direct research in Maine? We believe not - because several excellent syntheses (Parrish et al. 1998; O'Neil et al. 2000; Cairns 2001; National Research Council 2004) already exist that can readily be used in crafting and guiding strategic Atlantic salmon research plans. The common message from ALL of these syntheses is clear - Atlantic salmon populations are declining throughout their range and these declines are related to four principal concerns: (1) habitat connectivity (*e.g.,* dams); (2) marine survival; (3) hatchery influences; and 4) climate change. No single factor is responsible for the declines, and hence it is fruitless to look for a single-cure panacea (*i.e.,* a Holy Grail) that will miraculously recover Atlantic salmon in Maine. Overriding issues in the U.S. mirror those identified in larger-scale reports - some as old as the 1800's! An adaptive management approach is necessary to integrate research findings, recovery projects, and monitoring needs within a 'big picture' (ecosystem) context. Atlantic salmon life history and population dynamics are complex and naturally reproducing populations require balancing survival and production in both freshwater and marine systems. When new information is developed, these results need to be rapidly assimilated into recovery efforts. Two case studies are highlighted: (a) fry rearing alkalinity research and (b) smolt return data from in the Dennys River. Rigorous application of the scientific method and rapid adaptability and response to information are critical to understanding (1) what works, (2) what does not, and most importantly, (3) why.

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Session 4 ***4:20 p.m.***

Maine Atlantic salmon recovery and restoration priorities

Melissa Laser[1], Willa Nehlsen[2] and Mark Minton[3]
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NOAA Fisheries, the Atlantic Salmon Commission and the U.S. Fish and Wildlife Service are committed to working together to meet common objectives while fulfilling their respective responsibilities for Atlantic salmon management and recovery. While the three agencies may share common objectives, their priorities for actions to achieve these objectives are not always in the same order of preference, nor are they known to their partners. To improve collaboration and effectiveness among the agencies and partners, during the summer of 2005, the Services and ASC began a priority setting exercise to identify actions that the agencies believe should be accomplished in the near to medium term for Atlantic salmon survival and recovery, focusing on freshwater survival. The results of the priority setting exercise will be presented as well as a description of how these priorities fit in with the many other "lists" of priorities.

ABSTRACTS
POSTER PRESENTATIONS

Designing road-stream crossings to accommodate aquatic organism passage

Jason Czapiga
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Forestry and recreational roads constitute a large part of the road system in Maine. Scattered throughout this road system are a significant number of road-stream crossings that disrupt the form and function of stream channels. Culverts were installed exclusively to pass water and create a crossing; however, they have fragmented the aquatic habitat and impeded passage for aquatic organisms. Habitat connectivity in a watershed is as important on the main stem of the river as it is on the smallest of tributaries. Re-establishing habitat connectivity through installation of natural crossings would provide access to spawning and rearing grounds and restore thermal refuges for coldwater fish. Recently there has been an effort in Downeast Maine to inventory and prioritize passage improvement projects at road-stream crossings. This process will determine, at individual sites, the potential for culvert replacement with a natural stream bottom crossing or culvert removal and road discontinuation. The replacement culverts will create a road crossing that is invisible to the stream and passable to all aquatic organisms and most terrestrial animals. An interdisciplinary team of professionals including watershed groups, landowners, contractors, engineers, and state and federal agencies are collaborating to make assessments on what is best for the aquatic resource while maintaining the road infrastructure. Presented is a case study on a small tributary in the Machias River drainage.

The Student Conservation Association

Abraham R. Gates[1] and Douglas Smithwood[2]
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The Student Conservation Association (SCA) is a nonprofit organization that has been in existence for 48 years and is the oldest and largest conservation service organization in the USA. SCA works closely with Department of Interior (DOI) agencies and other public and private sector groups to provide low cost internship opportunities, outdoor education and leadership training to young people with an interest in conserving the natural environment. Around the nation, SCA has a well established fisheries program that provides many U.S. Fish and Wildlife Service (USFWS) facilities with interns who are college students or recent graduates looking to gain more experience in the fisheries field. SCA has a strong partnership with the Central New England Fishery Resource Complex which has helped expand SCA's involvement with several other USFWS sites within New England. We will be available for discussion and provide literature about the program, presenting an overview of what SCA can offer a facility and details on the logistics of the Internship Program.

In situ feeding behavior of Atlantic salmon juveniles at warm water temperatures: Are salmon in Maine adapted to warm water temperatures?

Alexandra Rohrer and Gregory Mackey
Maine Atlantic Salmon Commission, Jonesboro, Maine

Atlantic salmon (*Salmo salar*) in Maine occupy the southern extent of their range in North America. Therefore, salmon in Maine routinely experience warmer water temperatures than are reported in the literature for the upper limits of feeding and growth. We conducted a pilot investigation of the *in situ* feeding behavior of juvenile salmon across various water temperatures. Snorkeling observations of feeding strikes in relation to water temperature were made on unmarked Atlantic salmon young-of-the-year and parr in Northern Stream and Old Stream, Maine. Observations were made from 25 June to 6 August, 2005. During this time the water temperatures ranged between 17 and 23°C. Feeding strikes were recorded during timed observation events, and later converted into strikes per minute. No cessation or slowdown in foraging activity was observed across the range of temperatures in this study, and in fact, juvenile salmon were actively feeding beyond the maximum reported feeding temperature of 22.5°C. This suggests that these fish may be adapted to warmer water temperatures. Identifying the temperature ranges for feeding and growth is essential to understanding the role water temperature plays in limiting Atlantic salmon populations in Maine.

Atlantic salmon, smallmouth bass, and restored habitat in Kenduskeag Stream, Maine

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Maine Atlantic Salmon Commission, Bangor, ME

Two separate projects on Kenduskeag Stream are presented. The first addresses temporal effectiveness of electrofishing removal of smallmouth bass from juvenile Atlantic salmon habitat. In 2002 smallmouth bass were removed from seven sites distributed throughout the drainage. Electrofishing removal was found to be moderately effective in reducing smallmouth bass numbers in juvenile habitat. The second project was to stock fall parr from Green Lake National Fish Hatchery following minimal habitat restoration of an area where dairy cows had eroded the riverbanks and destroyed the riparian buffer. The first steps in stream habitat restoration were fencing out the cows (accomplished in 2000) and replacing a reduced hydraulic opening bridge with one that spanned greater than bankfull width (completed in 2004). The study area is the highest quality salmon habitat in the upper portion of the Kenduskeag Stream drainage, with cool water temperatures, good physical natural habitat, and suitable water chemistry. Two 50-unit reaches, a control area upstream of the bridge, and the cow loafing area downstream of the bridge were stocked in fall 2003, 2004, and 2005. A varying portion of the parr either died or left the area, presumably emigrating as smolts (size dependent). While habitat changed as a result of the fencing and bridge replacement, the outcome of the removal of the cows has had the greatest impact on riparian habitat recovery. The degraded area has not supported the same densities of stocked parr as the control site. The degraded area has more run habitat, slower velocity and shallower water depth than the control site, limiting carrying capacity. Further restoration is needed to increase the carrying capacity of the degraded area. However, parr grew at nearly the same rate throughout the study area.