2010 Research Forum
Maine Atlantic Salmon and their Ecosystems
6-7 January 2010
Wells Conference Center
University of Maine, Orono

Program

Wednesday, January 6

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

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

Session 1
Joan Trial, Moderator
Maine Department of Marine Resources
Bureau of Sea Run Fisheries and Habitat

8:40 a.m. **New insights into marine life of Atlantic salmon**
Gilles L. Lacroix

9:00 a.m. **Sonic tracking of Atlantic salmon smolts to sea: Correlates of survival and lessons on the migration pathway**
Fred Whoriskey

9:20 a.m. **Environmental and biological factors affecting the survival of Atlantic salmon in Maine**
Kevin D. Friedland, James P. Manning and Jason S. Link

9:40 a.m. **Coastal migration and survival of Atlantic salmon smolts in the Narraguagus River**
John F. Kocik, James P. Hawkes, Timothy F. Sheehan, Paul A. Music and Kenneth F. Beland

10:00 a.m. **Evaluating the influence of environmental conditions on the survival of outmigrating Atlantic salmon smolts within the Narraguagus River system, Maine**
Michael S. Cooperman, John F. Kocik and James P. Hawkes

10:20 a.m. *Break*

Session 2
G. Russell Danner, Moderator
Maine Department of Inland Fisheries and Wildlife
Fish Health Laboratory

10:40 a.m. **Atlantic salmon diet in coastal waters: Spatial and temporal forage patterns with inferences from alternative sampling platforms**
Mark D. Renkawitz and Timothy F. Sheehan

11:00 a.m. **Detection of carrier state infectious pancreatic necrosis in post-spawned sea-run Atlantic salmon at the Richard Cronin National Salmon Station**
Gavin Glenney, Patricia A. Barbash, John Coll and William Quartz

11:20 a.m. **Nonlethal detection of infectious salmon anemia virus (ISAV) in Penobscot River sea-run Atlantic salmon using Real-time Reverse Transcription-Polymerase Chain Reaction**
Patricia A. Barbash, Gavin Glenney and John Coll

11:40 a.m. **Mercury accumulation in stream-dwelling juvenile Atlantic salmon and brook trout (*Salvelinus fontinalis*)**
Darren M. Ward, Keith H. Nislow and Carol L. Folt

12:00 p.m. **Developing nonlethal biomarkers for waterborne organic contaminants**
Adria A. Elskus and Jennifer C. Meyers

12:20 p.m. *Lunch*

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

1:20 p.m. **Passage of hatchery reared Atlantic salmon smolts at dams and movement through estuary and bay on the Penobscot River, Maine**
Michael Bailey and Joseph Zydlewski

1:40 p.m. **Monitoring changes in resident and anadromous fish communities in Sedgeunkedunk Stream (Penobscot Co., Maine) after barrier removal**
Cory Gardner, Stephen M. Coghlan Jr., Joseph Zydlewski and Rory Saunders

2:00 p.m. **Barrier removal in Sedgeunkedunk Stream: Sea lamprey colonization and implications for Atlantic salmon habitat restoration**
Robert Hogg, Stephen M. Coghlan Jr. and Joseph Zydlewski

2:20 p.m. **Evaluating changes in diadromous species distributions and habitat accessibility following the Penobscot River Restoration Project**
Tara Trinko, Kyle Ravana and Rory Saunders

2:40 p.m. **Growth and survival of stocked juvenile Atlantic salmon in first and second order streams of the Machias River watershed**
Wesley Ashe and Stephen M. Coghlan Jr.

3:00 p.m. **Restoring stream connectivity in the Machias River watershed: A watershed based, focus area approach to salmonid restoration**
Steven Koenig and Scott Craig

3:20 p.m. *Break and* **Poster Session**

Poster Session
Wells Conference Center Sunroom

Diadromous Species Restoration Research Network (DSRRN): a five-year collaborative research effort
Barbara S. Arter

Atlantic and shortnose sturgeon management and research needs
Kim Damon-Randall, Lynn Lankshear and Jessica Pruden

Major Histocompatibility Complex Class II alleles: Genetic and functional variation in the Antigen Binding Site of Atlantic salmon
Ellen E. Hostert, Gerard Zegers, Mallory Ward and Amanda Corey

Monitoring progress for the Penobscot River Restoration Project
Blaine S. Kopp

Apparent channel alterations associated with historic log drives in the Machias River drainage
Derik Lee, Thomas Cochran, Tora Johnson, Steven Koenig and Sherrie Sprangers

Focus area approach to salmonid restoration: Basinwide stream-road crossing and fisheries assessment
Joseph McKerley, Josh Noll, Iris Lowery, Steven Koenig and Scott Craig

Restoring fish passage and natural stream function in eastern Maine

Katrina Mueller and Steven Koenig

Thursday, January 7

8:00 a.m. *Coffe*e

Session 1
Dan McCaw
Maine Department of Marine Resources
Bureau of Sea Run Fisheries and Habitat

8:30 a.m. **Interactive ecology of Atlantic salmon and smallmouth bass: Competition for habitat**
Gus Wathen, Stephen M. Coghlan Jr., Joseph Zydlewski and Joan Trial

8:50 a.m. **Assessing juvenile Atlantic salmon habitat suitability within small catchments (<2km^2) in Downeast Maine**
Scott Craig, Joseph McKerley, Jacques Tardie and Steven Koenig

9:10 a.m. **Effects of ice on juvenile Atlantic salmon in New Brunswick**
Tommi Linnansaari and Richard Cunjak

9:30 a.m. **Spawning behavior, reproductive success and production of juvenile offspring by stocked adult Atlantic salmon in four Maine streams**
Gregory Mackey, **Ernie Atkinson**, Colby Bruchs, Paul Christman and Dan McCaw

9:50 a.m. **Ontogenetic selection on hatchery salmon in the wild: Natural selection on artificial phenotypes**
Michael Bailey, Kevin Lachapelle and Michael Kinnison

10:10 a.m. **Historical summer baseflow trends in New England rivers**
Robert W. Dudley and Glenn A. Hodgkins

10:30 a.m. *Break*

Session 2
Mary Colligan, Moderator
NOAA's National Marine Fisheries Service
Northeast Regional Office

10:50 a.m. **Evaluating management strategies by individual based simulation**
Krzysztof Sakrejda-Leavitt and Benjamin Letcher

11:10 a.m.	**Basinwide Geographic and Ecological Stratification Technique (BGEST): Parr populations, habitat and management** **Joan G. Trial**, Greg Mackey and Paul Christman
11:30 a.m.	**American shad in the Penobscot River – choosing recovery tools** **Joseph Zydlewski** and Michael Bailey
11:50 a.m.	**American shad population genetics: Focus on Maine drainages** **Meredith L. Bartron**, Shannon Julian and Jeff Kalie
12:10 p.m.	**Outside the box: Coastal movements of shortnose sturgeon and implications for management** **Phillip Dionne**, Michael Kinnison, Gail Wippelhauser, Joseph Zydlewski and Gayle Zydlewski
12:30 p.m.	**Using acoustic telemetry to track movements of alewives (*Alosa pseudoharengus*) in freshwater and the coastal zone** **Jonathan Carr** and Fred Whoriskey
12:50 p.m.	**Tidal power development in Maine: Preliminary laboratory tests and field assessments in Western Passage and Cobscook Bay** **Gayle Zydlewski**, James McCleave and Haley Viehman
1:10 p.m.	**Closing** **John Kocik** *NOAA's National Marine Fisheries Service* *Northeast Fisheries Science Center*

ABSTRACTS
ORAL PRESENTATIONS

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

New insights into the marine life of Atlantic salmon

Gilles L. Lacroix
Department of Fisheries and Oceans, St. Andrews Biological Station, St. Andrews, NB, Canada

Atlantic salmon kelts from three different regions of the Bay of Fundy were tagged with pop-up satellite archival tags (PSATs) with 4-month pop-off delay as they left the rivers in the fall and spring for reconditioning at sea. Kelts from one region migrated thousands of kilometers to the northern edge of the Labrador Sea and as far east as the Flemish Cap, whereas those from the other two regions remained in the Bay of Fundy and Gulf of Maine. Detailed migration tracks were obtained from the archived light data (geo-positioning using sunrise and sunset times and day length). Preliminary examination of the water temperature and depth data archived at 2-15 min intervals revealed some interesting and common behavior. Although kelts encountered a wide temperature range (-1˚C to 20˚C), they tended to exploit areas within a narrow range (5-10˚C). Kelts spent most of their time near the surface (depth <2 m) while migrating, but nevertheless, there were frequent periods of repeated diving to 25-50 m, possibly associated with feeding. There were also occurrences of deep diving in the 100-500 m range (maximum depth 700 m). Mortality during migration was high and the archived parameters revealed that predation was a frequent cause. Changes in diving behavior and temperature also allowed for identification of a common predator for several cases in the Gulf of Maine.

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

Sonic tracking of Atlantic salmon smolts to sea: Correlates of survival and lessons on the migration pathway

Fred Whoriskey (presented by Jonathan Carr)
Atlantic Salmon Federation, St. Andrews, NB, Canada

We have used sonic telemetry to document Atlantic salmon smolt migration patterns and survival from freshwater river release sites to 1) the head of tide, 2) through the estuary, and 3) across the Gulf of St. Lawrence to the Strait of Belle Isle. The rivers studied [Miramichi, Restigouche, Cascapedia, Margaree and St. Jean (North Shore)] fell on an approximately 600 km south to north gradient. Survival patterns of smolts in freshwater and through the estuary were generally similar among years for a given river. We also found consistent differences in survival to the head of tide and across the estuary among rivers. However, these differences did not clearly correlate with latitude. Heavy losses occurred in most river estuaries. Twenty to 30% of the smolts that survived to exit the estuaries of the Miramichi, Restigouche and Cascapedia Rivers passed through the Strait of Belle Isle enroute to ocean feeding grounds off Greenland. Travel rates in the Gulf were estimated as 17- 25 km/d, and survivals and travel speeds were not correlated with fish body lengths. The results show that Atlantic salmon from different rivers migrate together in the sea, and suggest that behavioral and social factors may be important in determining smolt survival.

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

Environmental and biological factors affecting the survival of Atlantic salmon in Maine

Kevin D. Friedland[1], James P. Manning[2] and Jason S. Link[2]
[1]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Narragansett, RI; [2]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA

The general parameters of a recruitment mechanism for North American salmon have emerged that suggest sea mortality is a punctuated event that occurs within the first two months at sea. The post-smolt population is most likely decremented by predation, mediated by the changing nature of the predator field in the Gulf of Maine. We examined a suite of environmental and biological factors in order to test and extend the hypothesis formulated for the North American stock complex to the stocks that would utilize the Gulf of Maine as postsmolts. The marine survival of Atlantic salmon in the Gulf of Maine appears to be influenced by a complex set of physical and biological interactions. Marine survival has declined as sea surface temperature in the coastal ocean has increased, and there also appears to have been a deterioration of synchronization between smolt migration and ocean conditions for postsmolts. There has been a change in spring wind conditions in the Gulf of Maine area, which could be modifying the post-smolt migration across the Gulf of Maine and Georges Bank regions. The shift in environmental conditions have also affected the distribution in time and space of many predators that likely prey upon salmon postsmolts. Notably, hake species have increased in abundance in the areas that serve as migration corridors for postsmolts. The time series changes in environmental conditions and predator distribution is consistent with the hypothesis that Gulf of Maine salmon experience a growth-independent mortality during the first months at sea, thus forming the basis of recruitment control for these populations.

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

Coastal migration and survival of Atlantic salmon smolts in the Narraguagus River

John F. Kocik[1], James P. Hawkes[1], Timothy F. Sheehan[2], Paul A. Music[1] and Kenneth F. Beland[3]
[1]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME; [2]NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA; [3]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Bangor, ME

We studied the estuarine and early marine ecology of Atlantic salmon smolts within the relatively large and spatially dynamic environments of eastern Maine using ultrasonic transmitters and a large network of fixed receivers. We monitored natural smolt migration in the Narraguagus River and Bay, and the coastal environment of the Gulf of Maine (GoM). Our 30 km long study area began in the lower river, extended 8 km downstream to head-of-tide, 7 km through the estuary, then fanned out seaward 15 km in the western GoM along the interface with the Maine Coastal Current. From 1997 to 2004, we increased sampling network density in the estuary and expanded marine arrays further into the GoM. We designed receiver networks to monitor all smolt exit routes and were able to: (a) estimate smolt survival to the GoM; (b) map primary migration paths; and (c) document emigration timing. Survival ranged from 36% to 47% to the GoM. Median migration rates were 0.7 km/h in the estuary to Middle Bay and 1.0 km/h in the Outer Bay. Smolts generally traveled with the tides and upon entering saltwater and most commonly used the western 6 km of a 23 km wide embayment. These are among the first quantitative data to estimate survival during early marine migration of wild Atlantic salmon smolts. A Cormack-Jolly-Seber model estimated site efficiency and smolt survival simultaneously, providing a useful methodology and information benchmarks for other studies to better understand emigration dynamics and to help identify mortality factors at sea.

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

Evaluating the influence of environmental conditions on the survival of out migrating Atlantic salmon smolts within the Narraguagus River system, Maine

Michael S. Cooperman, John F. Kocik and James Hawkes
NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Orono, ME

The out migration of anadromous salmon smolts from freshwater to saltwater is a time of elevated mortality, but factors contributing to mortality have not been well quantified. During 2002-2004, we used acoustic telemetry to explore how environmental conditions affect Atlantic salmon smolt survival during their migration through the Narraguagus River system of Downeast Maine. Each year approximately 85 wild smolt in the Narraguagus River were tagged and smolt survival monitored within the ecozones of the lower river (FW), estuary (EST) and bay (SW). Tagged smolts were partitioned into one of 16 four-day cohorts based on date of entry to each ecozone. There were large differences among cohorts in survival within each zone (all χ^2 test $p < 0.03$), with mean cohort survival (i.e., # exiting an ecozone / # which entered) in FW of 0.85 (range 0.60 – 1.0), 0.70 in EST (range 0.25 – 1.0), and 0.65 in the SW (range 0.38 – 1.0). Our results suggest 1) smolts survived best when delaying migration until after the cold temperatures of early season, 2) late season river water temperatures can be stressful to smolts but rain events could improve survival, and 3) that surface oriented predators (i.e., birds) may be a primary source of mortality. These findings are consistent with other studies, but the observed relationships were weak (all $r^2_{adj.}$ of models with $\Delta AICc < 2$ were < 25.2). In contrast, wind speed and direction, tidal amplitude, lunar phase, and mean and variability of river discharge were not related to survival. When smolt cohorts were partitioned into groups of good (> 75%) and bad (< 60%) survival, MANOVA (all $p > 0.37$), MRPP (all $p > 0.18$), and NMS ordination each failed to identify environmental differences experienced by the groups. In total, our results suggest abiotic conditions were not a primary driver of differences in survival among cohorts in the Narraguagus system, and therefore provides evidence that predation is perhaps the principle mechanism of smolt mortality.

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

Atlantic salmon diet in coastal waters: Spatial and temporal forage patterns with inferences from alternative sampling platforms

Mark D. Renkawitz and Timothy F. Sheehan
NOAA's National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA

Atlantic salmon populations in the Northwest Atlantic have significantly declined in abundance. Conditions in the marine environment are at least partially responsible for these declines and are hampering recovery efforts. Populations in the southern extent of the species range are extinct, and the existing populations in the USA are currently classified as 'endangered'. These populations undertake extensive round trip migrations from natal rivers to feeding grounds off the coast of Greenland, utilizing different coastal environments over multiple life stages. To understand how Atlantic salmon forage in coastal environs, NOAA's National Marine Fisheries Service collected post-smolt stomachs from different rearing origins in Penobscot Bay, Maine, USA, and from immature adults off the west coast of Nuuk, Greenland. Significant dietary differences were found between years and between salmon life stages. Postsmolts in USA waters primarily fed on juvenile Atlantic herring (*Clupea harengus*) and euphausiids, while adults in Greenland primarily fed on capelin (*Mallotus villosus*) and amphipods (*Parathemisto* sp.). Significant differences were found in the quantity and quality of food items consumed by postsmolts from different rearing origins. Contemporary adult salmon diets at Greenland differed from those determined from studies conducted four decades earlier. Overall, considerable interannual variation was evident in the composition, availability, and abundance of prey species consumed by Atlantic salmon in coastal USA and Greenland waters. Similar interannual variations in the diets of co-occurring seabird species have been linked to patterns in fitness, and may influence Atlantic salmon survival and reproductive success, as well. It is unclear whether these dietary changes are related to cyclic interannual variations in the forage base or to permanent shifts caused by large scale climatic factors. No matter which, fluctuating foraging conditions at various life stages may be negatively impacting the marine survival of Atlantic salmon.

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

Detection of carrier state infectious pancreatic necrosis in post-spawned sea-run Atlantic salmon at the Richard Cronin National Salmon Station

Gavin Glenney, Patricia Barbash, John Coll and William Quartz
U.S. Fish and Wildlife Service, Lamar Fish Health Center, Lamar PA

The infectious pancreatic necrosis virus (IPNV) pathogen was isolated and identified from two pools of Connecticut River sea-run Atlantic salmon ovarian fluid during the 2007 spawning season at the Richard Cronin National Salmon Station. A small 130 base-pair (bp) polymerase chain reactions (PCR) product was amplified (USFWS and AFS-FHS 2003) and sent to the USGS Western Fisheries Research Center for sequence analysis. The isolate closely resembled the Canada_3 strain, falling into genogroup V described by Romero-Brey et al. (2009), which is different from the more common genogroup I in the USA. This information allows us to speculate that the Cronin Atlantic salmon were not infected with IPNV during the freshwater life stage in the Connecticut River watershed. On November 20, 2007, the Connecticut River Atlantic Salmon Commission (CRASC) voted to depopulate the infected stock at Cronin and the entire suspect egg lots held at White River National Fish Hatchery. Approximately 4 weeks following confirmation of IPN at Cronin, 121 Connecticut River Atlantic salmon sea runs were euthanized and sampled for a follow up investigation to determine the location and prevalence of infection and to perform a comparison between the standard lethal tissue samples (kidney/spleen) with various blood fractions for development of a reliable nonlethal screening tool for future years. Although no IPNV positive blood samples were detected, one kidney/spleen homogenate (male-#55) exhibited cytopathic effect on the chinook salmon embryo (CHSE) cell line and tested positive for IPNV via PCR. A total of 2,943 bp of segment A was sequenced and determined to be a new strain of IPNV closely resembling Canada_2 and Canada_3 of genogroup V. Further work is being conducted to develop a qPCR assay to detect a variety of IPNV isolates and increase sensitivity for potential nonlethal testing.

References:

Romero-Brey I, Bandin I, Cutrin JM, Vakharia VN, Dopazo CN. Genetic analysis of aquabirnaviruses isolated from wild fish reveals occurrence of natural reassortment of infectious pancreatic necrosis virus. J. Fish Dis. 32:585-595.

USFWS and AFS-FHS (U.S. Fish and Wildlife Service and American Fisheries Society-Fish Health Section). 2003. Standard procedures for aquatic animal health inspections. In: AFS-FHS. FHS blue book: suggested procedures for the detection and identification of certain finfish and shellfish pathogens. 2003 ed. Bethesda, MD: American Fisheries Society-Fish Health Section.

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

Nonlethal detection of infectious salmon anemia virus (ISAV) in Penobscot River sea-run Atlantic salmon using real-time Reverse Transcription – Polymerase Chain Reaction

Patricia A. Barbash, Gavin Glenney and John Coll
U.S. Fish and Wildlife Service, Fish Health Center, Lamar, PA

Since 2000, the U.S. Fish and Wildlife Service's Lamar Fish Health Center (LFHC) has been monitoring for infectious salmon anemia virus (ISAV) in Atlantic salmon (ATS) migrating to New England rivers, using tissue culture and polymerase chain reaction (PCR) techniques on whole blood. Standard PCR detected ISAV in one of 60 ATS sampled from the Penobscot River in 2001, but the virus did not cause cytopathic effect (CPE) on targeting cell lines. This was later determined to be the HPR0 genotype of ISAV, which had been reported in wild ATS in Europe, and thought to have low or no pathogenicity. In 2009, the LFHC implemented a real-time RT-PCR assay (Snow et al. 2006) in ATS sea-run broodstock health screening protocols. The more sensitive molecular tool produced positive detections of ISAV from 6 of 570 pre-spawn ATS sea-run blood samples screened from the Penobscot River. No CPE was observed in tissue culture assays. Sequence analysis of the PCR product targeting segment 8 of the ISAV genome confirmed the positive detection. Preliminary sequence analysis indicated the genotype to be similar to European ISAV types. In order to prevent possible viral transmission of the virus to progeny, and subsequently to facilities where progeny are cultured for stocking and domestic broodstock, the two females and 4 male fish suspected of carrying the virus were removed from the spawning population. Results from subsequent genotyping of the haemagglutinin (HA) gene in the highly polymorphic region (HPR) will be presented, as well as a discussion of fish health management implications for feral broodstock programs.

Reference:

Snow M, McKay P, McBeath AJ, Black J, Doig F, Kerr R, Cunningham CO, Nylund A, Devold M. 2006. Development, application and validation of a Taqman real-time RT-PCR assay for the detection of infectious salmon anaemia virus (ISAV) in Atlantic salmon (*Salmo salar*). IN: Vannier P, Espeseth D, editors. New Diagnostic Technology: Applications in Animal Health and Biologics Control. Basel, Karger. Dev. Biol. 126:133-145.

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

Mercury accumulation in stream dwelling juvenile Atlantic salmon and brook trout (*Salvelinus fontinalis*)

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, Forestry Service, Northern Research Station, University of Massachusetts, Amherst, MA

We measured mercury concentrations in juvenile Atlantic salmon and brook trout at 20 sites in tributary streams of the Connecticut River in 2008. All study streams were in largely forested watersheds with no point source inputs of mercury pollution. Mercury concentrations of both species varied widely across sites, with a >10-fold range in site mean concentrations for salmon (60-800 ppb dry) and a >5-fold range for trout (60-330 ppb dry), and concentrations frequently exceeded critical values for protection of piscivorous wildlife (ca. 100 ppb for birds, 500 ppb for mammals). For both species, variation in mercury concentrations across sites increased with environmental factors that reflect increased mercury bioavailability and accumulation in the stream food web (e.g. low pH, low ANC, high mercury concentrations in prey invertebrates) and decreased with factors that reflect increased secondary productivity (high prey biomass, high fish growth rate). Mercury concentrations in salmon and trout were significantly correlated across sites ($r=0.77$, $P<0.0001$). However, while salmon and trout concentrations were similar at sites with low mercury levels, salmon mercury concentrations were up to 3 times higher than mean trout concentrations at the most contaminated sites. This species-specific pattern may reflect bioenergetic differences in mercury and biomass accumulation or a differential switch to relatively uncontaminated terrestrial prey by trout at unproductive sites with high mercury levels.

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

Developing nonlethal biomarkers for waterborne organic contaminants

Adria A. Elskus[1] and Jennifer C. Meyers[2]
[1]*U.S. Geological Survey, Aquatic Toxicology Section, University of Maine, Orono, ME;*
[2]*University of Maine, School of Marine Sciences, Orono, ME*

Threatened and endangered (T&E) fish species are in decline due to many factors, including polluted habitats. A common approach to assessing contaminant exposure in fish is to measure chemical body burdens or to assess physiological, developmental, reproductive or biochemical changes; both approaches are typically lethal. Our objective is to develop nonlethal approaches for determining pollutant exposure and response for use with T&E species. The monooxygenase enzyme, cytochrome P4501A (CYP1A), is an established biomarker that is rapidly and strongly induced by many of the most toxic organic pollutants found in aquatic systems, including dioxin, polynuclear aromatic hydrocarbons, and polychlorinated biphenyls (PCBs). We hypothesized that CYP1A could be measured nonlethally using gill filaments and scales. We exposed Atlantic salmon parr to two aqueous concentrations of 3,4,3',4',5'-pentachlorobiphenyl (PCB-126, 0.01 µM & 0.001 µM, static exposure), vehicle (32.25 ppm acetone), or untreated water for 24 h before transferring the fish to clean, flow-through water. At 6 and 24 h during exposure, and at 2, 14 and 34 days post-exposure we sampled gill filaments and scales (nonlethally) and whole livers (lethally). PCB-126 treatment strongly and significantly induced CYP1A activity (measured as ethoxyresorufin-o-deethylase, EROD) in all tissues, with the strongest induction seen in the gills (up to 414 fold over controls), followed by the liver (up to 25 fold over controls), and the scales (up to 17 fold over controls). Significant elevation occurred within 6 hours of exposure and persisted for at least 34 days after fish were placed in clean water. Signs of disease and distress were not observed in fish sampled nonlethally and held for 34 days post sampling. We conclude that CYP1A activity in salmon gills and scales shows great promise as a nonlethal biomarker of organic pollutant exposure and response for use with threatened and endangered fish species.

Supported by Department of the Interior, U.S. Geological Survey, and the Senator George J. Mitchell Center for Environmental and Watershed Research at the University of Maine, Grant No. 06HQGR0089.

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

Passage of hatchery reared Atlantic salmon smolts at dams and movement through estuary and bay on the Penobscot River, Maine

Michael Bailey[1] and Joseph Zydlewski[1,2]
[1]University of Maine, Department of Wildlife Ecology, Orono, ME; [2]U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME

The Penobscot River hosts the largest return of adult Atlantic salmon in the US, but runs are very low compared to historic numbers. Stocking of hatchery reared smolts is a major restoration tool but has had only moderate success in recent years. Previous telemetry studies have shown that downstream passage success is variable among years and sites. We used acoustic telemetry to quantify downstream passage success and movement through the estuary in 2009. We also assessed the success of survival for three stocking areas: Milo, Passadumkeag and Verona Island. The heavily dammed sections of the river accounted for over 10% mortality in some study reaches. Our best fit model comparing reaches with and without dams demonstrates the lower survival of dam influenced sections. We found variable survival through the estuary for the different hatchery releases.

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

Monitoring changes in resident and anadromous fish communities in Sedgeunkedunk Stream (Penobscot Co., Maine) after barrier removal

Cory Gardner[1], Stephen M. Coghlan Jr.[1], Joseph Zydlewski[1,2] and Rory Saunders[3]
[1]*University of Maine, Department of Wildlife Ecology*, *Orono, ME;* [2]*U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME;* [3]*NOAA's National Marine Fisheries Service, Protected Resources Division, Orono, ME*

Sedgeunkedunk Stream is a third order tributary to the Penobscot River. The stream once supported anadromous fish runs that have declined or disappeared due to two barrier dams. A restoration project has been completed on the Sedgeunkedunk which removed the lowermost dam and replaced an upstream dam with a rock-ramp fishway. This project provides an opportunity to characterize the responses of resident fish communities and anadromous fish populations to dam removal. We anticipate dramatic impacts on the stream system associated with connectivity, hydrology, temperature and marine derived nutrient influx. In order to assess fish community response, we have collected data on abundance, length, and mass of all fish species present. The fish community in the stream sections above the dam shows reduced biomass, species richness, and species diversity, compared to the section below the dam. The immediate response to the removal of the lower dam was a drop in fish abundance and species richness downstream of the removal. Fish abundance above the site of the former dam increased, which could be caused by the more common species moving upstream in response to the disturbance caused by the dam removal. Sea lamprey, anadromous fish already present in the stream, are being monitored for both abundance and habitat use. This restoration will serve as a model for other small streams in the watershed, and elsewhere, targeted for dam removal.

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

Barrier removal in Sedgeunkedunk Stream: Sea lamprey colonization and implications for Atlantic salmon habitat restoration

Robert Hogg[1], Stephen M Coghlan Jr.[1] and Joseph Zydlewski[1,2]
[1]University of Maine, Department of Wildlife Ecology, Orono, ME; [2] U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME

Sedgeunkedunk Stream is a tributary of the lower Penobscot River, debouching downstream of several impassible barriers on the Penobscot main stem. Historically, Sedgeunkedunk Stream provided spawning habitat for several native anadromous fish species including endangered Atlantic salmon, but several small dams reduced or eliminated spawning runs entirely. Currently, only a small population of sea lamprey (*Petromyzon marinus*) uses the accessible portion of Sedgeunkedunk Stream regularly for spawning and rearing. As part of the Sedgeunkedunk Stream Restoration Project (SSRP), the abandoned Mill Dam was removed in August 2009, and this latest restoration effort has opened up an additional 5 km of potential lotic habitat. Consequently, Sedgeunkedunk Stream provides a unique opportunity to examine ecological interactions within a suite of diadromous species in the context of long-term restoration efforts. We hypothesize that semelparous sea lamprey may provide an influx of marine derived nutrients and energy (MDNE) in Maine streams, similar to that documented for Pacific salmon in western streams. Furthermore, we hypothesize that sea lamprey spawning will condition habitat to better suit Atlantic salmon spawning. Sea lamprey spawning activities rearrange gravel and small cobble substrate in the process of nest construction. Lamprey nest building also releases fine sediments while reducing embeddedness. Atlantic salmon prefer loose gravel substrate free of fine sediments for redd construction and as lamprey colonize previously inaccessible habitat beyond the former Mill Dam, lamprey conditioning may attract salmon spawners. Comparing lamprey abundances, stream productivity, and fine-scale changes in habitat before and after dam removal, as well as comparisons with a nearby control stream, will test these hypotheses. Johnson Brook is a stream similar to Sedgeunkedunk Stream but with a natural barrier waterfall excluding diadromous fishes. Comparisons with Johnson Brook will elucidate whether changes in Sedgeunkedunk Stream were a function of colonization and expanded range for diadromous species.

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

Evaluating changes in diadromous species distributions and habitat accessibility following the Penobscot River Restoration Project

Tara Trinko[1], Kyle Ravana[2] and Rory Saunders[1]
[1]*NOAA's National Marine Fisheries Service, Northeast Regional Office, Orono, ME,*
[2]*University of Maine, Department of Wildlife Ecology, Orono, ME*

The Penobscot River Restoration Project (PRRP) is a multimillion dollar endeavor that aims to restore native sea-run fish through the removal of two main stem dams and improved fish passage at a third dam on the Penobscot River. We used geographic information systems (GIS) to quantify changes in species distribution and habitat accessibility for 11 diadromous species in the Penobscot Basin following the PRRP. Using previously compiled accounts of historic range, barrier survey data, and simulated barrier passage data, we modeled species-specific distributions and river access for 11 species following the proposed dam removals and compared these against the current ranges and accessibility. For some species such as Atlantic sturgeon (*Acipenser oxyrhinchus oxyrhinchus*), the PRRP will provide access to 100% of their historic freshwater habitat. However, for alewives (*Alosa pseudoharengus*), approximately 46% of historic spawning and rearing habitat will remain inaccessible due to the presence of other passage barriers. These results demonstrate that the PRRP is an important step toward ecosystem recovery in the Penobscot Basin, but other restoration activities will be needed in order to realize the full potential of the PRRP.

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

Growth and survival of stocked juvenile Atlantic salmon in first and second order streams of the Machias River watershed

Wesley Ashe and Stephen M. Coghlan Jr.
University of Maine, Department of Wildlife Ecology, Orono, ME

The Machias River, located in Downeast Maine, harbors one of the few remaining wild populations of anadromous Atlantic salmon in the US. This study focuses on Atlantic salmon habitat in first and second order streams of the Machias River watershed. Over the past century, the Machias River watershed has experienced much alteration due to anthropogenic disturbances. These activities, mainly the construction of roads for timber harvest and log driving, have severely disrupted the structure and function of the river and its tributaries. The extensive network of logging roads required the construction of dozens of culverts on many of these headwater streams. Currently, these poorly designed and malfunctioning culverts impede the movement of juvenile Atlantic salmon into tributaries that historically provided nursery and rearing habitat. These productive habitats are essential to the growth and survival of juvenile Atlantic salmon, as they provide thermal refuge, protection from predators, and abundant food supply. However, current management of Atlantic salmon in the Machias River involves stocking fry in larger tributaries because many of these smaller tributaries are blocked by culverts and, thus, would be inaccessible to returning adults. The objectives of this study are to determine the growth and survival of stocked Atlantic salmon fry in these headwater streams, better understand those habitat characteristics most significant to juvenile salmon production, and assess the benefits of culvert removal in the context of Atlantic salmon restoration.

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

Restoring stream connectivity in the Machias River watershed: A watershed-based focus area approach to salmonid restoration

Steven Koenig[1] and Scott Craig[2]
[1]Project SHARE, Eastport, ME; [2]U.S. Fish and Wildlife Service, Maine Fishery Resources Office, East Orland, ME

Since 2001, Project SHARE (Salmon Habitat and River Enhancement) has organized aquatic habitat restoration work intended to improve Atlantic salmon populations in the Downeast Distinct Population Segment (DPS) rivers. The overreaching goal of the restoration strategy is to improve aquatic and riparian habitat conditions on a watershed scale. The restoration thought process is based on correction of stream process rather than technical modifications of a site-specific reach to achieve short-term habitat improvements. Recognition that stream process begins in small headwater streams that influence the entire downstream water course provides the basis for a top-down approach. Therefore, the restoration strategy intends to identify and address multiple habitat threats at many relatively small restoration sites on a watershed scale. Working within the context of SHARE's mission and authority, specific goals are to increase watershed connectivity (including fish passage), increase instream habitat complexity, decrease anthropogenic sedimentation inputs, and mitigate anthropogenic changes in water chemistry (pH, temperature). Identification of high priority subwatersheds and threats assessment within selected focus areas allows limited resources to be focused in a manner that improves the potential for long-term success and benefit to the resource. It is generally recognized that dams and culverts can present barriers to both upstream and downstream fish passage. Less obvious disruptions of the continuum of stream ecological processes have not reached a similar level of mainstream awareness among land-use planners, regulators, and conservation groups. Road-stream crossings have been identified as a principle impact to stream connectivity and subsequently to salmon recovery in the Machias River watershed. Working cooperatively with landowners, state and federal agency partners, SHARE has replaced 50+ undersized round culverts with open bottom arch culverts and has decommissioned 10+ road crossings in the Machias River watershed. Funding is in place to complete 30+ additional road crossings in 2010. Although dams are recognized as a similar threat to salmon restoration in other areas of the DPS, it is generally recognized that most of the dams on the Machias River were removed at the end of the log drive era. SHARE has documented the existence of 50+ historic dam sites in the Machias River drainage. In most cases, the sites do not present impairment to fish passage. However, remnant structures and the reservoirs associated with the sites do present an anthropogenic impact to channel morphology that continues to affect hydrology, sediment transport and water temperature. We will present an overview of the Machias Watershed restoration strategy including: identified threats, symptoms of altered stream connectivity, and habitat restoration efforts to date.

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

The interactive ecology of Atlantic salmon and smallmouth bass: Competition for habitat

Gus Wathen[1], Stephen M. Coghlan Jr.[1], Joseph Zydlewski[1,2] and Joan Trial[3]
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We are investigating competition for habitat between native Atlantic salmon (ATS) and invasive smallmouth bass (SMB). Our major objectives are to determine if: (1) the two species overlap in habitat use, and at what time of year; (2) the overlap causes ATS to shift in their habitat use; and (3) the presence of SMB negatively impacts ATS growth rates. The first objective will be met through a series of snorkel observations of habitat use of both fish in sympatry and allopatry. A simulated stream and an *in situ* "controlled invasion" experiment are being used to meet objective two. Measurements incorporated into a Wisconsin Bioenergetic Model will allow us to calculate ATS growth rates in sympatry and allopatry. Initial results indicate that ATS and SMB age 0+ fish overlap significantly in habitat use during the late summer months, and the overlap does cause shifts in ATS habitat use. Results from this study will be used to better inform managers on the interactive ecology of two of Maine's most culturally and economically important fish.

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

Assessing juvenile Atlantic salmon habitat suitability within small catchments (<2 km^2) in Downeast Maine

Scott Craig[1], Joseph McKerley[1], Jacques Tardie[2] and Steven Koenig[2]
[1]*U.S. Fish and Wildlife Service, Maine Fishery Resources Office, East Orland, ME*
[2]*Project SHARE (Salmon Habitat and River Enhancement), Eastport, ME*

The U.S. Fish and Wildlife Service's Maine Fishery Resources Office has been collaborating with multiple partners to restore ecological stream processes within small catchments in Downeast Maine. In the past four years, over 80 projects have restored aquatic organism passage and ecological stream functions within fish bearing catchments varying in area from 0.2 to 61.7 km^2 (mean 3.8 km^2). In 2009, we collected pre-restoration stream data to quantify juvenile Atlantic salmon "Habitat Suitability" as defined by Stanley and Trial (1995). This habitat suitability index (HSI) model is useful for evaluating stream habitats for production and survival of juvenile Atlantic salmon. HSI results of fry and parr, and water quality components, will be summarized for tributaries ranging in size from 0.3 to 2.0 km^2.

Reference:
Stanley JG, Trial JG. 1995. Habitat suitability index models: nonmigratory freshwater life stages of Atlantic salmon. U.S. Dept. Interior, Nat. Biol. Serv., Biol. Sci. Rep. 3. 19 pp.

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

Effects of ice on juvenile Atlantic salmon in New Brunswick, Canada

Tommi Linnansaari and Richard Cunjak
Canadian Rivers Institute, University of New Brunswick, Department of Biology, Fredericton, NB

Winter is often considered to be a bottleneck for survival of juvenile stream salmonids in temperate and arctic latitudes. Due to logistical difficulties in following fish behavior in ice-covered streams, the effects of different ice formations have not been thoroughly understood. The study used Passive Integrated Transponder (PIT) technology that allows fish monitoring throughout the winter and was carried out over three years to understand how different winter periods, distinguished by contrasting ice condition, affect the ecology of the species. The steepest decline in apparent survival of salmon parr was observed during the pre-ice period in late autumn/early winter, whereas relatively high apparent survivals was observed during the period dominated by ice. Apparent survival possibly decreased again in early spring. Large-sized pre-smolt individuals obtained positive growth during winter. Salmon parr showed plasticity in their winter behavior in relation to prevailing ice conditions. The activity pattern remained generally nocturnal throughout the winter regardless of ice conditions. The level of activity was adjusted, however, being reduced during subsurface ice events, while more daytime activity was observed when the amount of surface ice increased. Salmon parr were sedentary during winter, showing generally short and nonrandom movements. Movement tactics were adjusted relative to the prevailing ice conditions. Subsurface ice did not preclude tagged salmon parr from large areas. The presence of ice cover allowed salmon parr to disperse to areas where no other cover was available. Overall, negative effects of ice on Atlantic salmon parr were minimal and the presence of stable surface ice cover was considered beneficial for salmon parr when water temperatures remained close to 0^{o}C. In the future, anthropogenic impacts such as climate change and hydropower regulation can lead to changes in the natural ice regime of fluvial waters. Therefore, consideration of winter at a subperiod level will be crucial in order to assess how different salmon populations and their behaviors will be affected.

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

Spawning behavior, reproductive success, and production of juvenile offspring by stocked adult Atlantic salmon in four Maine streams

Gregory Mackey[1], Ernie Atkinson[2], Colby Bruchs[2], Paul Christman[3] and Dan McCaw[3]
[1]Douglas County P.U.D. #1, East Wenatchee, WA; [2]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Jonesboro, ME; [3]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME

Management strategies used to restore endangered populations of Atlantic salmon within the Gulf of Maine Distinct Population Segment (DPS) have included fry stocking, smolt stocking, egg planting, and stocking gravid adults. Management focusing on fry and smolt stocking has not resulted in significant adult returns and natural reproduction. Adult stocking circumvents much of the hatchery influence on mate selection and potentially results in progeny that are more likely to survive and reproduce in the wild. However, stocking adults sacrifices numerical production advantages achieved by traditional hatchery methods. In 2005, an adaptive management project began in Mopang Stream (Machias), Chase Mill Stream (East Machias) and the Sheepscot River in which river specific Atlantic salmon adults, reared to maturity from captive large parr, were stocked in the autumn. In 2006, a similar project began on Hobart Stream. Results varied across streams, stocked adults successfully spawned, and fry were captured during the following spring. However, the number of redds per female was less than the expected two redds per wild female spawner. Movements of stocked adults were highly variable. The captive reared pre-spawn salmon often left the study reach but did not move upstream of passable obstacles such as waterfalls. Juvenile assessments documented that 0+ and 1+ parr densities were similar to densities in fry stocked areas. However, stocked adults produced fewer 0+ and large parr per capita than adults spawned for fry stocking. Managers need to consider lifetime fitness in evaluating large scale gravid adult stocking projects.

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

Ontogenetic selection on hatchery salmon in the wild: Natural selection on artificial phenotypes

Michael Bailey, Kevin Lachapelle and Michael Kinnison
University of Maine, School of Biology and Ecology, Orono, ME

Captive rearing often alters the phenotypes of organisms that are destined for release into the wild. Natural selection on these unnatural phenotypes could have important consequences for the utility of captive rearing as a restoration approach. We show that normal hatchery practices significantly advance the development of endangered Atlantic salmon fry by 30+ days. As a result, hatchery fry might be expected to face strong natural selection resulting from their developmental asynchrony. We investigated patterns of ontogenetic selection acting on hatchery produced salmon fry by experimentally manipulating fry development stage at stocking. Contrary to simple predictions, we found evidence for strong stabilizing selection on the ontogeny of unfed hatchery fry, with weaker evidence for positive directional selection on the ontogeny of fed fry. These selection patterns suggest a seasonally independent tradeoff between abiotic or biotic selection favoring advanced development and physiological selection linked to risk of starvation in unfed fry. We show through a heuristic exercise how such selection on ontogeny may exacerbate problems in restoration efforts by impairing fry productivity and reducing effective population sizes by 13 to 81%.

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

Historical summer baseflow trends for New England rivers

Robert W. Dudley and Glenn A. Hodgkins
US Geological Survey, Maine Water Science Center, Augusta, ME

River baseflow is important to aquatic ecosystems, particularly because of its influence on water temperatures. Summer (June through September) daily mean streamflows were separated into baseflow and stormflow components by use of an automated method at 25 stations in the New England region of the United States that have long term records and predominantly drain natural basins. Summer monthly mean baseflows increased at most stations in western New England from 1950 to 2006 with many large increases (>20%) and some very large increases (>50%) in New Hampshire and Vermont. The same was true for increases in summer 7-day low baseflows in New Hampshire and Vermont during this same period; in contrast, there were small and large decreases in 7-day low baseflows in northern and coastal areas of Maine. Seven-day low baseflow trends at the 10 stations with records from 1930 to 2006 were similar to trends from 1950 to 2006. Summer stormflows increased from 1950 to 2006 by more than 50% at many stations in New England, particularly in New Hampshire and Vermont. Summer rainfall increased at most weather stations in New England from 1950 to 2006 with many increases of more than 20% in western New England.

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

Evaluating management strategies by individual based simulation

Krzysztof Sakrejda-Leavitt[1] and Benjamin Letcher[2]
[1]*University of Massachusetts, Organismic and Evolutionary Biology, Amherst, MA*; [2]*U.S. Geological Survey, Silvio O. Conte Anadromous Fish Research Laboratory, Turners Falls, MA*

Allocating resources between different habitat improvements and stocking strategies is key to optimal use of resources in salmon conservation. Presently, it is difficult to evaluate the trade-offs inherent in management decisions because no single model incorporates all the relevant aspects of the salmon life cycle. We developed an individual based simulation model of freshwater growth, movement, and survival for the Atlantic salmon life cycle from stocking to smolting. All three parts of the simulation are driven by a common set of factors: local density, water temperature, discharge volume, seasonality, and habitat quality. The simulation model is parameterized based on statistical models developed directly from a mark-recapture study on a stocked population. These features allow us to evaluate the trade-offs between management strategies in terms of the effect on the number and size distribution of salmon smolts.

(Abstract only, no presentation)

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

Basinwide Geographic and Ecological Stratification Technique (BGEST): Parr populations, habitat and management

Joan G. Trial[1], Greg Mackey[2] and Paul Christman[3]
[1]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Bangor, ME; [2]Douglas County P.U.D. #1, East Wenatchee, WA, [3]Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat, Hallowell, ME

Basin large parr populations have been estimated on the Narraguagus River (1991 to 2006), the Dennys River (2001-2005), and the Sheepscot River (2003 - 2006). The estimates, based on stratifying the watersheds (geographic) and habitat (ecological), and expanding population parr estimates from sites based on the proportion of habitat sampled, have annual confidence intervals (±) that averaged 29 % of the estimate on the Narraguagus River, 34% of the Dennys River estimates, and 45 % of the Sheepscot River estimates. The estimates represent a large investment in planning, field work, and data management and computation. While the parr numbers track population trends, their strengths are in what can be learned about habitat and as the basis of adaptive management. On the Narraguagus River in 10 of 16 years, tributaries containing only 1.6 % of the surveyed juvenile rearing habitat reared approximately 19 % of the annual estimates (range 13 % to 33 %). In three of four years, the Upper West Branch of the Sheepscot River reared on average 49% of the large parr (range 37 % to 59 %), yet contained only 17 % of the surveyed habitat. In 2005 and 2006, the lower main stem Sheepscot strata population was over six times higher than the two previous years, corresponding to 0+ parr stocking in 2004 and 2005. Following an assessment year, 0+ parr stocking was continued in this portion of the Sheepscot River. The switch from scatter to clump stocking in the main stem Narraguagus strata immediately below Beddington Lake in 2005 did not result in lower parr populations, and clump stocking fry will be continued in this portion of the Narraguagus. The key to using ecologically stratified large parr estimates in adaptive management is to geographically and temporally segregate management strategies.

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

American shad in the Penobscot River –choosing recovery tools

Joseph Zydlewski[1,2] and Michael Bailey[1]
[1]*University of Maine, Department of Wildlife Ecology, Orono, ME;* [2]*U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME*

The planned restoration efforts in Penobscot River include the removal of two main stem dams and the improvement of passage at the lowest remaining dam, Milford. This ambitious undertaking has generated optimism for the recovery of anadromous fish such as Atlantic salmon, but also for alosine fishes such as American shad. Shad are present in the Penobscot River, though presumed to be few in number, fueling concerns that unaided recovery could either fail or be unnecessarily protracted after access to upriver habitat is restored. While supplementation is a commonly used tool in fisheries management, the use of hatchery products is often a contentious issue. Concerns include impacts of hatchery reared fish on natural populations via behavioral, ecological and genetic effects. The cost effectiveness of supplementation strategies can also be questionable. In order to assess the possible benefits of artificial supplementation on the rate of recovery, we applied data from several sources to build a deterministic population model. In this model, the shad population was represented by age classes up to 11 years (representative of age structure of shad observed in the Gulf of Maine) and iteroparity was included. Age of first maturation, at sea mortality, and fecundity were derived from Atlantic States Marine Fisheries Commission reporting. Shad stocked as fed larvae were assumed to have ten-fold higher survival than wild spawned fish. As expected, the model was very sensitive to initial population. Presuming a current run of 1,000 shad to the river and a population that stabilizes at 600,000 upon restored connectivity, the population would increase to 15,000 within 15 years and stabilize in less than 40 years. A stocking scenario that adds 12 million fry annually would accelerate stabilization to less than 30 years. It is hoped that this heuristic exercise may inform decisions associated with an intensive shad stocking program.

Session 2 ***11:50 a.m.***

American shad population genetics: Focus on Maine drainages

Meredith L. Bartron, Shannon Julian and Jeff Kalie
U.S. Fish and Wildlife Service, Northeast Fishery Center, Lamar, PA

American shad (*Alosa sapidissima*) are an important component of the diadromous fish community and ecosystem for Atlantic salmon. Evaluation of the genetic structure of American shad stocks, with particular focus on northeastern and Maine drainages, can be used to understand the genetic relationships among drainages and provide information for management and conservation. Samples were obtained in 2008 from five drainages in Maine, and genetic results obtained from 15 variable microsatellite loci were compared to other primary American shad rivers in the northeast: Merrimack, Connecticut, Hudson, Susquehanna, and Delaware. Observed estimates of genetic diversity were slightly lower in Maine drainages relative to other populations examined. Mean observed heterozygosity (H_o) and mean allelic richness (A_r) were lower among Maine populations (H_o=0.795 and A_r=9.414) compared to estimates observed among other populations (H_o=0.809 and A_r=10.061). Comparisons of differences in allele frequencies among all rivers sampled indicated that samples obtained from the Narraguagus River were significantly different ($P<0.01$) from all rivers analyzed, including Maine rivers. Samples from the Merrimack River, which has been and is currently used as a source for American shad stocking throughout New England, did not differ significantly in allele frequencies from the Androscoggin, Kennebec, Saco, or Sheepscot drainages, but did significantly differ in allele frequencies from the Narraguagus River ($P<0.01$). Allele frequencies from American shad sampled from the Hudson, Susquehanna, and Delaware rivers generally were significantly different from the Connecticut, Merrimack, and Maine rivers ($P<0.01$). Resulting information about the genetic structure of American shad populations and knowledge of the history of stock transfer can be used to evaluate past and current reintroduction efforts, and to assist ongoing management and conservation efforts for American shad in New England.

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

Outside the box: Coastal movements of shortnose sturgeon and implications for management

Phillip Dionne[1], Michael Kinnison[2], Gail Wippelhauser[3], Joseph Zydlewski[4] and Gayle Zydlewski[1]
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The shortnose sturgeon (*Acipenser brevirostrum*) is managed as 19 river-specific distinct population segments under the US Endangered Species Act. River-specific information about population size, distribution, and habitat use are critical to the management of this species. Recently, answering such questions has become complicated by evidence of movement between distant river systems, e.g., the Penobscot and Kennebec rivers in Maine (>140km direct path). Closed population estimates for the Penobscot and Kennebec rivers are 1,531 (95% CI: 885 – 5,681), and 9,488 (95% CI: 6,942 to 13,358), respectively. In 2006 and 2007, 40 shortnose sturgeon captured in the Penobscot River were implanted with acoustic tags; 10 of these tags were subsequently detected in the Kennebec River. The high rate of exchange between these systems indicates that we are likely sampling individuals from multiple sources. We have been using mark-recapture methods and acoustic telemetry to estimate the proportion of sturgeon moving between these two rivers. In 2008, individuals were documented using three additional coastal Maine rivers. Sampling techniques since 2008 reflect the open nature of this population and abundance estimates based on discrete closed population periods bounded by periods of emigration and immigration. Our current population estimates are: for summer 2008: 1,739 (95% CI: 847-3653) and fall 2008: 1,007 (95% CI: 674 – 1531). These estimates will be applied to data collected in 2009. These, along with movement patterns, will provide more accurate information for the management of this endangered species.

Session 5 ***12:30 p.m.***

Using acoustic telemetry to track the movements of alewives (*Alosa pseudoharengus*) in freshwater and the coastal zone

Jonathan Carr and Fred Whoriskey
Atlantic Salmon Federation, St. Andrews, NB, Canada

We used acoustic telemetry to assess the pre- to post-spawning movement and survival of alewives in a Canadian river. A total of 40 alewives were tagged (20 each in 2007 and 2008) after they ascended a fish ladder at the Magaguadavic River's head of tide hydroelectric dam. Fish resided in the lower river reaches and a nearby lake during the spawning period. Six and two alewives are presumed to have died during the 2007 and 2008 spawning periods, respectively. During the return to sea, signals from five (2007) and two (2008) fish were lost near the top of the dam. Nine (2007) and four (2008) fish passed the dam via the turbines and suffered a mortality rate of 62%. No alewives used the downstream fish bypass facility in 2007. However, 12 fish used the bypass facility in 2008 when increased attraction flow was provided. Fish passing the dam alive were subsequently tracked through the river estuary and up to 28 km through the coastal zone. This study has demonstrated that sonic telemetry can be successfully employed for this species.

Session 5 ***12:50 p.m.***

Tidal power development in Maine: Preliminary laboratory tests and field assessments in Western Passage and Cobscook Bay

Gayle Zydlewski, James McCleave and Haley Viehman
University of Maine, School of Marine Sciences, Orono, ME

Waterfront communities are changing nationwide and Maine is no exception. One change that some communities will face is the development of alternative energy, including wind and tidal power. It is only when the value of the energy resource is balanced against the environmental and social impact that the potential for developing a site can be understood. While environmental impacts of tidal turbines will be complex, the most acute impacts are likely to be observed as direct contact of aquatic species with turbines. Because open turbine designs are new technology, studies examining the ability of fishes and other aquatic organisms to avoid a turbine are not standardized. Test procedures necessarily will be different from those used with conventional (enclosed) hydroelectric turbines. We have initiated laboratory studies to consider how Gorlov turbines may impact free swimming fish, examining turbine blade strikes and turbine avoidance. In addition, we have examined individuals for injury (bruising, descaling) and stress levels. We have also initiated field testing. Baseline fisheries data were collected in Western Passage and Cobscook Bay in summer/fall of 2009. Baseline data include stationary acoustic surveys (24 h) of proposed turbine deployment sites to determine vertical distribution of aquatic organisms. In fall of 2009 a barge-deployed turbine will be tested by Ocean Renewable Power Company in Cobscook Bay and a field deployment is scheduled for fall 2010. Barge deployment will be assessed using DIDSON (Dual-frequency Identification SONAR) in fall of 2009. Laboratory and field results will be used to inform engineers about turbine design and/or operation to minimize environmental impacts as well as informing resource agencies in permitting decisions.

ABSTRACTS
POSTER PRESENTATIONS

Diadromous Species Restoration Research Network: A five-year collaborative research effort

Barbara S. Arter
University of Maine, George J. Mitchell Center for Environmental and Watershed Research, Orono, ME

The goal of the Diadromous Species Restoration Research Network (DSRRN) is to advance the science of diadromous fish restoration and promote state-of-the-art scientific approaches to multispecies restoration at the ecosystem level. DSRRN integrates many diverse activities that improve the understanding of ecosystems and enhance restoration outcomes, facilitates the study of questions fundamental to diadromous fish ecology and restoration through scientific meetings, workshops and local networking, and enhances coordination of diadromous species restoration efforts of academic, government, and watershed stakeholders. The Network which is funded through the National Science Foundation, provides information and networking on research and restoration funding opportunities, research and restoration project partnerships, conferences and meetings, the Penobscot Science Exchange, fisheries and restoration links, and the Gulf of Maine Knowledge Base which provides access to spatially referenced bibliographic information so that users can locate information using text based and map based searches by state/province and by watershed.

Atlantic and shortnose sturgeon management and research needs

Kim Damon-Randall, Lynn Lankshear and Jessica Pruden
NOAA's National Marine Fisheries Service, Protected Resources Division, Gloucester, MA

NOAA's National Marine Fisheries Service (NMFS) has jurisdiction for both Atlantic and shortnose sturgeon. Atlantic sturgeon is currently designated as NMFS Species of Concern and Candidate species. In 2007, a status review team completed a status review for Atlantic sturgeon indicating that there are five distinct population segments of Atlantic sturgeon in the United States and recommending that three of the five Distinct Population Segments (DPS) be listed under the Endangered Species Act (ESA). The five DPS are: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. NMFS is currently in the process of considering the existing information to determine if listing is warranted for Atlantic sturgeon, and the Northeast Regional Office will be publishing a listing determination for the three DPSs in the Northeast early in 2010. Shortnose sturgeon is listed as endangered throughout its range. NMFS recently assembled a status review team to update the existing status of shortnose sturgeon. The status review report is expected in 2010, and it is possible that based on the information in this report, NMFS could propose to list DPSs of shortnose sturgeon. Consequently, the listing status of shortnose sturgeon in Maine could change in the near future. The Northeast Regional Office has been working with sturgeon researchers for several years to compile information on both species of sturgeon. Much of this research effort has been focused in Maine in recent years including projects on the Penobscot, Kennebec, and Saco Rivers. The various research efforts have provided crucial information that is being considered by NMFS in recovery efforts and in consultations under Section 7 of the ESA. While a significant amount of information has been collected in recent years, there are still many remaining questions that need to be answered including: information on the distribution, abundance, and movements of all life stages, particularly for young-of-the year and juveniles; identification of particular spawning locations; developing population estimates for both species where they occur in Maine; assessing impacts of water quality and contaminants on sensitive life stages; assessing interbasin movements and potential for colonization; and basic habitat characterizations.

Major histocompatibility complex class II alleles: Genetic and functional variation in the antigen-binding site of Atlantic salmon

Ellen E. Hostert, Gerard Zegers, Mallory Ward and Amanda Corey
University of Maine at Machias, Division of Environmental and Biological Sciences, Machias, ME

Our strategy is to use comparative genomic analysis to study the evolution of immune system genes in response to differences in life history strategies, specifically the differences in the suites of parasites experienced by landlocked versus anadromous fish. Here we report early results from a comparison between landlocked and anadromous populations of Atlantic salmon distributed throughout the Distinct Population Segment (DPS). Preliminary work in our laboratory indicated high levels of heterozygosity for the major histocompatibility complex (MHC) class-IIβ gene. Analysis of single-strand conformational polymorphisms (SSCP) from the Machias, East Machias, and Dennys rivers salmon indicates a general pattern of shared polymorphism within the DPS and with fish from Atlantic Canada. Extensive sharing of alleles among closely related species is well known for MHC alleles. We demonstrate that our SSCP patterns are repeatable, and that SSCP patterns derived from cloned DNA are identical to alleles observed in our source fish. DNA sequencing demonstrates that at least some DPS fish alleles are similar to those previously reported from Atlantic Canada. Future work includes identification of the corresponding amino acid changes in the antigen-binding site for each allele sampled, and broad correlation of functional allelic diversity with life history differences. This study will be expanded to other immune system genes, especially MHC class-IIα, as well as MHC class-I and a minor histocompatibility complex gene such as transporter associated with antigen processing (TAP). This will allow multilocus genotyping of fish, and determination of the existence of unique immune system genotypes within the DPS.

Monitoring progress for the Penobscot River Restoration Project

Blaine S. Kopp
Penobscot River Restoration Trust, Augusta, ME

In June 2009, the National Oceanic and Atmospheric Administration (NOAA) announced it would invest $6.1 million through the American Recovery and Reinvestment Act of 2009 (Recovery Act) to help rebuild the sea-run fisheries of Maine's Penobscot River. A grant to the Penobscot River Restoration Trust will fund removal of the Great Works dam. It will also initiate scientific baseline monitoring to allow tracking of physical, chemical and biological changes in the river following the removal of Great Works and Veazie dams, and the decommissioning and bypass of the dam at Howland. Understanding the effectiveness of dam removal requires systematic project monitoring and data reporting. Toward that end, a diverse group of government agency staff, academic researchers, and non-profit representatives established the Penobscot River Science Steering Committee (PRSSC) and developed a conceptual framework for monitoring. Concurrently, the Gulf of Maine Council on the Marine Environment (GOMC) sponsored a similar effort to develop regional guidance for stream barrier removal monitoring. NOAA was represented in both of these efforts, and their priorities for Recovery Act funding were aligned with metrics identified as both "core" to the PRSSC monitoring framework, and "critical" within the GOMC guidance. This includes monitoring of: (1) fish community structure and function, passage at barriers, assembly of diadromous species at the most seaward dam, and import of marine derived nutrients and organic matter; (2) monumented river cross-sections to document vertical and horizontal channel adjustments; (3) sediment grain size distribution at the above cross-sections to document changes in bed material; (4) photos taken quarterly at permanent stations to provide a visual record of riparian vegetation and channel configuration; (5) basic water quality for assessing and understanding changes in fish habitat use, population numbers, and community structure; (6) benthic macroinvertebrate community structure as an indicator of aquatic ecosystem habitat quality; (7) wetland and riparian plant communities. This baseline monitoring will provide an objective basis for evaluating restoration outcomes, and a framework for researchers to address additional PRSSC and GOMC monitoring priorities.

Apparent channel alterations associated with historic log drives in the Machias River drainage

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Spring log drives were an annual event on the Machias River from the 1800's through 1977. Remnants of the infrastructure associated with the drives are scattered throughout the watershed. Landings used for transferring logs onto the river or lakes and water control dams are the most commonly identified structures. Rock footings and earthen and wood berms are common structural remnants of the water control dams both on the main stem of the river and its tributaries. These channel alterations potentially degrade Atlantic salmon spawning and rearing habitat by creating a hydraulic check in the stream. As a result, the channel is artificially widened upstream and sediment deposition occurs both upstream and downstream of the check. Another type of log drive relic has been identified along the main stem of the Machias River between Second and Third Machias Lakes: rock and log walls appear to have been constructed to essentially cut off side channels, resulting in the creation of artificial oxbows behind the walls. Project SHARE (Salmon Habitat and River Enhancement) in partnership with faculty and students at the University of Maine at Machias have removed dam remnants at some sites in the Machias and East Machias watersheds. During the fall of 2009, a project was initiated on the Machias to map the locations of the rock walls, the length of the blocked side channels behind each wall, the substrate characteristics of the blocked side channels, and cross-sectional profiles through the side channels and associated main channel. Future studies will combine the data from these projects with existing salmon habitat survey data for the same reaches of river, assess the potential effect of the channel alterations on Atlantic salmon habitat availability, and evaluate potential habitat unit gains (or losses) that might be realized by removal of some of these channel altering structures.

**Environmental Studies undergraduate*

Focus area approach to salmonid restoration: basinwide stream-road crossing and fisheries assessments

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In 2007 and 2008, the USFWS Maine Fishery Resources Office and Project SHARE (Salmon Habitat and River Enhancement) completed culvert and fisheries assessments at all stream-road crossings in two high priority salmonid subbasins in Downeast Maine – West Branch Machias River and Old Stream (above Rt. 9). We identified fish bearing, stream-road crossings for a restoration strategy designed to restore ecological stream processes within watersheds that have exceedingly high conservation merit in terms of both existing high quality salmonid habitat *and* projected long term protection from threats such as urbanization and increased road development. Identification of high priority focus areas allows limited resources to be focused in a manner that improves the potential for long term success and benefit to the natural resource. It should be noted that private landowner support was established prior to conducting surveys. Working within the context of the 2009 Project SHARE Restoration Strategy, specific goals are to increase watershed connectivity and instream habitat complexity, decrease anthropogenic sedimentation inputs, and mitigate anthropogenic changes in water chemistry (pH, temperature). The principle target species are Atlantic salmon (federally endangered) and brook trout.

Restoring fish passage and natural stream function in eastern Maine

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Undersized round culverts at road-stream crossings on first and second order perennial streams are the principle impediment to fish passage in the Downeast coastal region of Maine. Whereas rivers draining this region are relatively free of main stem dams, the impact of commercial road networks on connectivity and natural stream function is extensive. Road-stream crossings can create fish passage barriers through hanging outfalls and excessive or insufficient velocity and flow. En masse, they can alter temperature, hydrologic and sediment transport regimes, and subsequently decrease the quality and quantity of available habitat for native fishes. Recent habitat assessments suggest that legacies from the log driving era might also be wide ranging, significant, and wholly negative from a native species standpoint. Since 2005, SHARE (Salmon Habitat and River Enhancement) has focused its on-the-ground efforts on restoring natural function to all first and second order perennial streams within high priority subwatersheds draining the Machias River (a historically important and well protected Atlantic salmon migration corridor). These subwatersheds are considered the "best of the best" in terms of habitat quality (existing and potential) by regional salmon biologists and also rank very high in terms of habitat quality for native eastern brook trout and future security from urbanization. In 2009, SHARE received funding under the American Recovery and Reinvestment Act to decommission or replace 53 undersized round culverts with open bottom structures in its current geographical focus area. With half of these sites completed in 2009, we are actively working towards our goals of reconnecting headwaters to the main stem and lower watershed; re-establishing fish passage and natural temperature, sediment and nutrient transport regimes at all fish-bearing sites; and continuing to expand our capacity as an organization to coordinate with regional stocking efforts and engage a broader base of youth and professionals on-the-ground.