

2015 AIC Conference

Presentation Abstracts

Preliminary results of a capture-mark-recapture study of striped bass, *Morone saxatilis*, in the Inner Bay of Fundy, Nova Scotia: Evaluating outreach success, determining growth rate, and examining evidence of school fidelity

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The Inner Bay of Fundy (iBoF) striped bass population was assessed by COSEWIC as Endangered in 2012, and currently only one of three historical spawning sites is recognized as having successful spawning events. Over 1000 striped bass have been dart tagged opportunistically in iBoF since 2013, with the majority of individuals accessed as bycatch at a commercial intertidal herring weir in Bramber, Nova Scotia. Approximately 10% of these fish have been recaptured. Our vigorous outreach program has also successfully encouraged anglers and commercial fishermen to report tags using our online database, Track My Fish (www.trackmyfish.ca). The high frequency of recaptures and temporal span over which these recaptures have occurred allows for growth rates to be calculated for striped bass over multiple size classes. These data have also provided evidence of potential school fidelity; bass captured and tagged at the same time are often caught together, up to two years later. These observations may provide insight into schooling and migration behaviour of striped bass in the iBoF. Future plans for population identification through DNA analyses will be discussed, along with the potential implications of these results.

Mortality of Striped Bass at a Power Plant Discharge in Nova Scotia

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Striped Bass (*Morone saxatilis*) often overwinter in the warm water discharge of power plants where they are susceptible to mortality resulting from an abrupt loss of thermal habitat during disruptions in power generation. Department of Fisheries and Oceans Canada has identified these mortality events as an uncertain and recurring source of overwintering mortality for the southern Gulf of St. Lawrence (sGSL) Striped Bass population. We collected Striped Bass from a 2013 mortality event at the Trenton power plant in Pictou Harbour, Nova Scotia and described age and size structure, diet, and population of origin of collected specimens. Striped Bass ranged from 1 to 5 years of age and 11.8 to 60.2 cm TL. Fifteen percent of stomachs contained food. Striped Bass and Fourspine Stickleback (*Apeltes quadracus*) were the only identifiable prey items in 57% and 29% of stomachs containing food, respectively. Microsatellite DNA analysis suggested Striped Bass from Pictou Harbour may be genetically different from the Miramichi River population indicating genetic heterogeneity within the sGSL.

Adaptively Managing Stocked Salmonine Waters of the Belgrade Lakes (Maine) in the Presence of Invasive Species

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The Belgrade Lakes located in central Maine is a series of seven waters with a combined surface area of over 20,000 acres. Historically, much of “The Belgrades” were managed by the Maine Department of Inland Fisheries and Wildlife (MDIFW) primarily as coldwater fisheries, and recognized nationally for their renowned brook trout and landlocked salmon fisheries. Over the past few decades, several factors including land use practices, water quality degradation, and the illegal introduction of numerous invasive fish species have required biologists to adaptively manage these fisheries. In many cases these management changes affected either the stocking program, the regulations, and/or modifications to the duration or timing of the fishing season. Although many of these changes have been accepted by Maine anglers, there are a few that have met public scrutiny and resistance, due mainly to a sense of nostalgia and the perception that the historic salmonine fisheries can be restored. After years of data collection, MDIFW fisheries biologists are confident that one lake’s landlocked salmon fishery has irreparably collapsed. This has prompted MDIFW to begin developing a comprehensive fisheries management plan; attempting to provide a better coldwater fishing opportunity in a lake that has been severely impacted by numerous factors.

Investigating Atlantic salmon stock recruitment relationships in the Miramichi River.

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Atlantic salmon populations have been steadily decreasing since the 1980’s. Estimates for 2014 represent historic lows for returning spawners to the Miramichi River. Consequently, there has been a widespread call to address the decline and devise a comprehensive conservation plan for Atlantic salmon in eastern Canada. Key to such an effort is a thorough analysis of the freshwater data to identify temporal and spatial trends in stock recruitment dynamics, and potential bottlenecks to production (e.g. climate warming). To investigate this, we will carry out a rigorous analysis of DFO’s long-term, electrofishing data and returning adult salmon numbers in the Miramichi and Restigouche Rivers. We will determine whether spawner estimates correlate with indices of juvenile (parr) abundance and freshwater production (smolts) using field surveys, statistical analyses and hierarchical (Bayesian) modeling. This project started at the end of July 2015; our talk will present the general framework and challenges associated with this study as well as some preliminary results for the stock recruitment relationships.

Using video counts of spawning alewife, *Alosa pseudoharengus*, in the Gaspereau River, Nova Scotia to assess spawning run size, and escapement.

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The upstream migration of the anadromous alewife, *Alosa pseudoharengus*, is integral for both recreational and commercial fisheries. In 2001, an assessment of the alewife population in the Gaspereau river revealed that the stock was heavily exploited resulting in the establishment of a fisheries management plan with a primary goal to reduce fishing mortality and reach a spawning escapement of 400 000 adults. Based on an assessment up to 2006, the management plan did reduce the exploitation rate and the escapement more than doubled over values in the late 1990’s. Video monitoring at the White Rock fish ladder occurs annually during the spawning run, but recent video has not been counted. Counts of two recent years are being undertaken using a two-way stratified statistical

sampling method and will provide information about the more recent spawning escapement of alewife in the Gaspereau river system with respect to management goals. Commercial landings on this river will be compared with run size estimates.

Methodologies of acoustic telemetry tags in American Shad

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Telemetry is a quickly advancing tool for fisheries biologists. Advances in technology have improved efficacy in coastal marine waters and increased tag life now enables multi-season studies. American shad are often the focus of upstream and downstream fish passage studies on the East coast of North America. Shad are easily stressed from handling and gastric insertion of a transmitter is considered the standard method for tagging for both radio and acoustic telemetry studies. However, gastric tagging is not considered a viable long term methodology as fish will regurgitate or pass transmitters. In 2015, we implemented a study of tag retention and survival on tagged shad in a limited husbandry (minimal temperature control, unfiltered water) aquaculture setting. We were able to compare gastric tagging (standard methodology) to three methods of surgical tagging (single suture closure of incision, no closure of incision, and chemical adhesive closure of incision). In addition, we will include preliminary results of fall back metrics of shad that were tagged surgically in the field.

Preliminary results of a capture-mark-recapture study of winter skate, *Raja ocellata*, and little skate, *Raja erinacea*, in the Inner Bay of Fundy, Nova Scotia: Evaluating outreach success, determining growth rate, and examining evidence of school fidelity

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The family Rajidae has high species diversity and low morphological diversity. Winter skate (*Raja ocellata*) and little skate (*Raja erinacea*), are sympatric sibling species found in the Bay of Fundy, Nova Scotia. Until recently, neither species had been studied in the Inner Bay of Fundy (iBoF). The iBoF presents a unique and dynamic environment with an extreme tidal range and extensive intertidal zone where skates are frequently found. Over the past 4 years (2012-2015), approximately 2800 skates have been dart tagged opportunistically when captured as bycatch at a commercial intertidal fishing weir in Bramber, Nova Scotia. About 5% of these skates have been recaptured. These recaptures allow for both a population estimate of winter and little skate in the iBoF, and provide insights into growth rates and school fidelity of both species. Sequencing of mtDNA COI genes were used for species identification, resulting in clarification and adjustment of morphological characteristics traditionally used to differentiate the species. These findings will be relevant to conservation efforts of both species, and provide a baseline for winter and little skate population structure in the iBoF.

The influence of vertical movement on dispersal of American lobster (*Homarus americanus*) larvae: Application to fisheries management

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We applied a bio-physical semi-Lagrangian model to predict the drift of larval American lobster from hatch to post-larval settlement. Packets of simulated larvae were released from St. George's Bay, in the Gulf of St. Lawrence, and were allowed to drift within the model domain of coastal Atlantic Canada at 2 km resolution. We set pelagic residency according to temperature-dependent stage durations and relative vertical position. Laboratory experiments helped evaluate swimming capability and relative vertical position of four pelagic larval stages under various lighting conditions. We observed variable vertical distribution for first stages, subsurface distributions for intermediate stages, and surface distributions for final stage larvae. We formulated behavioural rules of simulated larvae for each developmental stage from laboratory observations. Vertical movement in the water column significantly influenced simulated dispersal trajectories and distance. In particular, increased vertical movement significantly extended dispersal compared to the static surface distributions often utilized in larval dispersal models. Our results highlight the implications of behaviour on dispersal and connectivity of larval American lobster and demonstrate how incorporation of realistic behavioural inputs into bio-physical models offers a powerful tool to advance understanding of larval transport and recruitment. The use of this tool in the context of fisheries management is explored.

Population Demographics and Egg Colouration of Lady Crab, *Ovalipes ocellatus*, in Minas Basin, Bay of Fundy

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Lady crab, *Ovalipes ocellatus*, is a swimming crab inhabiting the Atlantic coast of North America. There are two identified disjunct populations located in the Minas Basin and Northumberland Strait. Lady crab are not economically important in this region, but are prevalent in high numbers for a brief period each summer. Previous research on this species, especially in the Minas Basin, is rare. Morphological and reproductive characteristics were investigated to better understand population demographics within Minas Basin. This research was conducted at a commercial herring weir on the Southern Bight of Minas Basin. Over 10,000 crabs over two years (2014 – 2015) were counted; a proportion were measured, and a smaller proportion used for investigations into egg characteristics. Measurements focused on carapace length and width, general condition, sex and colour of eggs in carrying females. Abundance was only coarsely tallied due to haphazard sampling. Preliminary results showed a sex ratio favouring females, an abundance of small crabs, crabs of poor condition resulting in a majority of crabs having injuries, and egg colour varied within and among years.

Life History of Atlantic Halibut in the Gulf of St. Lawrence

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The life history of Atlantic Halibut (*Hippoglossus hippoglossus*) is poorly studied within the Gulf of St. Lawrence. Managers lack information on halibut migration, breeding areas/habits, and genetic status, which is necessary to accurately assess the population (DFO 2013). Pop up satellite archival tags (PSATs) combined with traditional tagging provide tools were used to explore migration and breeding activities. DNA microsatellites were used to assess the population genetics. Preliminary results indicate that halibut depart from shallow (30-200m) summer feeding grounds in late fall and migrate to deeper (>200m) overwintering areas, returning in the early spring. Overwintering areas likely also represent breeding grounds as halibut are believe to reproduce in the winter months. Reproduction can be observed using PSATs to identify short term changes in depths known as spawning rises (Loher & Seitz 2008). Identifying breeding areas will provide insight into whether Gulf of St. Lawrence Halibut form a single stock or are part of a larger continuous population. Early recaptures indicate that fish stray little within a season, but may disperse significantly between seasons. This indicates that dispersal is likely seasonal rather than continuous.

Eel River Dam Removal *a posteriori*: A Cooperative Template for Environmental Impact Assessment Follow-up Programs

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Eel River (South of Dalhousie, New Brunswick) dam was removed in 2010 following a detailed provincial Environmental Impact Assessment (EIA). As part of the environmental management plan for the project, a follow-up program was developed to, in part, monitor changes in the environment following dam removal. In addition, a steering committee was created to provide advice on activities related to the follow-up program. The steering committee membership includes various key stakeholders such as Ugpi'Ganjig (Eel River Bar) First Nation; Gespe'gewaq Mi'gmaq Resource Council; various provincial and federal departments; and consultants. With a focus on fisheries matters, here we present the Eel River dam removal follow-up program as an organizational case study on the delivery of this cooperative program.

[†] *Presenter*

River temperatures modeling and fisheries management implications

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The thermal regime of rivers plays an important role in the overall health of aquatic ecosystems. River water temperatures are also important for water quality, for conducting environmental impact assessments and for effective fisheries management. In the present study, a river temperature model was developed for short-term water temperature forecasting (1 to 3 days). Such a model can be a useful tool in fisheries management for in-season closing and subsequent reopening of angling fisheries based on water temperature threshold criteria. The model was developed and tested on the Little Southwest Miramichi River (New Brunswick), a tributary of the Miramichi River. The Miramichi River experiences high temperatures during the summer (reaching 30°C) and, as such, both monitoring and modeling of river temperature is becoming important in the management of this system.

Animal Passage Project: Assessing the movement patterns of fishes and amphibians through aquatic passageways

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Highways can be detrimental to biodiversity by posing significant barriers to foraging and dispersal, and through habitat alterations. Our project aims to characterize the effects of a culvert on the movement patterns and habitat use by aquatic species that inhabit the surrounding area, and whether or not a culvert can provide a useful link between habitats. The culvert is one part of a dry and wet passageway project located near Antigonish, Nova Scotia, Canada. Fish, tadpoles, and frogs were tagged with Passive Integrated Tags (PIT) and tracked using traps, nets, and antenna arrays. The main objectives of this study are: a) to determine movement patterns; and b) to determine the efficacy and effectiveness of using one-time PIT tagging and antenna tracking for compiling recaptures of marked individuals. This research is significant because it has the potential to improve transportation planning to decrease the negative effects of roads on amphibians and fishes, and to improve monitoring protocols by using less invasive, longer-lasting, and more efficient means.

An assessment of the Effects of Herbicide Treatments on Target and Non-target Plants and Dissolved Oxygen in Two New Hampshire, USA, Lakes.

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Dissolved oxygen and turbidity data were collected and qualitative visual observations of aquatic plants were made in Drew Lake and Scobie Pond, NH, in 2013 and 2014. In 2013, site visits were performed several weeks before and weekly for eight weeks after herbicide treatments. In 2014, no herbicide treatment was conducted in Drew Lake and site visits were done five times during the summer, and once in September in Scobie Pond, several weeks after an herbicide treatment. Native plants were impacted in both waterbodies in 2013, with the death of about 50-75% of the leaves of white waterlily and the near disappearance of watershield and yellow waterlily. The impacts on native plants were much less so at Scobie Pond. Dissolved oxygen concentrations at Drew Lake in 2013 were below 5 mg/L throughout the water column in 2013, beginning about three weeks after the herbicide treatment and lasting for several weeks. An algal bloom containing two cyanobacteria species formed several weeks after the treatment at Drew Lake in 2013. Dissolved oxygen values in 2014 were >5 mg/L at all sites, depths and on all dates despite similar water temperatures as in 2013.

Maine's Brook Trout Stream Monitoring Project: Trends in Abundance and Size Quality of Stream-Dwelling Brook Trout, 1990-2014

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A long-term brook trout stream monitoring (TSM) project was initiated in 1990 in order to assess brook trout populations in select Maine streams and to determine the effects of a change in the general law bag limit. Seven long-term index sites were chosen for the TSM and many additional streams were also chosen for shorter-term monitoring throughout the project's duration (1990-2014). For 29 study stream trout populations, 11 trended upwards, 16 trended downwards, two had no trend, and only 3 exhibited significant trends (Big Brook and North Branch Fox Brook in Region G – upward trend; Rome Trout Brook in Region B – downward trend). Study streams that exhibited significant trends were impacted by several different environmental, social, and/or cultural variables. The overall lack of broad significant trends based on monitoring data indicate that most of Maine's stream brook trout populations are likely more heavily influenced by environmental variables than changes in fishing regulations. Future TSM efforts should continue at established index sites, but at less frequent survey intervals. Effort previously spent on other TSM sites should be redirected at collecting less intensive data, but on a broader scale among more reaches of individual streams.

Brook trout response to strategic wood additions in the East Branch Nulhegan watershed, Vermont

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Log driving and other poor logging practices have severely degraded fish habitat in many rivers in northern New England. The East Branch Nulhegan River in northeastern Vermont is one of many rivers in this region that continues to suffer from past damage from multiple rounds of clear cutting, the construction and operation of several log driving dams, and the removal of large boulders and large wood from the channel. Much of the East Branch Nulhegan River remains wide and shallow with little cover for salmonids. In 2012 and 2013, approximately 120

large woody material structures were constructed using chain saws and a grip hoist in the East Branch Nulhegan River and two of its tributaries. Twelve pairs of control and treatment sites are being monitored for long term response of the brook trout population to these strategic wood additions. In this presentation, I will present our preliminary findings based on two years of pre-treatment data and two years of post-treatment data, which suggest that these wood additions have resulted in increased brook trout biomass at eight of the twelve treatment sites. (Note: Our first year of post-treatment data showed a positive response at 8 of the 12 treatment sites. We won't collect our second year of post-treatment data until next month). I will also describe the common features of woody structures that are contributing to increased brook trout biomass as well as those structures that, at least preliminarily, are not providing an obvious benefit to brook trout.

RAD Sequencing Highlights Polygenic Discrimination of Habitat Ecotypes in the Panmictic American Eel

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American Eel (*Anguilla rostrata*) presents a paradox; despite being a panmictic species, it exhibits drastic phenotypic differences depending on rearing environment. Individuals rearing in freshwater tend to grow slowly, mature older, and are more likely to be female in comparison to individuals that rear in brackish and saltwater. The hypothesis that phenotypic plasticity alone can account for the differences has been disproven. Here, we present a genome-wide association study demonstrating that divergent ecology of rearing sites causes within-generation selection resulting in drastic phenotypic differences. 331 loci out of 42,424 considered were most associated with the divergent ecotypes. These 331 loci are within 101 genes that represent vascular development, calcium ion regulation, growth and transcription factors, and olfactory receptors. Our results demonstrate that divergent natural selection of phenotypes can have a subtle polygenic genomic signal, can occur within a single generation, and manifest in divergent ecotypes, despite panmixia.

Transit of Silver Eels through Five Hydroelectric Facilities on the Merrimack River

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The Merrimack River is an extensive watercourse (188 rkm) traversing the states of Massachusetts and New Hampshire. Large female silver eels need to successfully navigate five hydroelectric dams from headwater rearing locations to reach the estuary during their spawning migration. This presentation will discuss the findings of a two year radio telemetry study of the delays of migration and mortality associated with the outmigration of silver eels through this migratory corridor.

Near dam, spatio-temporal distribution of migrating American Eel elvers

Dixon, Brittany; Linnansaari, Tommi; and Curry, R. Allen.

American eel (*Anguilla rostrata*) is a catadromous species that is native to the Saint John River (SJR) system. Young American eel (termed elvers) migrate up the river during the spring of each year, and during this stage, distribute themselves as far to the headwaters as possible. Hydropower dams, like the Mactaquac Generating Station (MGS), block the upstream movement of elvers, resulting in barriers to their migratory potential. Historically, high numbers of elvers had been observed making their way up to MGS. However, since 1980, a complete absence of elvers has been reported nearing the fish collection gallery of MGS, possibly signifying the presence of a migration

bottleneck downstream due to a potential velocity barrier created by the operational conditions at MGS and coinciding with the installation of the last two Kaplan turbine units at MGS.

Using knowledge of potential velocity barrier locations within the SJR, a variety of elver traps were deployed along riverbanks and islands of the SJR, within 20km downstream of MGS. Four trap styles were designed and deployed, each attempting to function off of an aspect of elver behaviour (such as resting among rocks and vegetation, or hiding in dark locations).

It was determined that elvers do make their way up to certain locations at the MGS collection facility and there is no apparent downstream velocity barrier. We observed elver behaviour during both day and night and determined areas where elvers are encountered and determined that while certain locations seem completely void of elvers, other locations attract them by large quantities. In particular, some (but not all) locations where on-shore pipes release small streams of water appear very attractive to elvers. In conclusion, there is potential to use this information when constructing a specialized migration structure that would allow elver passage upstream.

Atlantic salmon movement in the Mactaquac Reservoir, Saint John River

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The Mactaquac Generating Station (MGS), Saint John River, New Brunswick, Canada, is reaching the end of its service life. There are many ecological considerations as future options for the facility are being evaluated. The 100 km MGS reservoir has minimal current, restricting natural environmental cues for Atlantic salmon migration. The effects the MGS reservoir may have on migration are unknown, including the proportion of successful navigation through the reservoir, and the potential migration delay caused by reduced currents.

The main objective of this project is to determine, via acoustic telemetry (Vemco, Bedford NS), the migration rates and success of juvenile (smolt), adult, and post-spawning adult Atlantic salmon through the MGS reservoir.

In 2014, 40 smolts, 20 adults, 25 post-spawned adults were tagged. A reduced number of fish were successfully tracked actively (>100 h), and passively (33 VR2W receivers), with 19/20 smolts and 5/5 adults successfully navigating through the reservoir. Atlantic salmon smolts (7 ± 1 [mean \pm SE] km/d and 76 ± 11 km/d, respectively) and adults (7 ± 3 km/d and 10 ± 4 km/d, respectively) moved slower downstream through the reservoir than the riverine section. Preliminary evidence of migration delay could be detrimental to the population's recovery.