Compiled Eel Abstracts: American Fisheries Society 2014 Annual Meeting

August 18-21, 2014

Quebec City, Quebec, Canada

[Compiled/organized by R. Wilson Laney, U.S. Fish and Wildlife Service, Raleigh, NC, USA]

International Eel Symposium 2014: Are Eels Climbing Back up the Slippery Slope?

Monday, August 18, 2014: 1:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
Martin Castonguay, *Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada*
David Cairns, Science Branch, Fisheries and Oceans Canada, Charlottetown, PE, Canada
Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada

This talk will introduce the symposium. The first part will outline how the Symposium is structured, where to see Symposium posters, the panel, publication plans, etc. This would be followed by a brief outline of eel science and conservation issues, and how the Symposium will address these. I will then present with some level of detail the themes that the symposium will cover. The Introduction would also state the question that will be addressed by the panel discussion, and ask participants to keep this question in mind as they listen to the various talks. In closing, the introductory talk will outline the purpose of the Canada/USA Eel governance session that will be held at the very end of the meeting, after the Symposium panel.

Publishing in the eel symposium proceedings - An orientation from the Editor-in-Chief of the ICES Journal of Marine Science

Monday, August 18, 2014: 5:00 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
Howard Browman, *Marine Ecosystem Acoustics, Institute of Marine Research, Storebø, Norway*

I will provide symposium participants with a status report on the ICES Journal of Marine science. I will describe our editorial screening and manuscript assessment procedures, acceptance criteria and what we are and are not looking for, and timelines for decision and publication. I will then field questions.

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American Eel Papers—Canada

Chemical Contamination As a Potential Factor in Recruitment of American Eel to Lake Ontario

Wednesday, August 20, 2014: 11:50 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
Peter Hodson, School of Environmental Studies, Queen's University, Kingston, ON, Canada
Mehran Alaee, National Water Research Institute, Environment Canada
Claude Belpaire, Research Institute for Nature and Forest, Belgium
R. Stephen Brown, Department of Chemistry, Queen's University
Jonathan Byer, Leco Corporation
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada
***Catherine Couillard**, Institut Maurice Lamontagne, Fisheries and Oceans Canada, Mont-Joli, QC, Canada*
Sharilyn Kennedy, Environmental Sciences Group, Royal Military College of Canada
Michel Lebeuf, Institut Maurice Lamontagne, Fisheries and Oceans Canada
Jocelyne Pellerin, Centre Océanographique de Rimouski, U. de Québec à Rimouski
Cyril Rigaud, Centre Océanographique de Rimouski, U. de Québec à Rimouski

Pollutants are a possible cause of declines in yellow eel recruitment to L. Ontario since the 1980s. L. Ontario eels accumulate dioxin-like compounds (DLCs) to the same extent as lake trout, which suffered embryo mortality from maternally-derived DLCs. Sexual maturation transfers lipids and associated persistent, hydrophobic contaminants to oocytes. Eels recruiting to L. Ontario in the 1980s-90s were spawned from parents that integrated contaminant exposures from the 1960s-70s, when contamination was highest. Chemicals extracted from L. Ontario eels captured in 1988 and 98 caused dioxin-like toxicity when injected into eggs of mummichog. However, extracts from 2008 eels were non-toxic to embryos of mummichog and Japanese medaka, as were extracts of eels from other locations in E. Canada, in contrast to extracts of European eels from a contaminated site in Belgium. The decrease in toxicity from 1988 to 2008 corresponds to decreasing concentrations of DLCs and total dioxin equivalents in eel tissues, and to early signs of a recovery of recruitment to L. Ontario. While impacts of DLCs on eels might be a concern of the past, measurements of brominated and fluorinated compounds argue for on-going monitoring of trends in contamination and assessment of toxic effects.

Habitat Use of American Eels in the Saint Lawrence River Inferred from Multi-Element Otolith Line Scans

Tuesday, August 19, 2014: 11:50 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***José Benchetrit**, Département de biologie, Université Laval, Quebec, QC, Canada*
Mélanie Beguer-Pon, Department of Biology, Université Laval, Québec, QC, Canada
Pascal Sirois, Chaire de recherche sur les espèces aquatiques exploitées, Université du Québec à Chicoutimi, Chicoutimi, QC, Canada
Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada

John D. Fitzsimons, Department of Fisheries and Oceans, Burlington, ON, Canada
Julian J. Dodson, Département de biologie, Université Laval, Quebec, QC, Canada

Although considerable evidence has demonstrated that catadromy is a facultative behavior for the American eel, this question has yet to be investigated within a large hydrographic system. In an attempt to retrace habitat use retrospectively, LA ICP-MS was used to obtain multi-element line scans from the otoliths of 110 yellow-stage and silver eels sampled at various locations throughout the vast Saint Lawrence River Lake Ontario (SLRLO) system. Elemental profiles for ^{88}Sr, ^{138}Ba, ^{55}Mn and ^{24}Mg enabled us to quantitatively distinguish three chemical signatures that might correspond to distinct habitats within the SLRLO. Elevated strontium and low barium levels suggest that one of these signatures corresponds to brackish estuarine habitats while the other two represent habitats within freshwater. Analysis of dissolved element concentrations from water samples supports the interpretation that the latter two correspond to tributary and main stem river signatures. Most (78%) of the observed switches between these three habitats occurred within the first four years after the elver check, providing evidence that eels are more likely to settle in one habitat as they grow older. The patterns of habitat use and movements inferred from this study have important implications for the management and conservation of the species.

How Does Salinity Influence Habitat Selection and Growth in Juvenile American Eels?

Tuesday, August 19, 2014: 4:20 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Brian Boivin**, Océanographie, Université du Québec à Rimouski, Rimouski, QC, Canada*
Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada
Céline Audet, Océanographie, UNIVERSITÉ DU QUÉBEC À RIMOUSKI, Rimouski, QC, Canada
Scott Pavey, Biologie, Institut de Biologie Intégrative et des Systèmes (IBIS), Université Laval, Québec, QC, Canada
Mélanie Dionne, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec, Québec, QC, Canada
Louis Bernatchez, Biologie, Université Laval, Quebec City, QC, Canada

Despite the collapse in abundance of the American eel (*Anguilla rostrata*) in the upper St. Lawrence River, little remains known about the influence of environmental cues on habitat selection by glass eels (juveniles) and how this distribution affects growth. Glass eel's salinity preference and locomotor activity were assessed in 4 rivers across eastern Canada for 2 sampling time periods in 2011 and 2012. Glass eels were categorized according to their salinity preference and the growth rate of each group was subsequently monitored in controlled fresh (FW) and brackish (BW) environments for 7 months. Most glass eels (78-89 %) did not show any preference toward either FW or salt water (SW) suggesting that a majority of glass eels may remain in brackish water environments in the wild. Neither the salinity preference showed by glass eels in previous experiments nor the rearing salinity influenced growth during the course of the experiments. However, glass eels from the Atlantic coast reached a significantly higher mass than those from the St. Lawrence Estuary, supporting the hypothesis of genetic differences between glass eels of different locations. Our results provide important ecological knowledge for the sustained exploitation and conservation of this endangered species.

American Eel Tracking and Tag Detection Efficiency in High Flow Environments

Wednesday, August 20, 2014: 9:20 AM
2104A (Centre des congrès de Québec // Québec City Convention Centre)
***Jeremy E. Broome**, Acadia Centre for Estuarine Research, Acadia University, Wolfville, NS, Canada*
Anna M. Redden, Biology Department, Acadia University, Wolfville, NS, Canada
Rod Bradford, Population Ecology Division, Fisheries and Oceans Canada, Dartmouth, NS, Canada
Michael Stokesbury, Department of Biology, Acadia University, Wolfville, NS, Canada
Edmund Halfyard, Biology, Dalhousie University, Halifax, NS, Canada

A collaborative, multi-year, acoustic telemetry project was developed to investigate fish movements in and near the FORCE in-stream tidal energy test site within Minas Passage, Bay of Fundy, NS. This presentation addresses two sets of data: 1) results of a directed investigation of acoustic receiver detection performance under high flow conditions, and 2) results of two seasons of American eel tracking. Forty-five (45) eels were acoustically tagged during the fall of 2011 and 2012. Twenty-one (21) eels were detected within Minas Passage, of which eight (8) were detected within the FORCE site. Presence within Minas Passage occurred over a short time frame due to the single passage nature of eel out-migration. Little selectivity was shown for a specific migration pathway. Depths of transit through Minas Passage were highly variable among individuals, ranging between surface and 110m. Patterns in movement through Minas Passage, with regards to time of day and tidal stage, that might help inform when eels could be most at risk during the installation and testing of TISEC devices, were not well resolved. Detection efficiency is significantly reduced in high flow environments; therefore, cautious interpretation of animal detection data, in light of instrumentation limitations and flow considerations, is advised.

Trap and Transport of large American eels in Upper St. Lawrence River – Implications for Turbine Mortality Mitigation

Thursday, August 21, 2014: 1:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***David Stanley**, Ontario Power Generation, Niagara on the Lake, ON, Canada*
Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada
Alastair Mathers, ?, Ontario Ministry of Natural Resources, Picton, ON, Canada
Pierre Dumont, ?, Ministère du Développement durable, de l'Environnement de la Faune et des Parcs, Longueuil, QC, Canada
Greg Pope, Ontario Power Generation, Niagara on the Lake, ON, Canada

Trap and transport (T&T) of American eels has proven to be an effective way to avoid turbine mortality at generating stations on the St. Lawrence River. Original plans specified migrating silver eels be captured and transported, however, large yellow eels (length > 800mm) were substituted due to difficulty in capturing silver eels. T&T of large yellow eels has proven successful as within 5 years of transport, large yellow eels mature and migrate successfully down the St. Lawrence River. Based on morphometric characteristics and silvering indices there are no differences between wild migrants and transported silver eels captured in the Quebec fishery. Evaluation of migration rates between transported and reference

silver eels show that after 3 years there is no difference in the overall migration rate. While some differences exist between wild migrating and T&T eels, overall migrating T&T eels had a normal rate of gonadal maturation and similar body fat content as wild migrants. A criticism of T&T is the inability to capture and transport large numbers of yellow eels. Currently, up to 2200 large yellow eels can be captured per year by commercial fishers in Ontario waters of the upper St. Lawrence River and Lake Ontario.

Are Fat Reserves Adequate in Migrant Silver American Eels of a Large-Scale Stocking Experiment in the St. Lawrence/Lake Ontario System?

Thursday, August 21, 2014: 11:50 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Guy Verreault, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Rivière-du-Loup, QC, Canada
Pierre Dumont, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Longueuil, QC, Canada
David Stanley, Ontario Power Generation, Niagara on the Lake, ON, Canada
Ron Threader, Retired, Ontario Power Generation, Renfrew, ON, Canada

An experimental stocking program in the St. Lawrence River/Lake Ontario system provided a unique opportunity to compare fitness of migrant silver American eels *Anguilla rostrata* from the stocking program (SM) and wild migrants (WM), that have grown in the same location, and were captured in the St. Lawrence River Estuary. SM were smaller than WM and of similar length than silver eels from their site of original capture, in the Maritimes. A bio-energetic model was used to estimate costs of migration and reproduction and duration of migration. The adequacy of the measured lipid reserves to meet these energetic costs was assessed. Compared to WM, SM had lower initial muscle fat reserves and higher estimated energetic requirements for migration as a consequence of their smaller size. It was estimated that 57% of the WM and none of the SM would have adequate fat reserves for migration and reproduction. SM would take 1.6 times longer to reach the spawning grounds than WM. Thus, SM are less likely to complete successfully spawning migration than WM. These results support the recommendation to source and stock eels at sites where they have similar life strategies to increase the likelihood of successful silver eel escapement.

Monitoring the Migration of American Eel in the Beauharnois Canal of the Upper St. Lawrence River Using Acoustic Telemetry

Thursday, August 21, 2014: 1:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Daniel Hatin**, Direction régionale de l'Estrie, de Montréal et de la Montérégie, Ministère du Développpement durable, de l'Environnement, de la Faune et des Parcs, Longueuil, QC, Canada*
Mélissa Larochelle, Direction régionale de l'Estrie, de Montréal et de la Montérégie, Ministère du Développpement Durable, de l'Environnement, de la Faune et des Parcs, Longueuil, QC, Canada
Jean Caumartin, V-P Exploitation des Équipements de Production, Hydro-Québec, Montréal, QC, Canada
David Stanley, Ontario Power Generation, Niagara on the Lake, ON, Canada

Knowledge of silver American eel migration patterns are essential to determine mitigation options related to turbine mortality at hydroelectric dam. In 2012, we studied the spatio-temporal migration pattern of 88 silver American eel using acoustic telemetry in a 25 km canal upstream of the Beauharnois Generating Station in Québec, Canada. Silver American eel started their migration in June, peaked in July-August and end in September. Most of the migration occurred at night. Two behavioral pattern were observed with most eel exhibiting a rapid straightforward downstream migration. The second pattern was a slower downstream migration with some fish moving in the canal upstream and downstream. From the beginning to halfway down the canal, silver American eel oriented to the north side or were evenly distributed across the canal width. After the halfway point down the canal, their orientation switched to the south side of the canal. This large scale study is a starting point to address mitigation options dealing with turbine mortality but more details are need to better understand eel behavior in the canal and in close proximity to the dam.

American Eel: A Food, a Medicine and Responsibility

Tuesday, August 19, 2014: 8:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
F. Henry Lickers, Environment Program, Mohawk Council of Akwesasne, Cornwall, ON, Canada
***Larry McDermott** , Plenty Canada, Lanark, ON, Canada*
Ethan Huner, Algonquins of Ontario, Pembroke, ON, Canada
Katrinna Demers, Algonquins of Ontario, Pembroke, Canada

The American Eel has long been a sacred food, medicine and responsibility of the First Nation People in Eastern Ontario. The First Nation Peoples knowledge of the American Eel was based on centuries of observation and use. The St. Lawrence River and its tributaries provided a rich environment for American Eels and the species flourished in this environment. Populations numbering in the billions were not unusual during the pre-contact times and this species sustained the First Nations People, especially during the hard winter months. Presenters will convey the importance of American Eel to our First Nations through stories, anecdotes and the traditional knowledge of our peoples. Our narrative will begin long before contact and travel forward to the present and into the future.

A Comparison of Body Condition and Composition, Fecundity, and Body Meristics Between Natural and Translocated Outmigrating, Adult American Eels, *Anguilla rostrata*, from Canadian Waters

Thursday, August 21, 2014: 1:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Mary McNiven, Department of Health Management, Atlantic Veterinarian College, University of PEI, Charlottetown, PE, Canada
Tracy Maynard, Kleinschmidt Associates, Essex, CT
Kevin Nebiolo, Kleinschmidt Associates, Essex, CT

From 2006-2010, ~4 million glass phase American eels were translocated from maritime Eastern Canada to the upper St. Lawrence River/Lake Ontario watershed, Canada. Historically, adult eels emigrating from this drainage are greater than 800 mm total length but in 2009 and 2010, eels ranging from 570 to 668 mm were captured in the silver eel fishery at Kamouraska, Québec; subsequently shown originating from the translocation program. Significant differences were observed in age, length, weight, and body composition between the wild and translocated silver eels, although no differences were observed in relative condition factor, ocular index, and gonad development. Translocated eels had significantly less lipids per whole body than wild eels, simply a result of size disparity, but body energy reserve estimates compared to migration energy requirements indicate both groups have adequate lipid reserves to reach the Sargasso spawning grounds and spawn. Energetic comparisons of translocated silver eels were made to the Maritime donor site silver eels. Comparatively, donor site silver eels were statistically similar in age but statistically lower in body condition and composition. Nonetheless, energy reserve estimates for the smaller maritime silver eels were also shown to be adequate to meet the rigors of migration and spawning.

Evaluating American Eel Seasonal Habitat Relationships in the Upper St. Lawrence River in Relation to Ongoing Recovery Efforts

Tuesday, August 19, 2014: 11:10 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Matthew Windle**, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON, Canada*
Kirstie Delag, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON, Canada
Brian Hickey, St. Lawrence River Institute of Environmental Sciences, Cornwall, ON, Canada

Recently, a comprehensive review of the status of the American eel (*Anguilla rostrata*) in Ontario waters established a number of recovery objectives and recommendations, including the identification and protection of critical habitat for this species. Specific habitat associations in Ontario are currently not well understood and may include areas that are vulnerable to modification from human activities and climate change. We investigated the seasonal movements and habitat associations of juvenile (yellow-phase) eels in Lake St. Francis, a fluvial lake in the Upper St. Lawrence River (USLR) with the highest remaining abundance of wild eels in Ontario. A combined approach of radio-telemetry, electrofishing, and trap-netting was used examine the relationships between eel distributions and environmental features within the study area from 2013 to 2014, and was supplemented by anecdotal reports from local fishing and SCUBA diving organizations. Preliminary results from electrofishing surveys indicate significant abundance and size-based trends in relation to proximity to a large hydroelectric facility and bottom substrate types, respectively, while radio-telemetry results indicate that larger eels (70-100 mm TL) are highly mobile within this river reach. The results of this ongoing research project are discussed in terms of potential applications to ongoing recovery activities in the USLR.

Stable Isotopic Analysis of American Eel Otoliths: Thermal and Microhabitat Associations Provide Stocking Insights

Tuesday, August 19, 2014: 11:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Courtney V. Holden** , Department of Biology, Queen's University, Kingston, ON, Canada*
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada
Kurt Kyser, Geological Sciences and Geological Engineering, Queen's University, Kingston, Canada

Conservation stocking in the upper St. Lawrence River has been conducted in an attempt to mitigate recruitment declines in the threatened American eel (*Anguilla rostrata*). Stable isotopic analysis of otoliths is a useful tool for documenting microhabitat and thermal associations of recently stocked eels. Whole otolith dissolution and gas source mass spectrometry were used to measure $\delta^{18}O$ and $\delta^{13}C$ in otoliths of stocked eels (age 1-7 years) collected 2011-2013 from the St. Lawrence River and Jones Creek, a tributary and stocking location; $\delta^{18}O$ values were used to estimate habitat temperature. Age is the best predictor of habitat selection and temperature for young stocked eels (1-3 years). In older eels (4-7 years) both otolith isotopes are significantly different and more variable than in younger eels, indicating that size is more important in habitat selection. These changes coincide with a microhabitat change when larger eels move from a creek to river environment. Specific habitat associations in relation to size and age are confirmed by using quantitative electrofishing and microhabitat data. Otolith isotopes of stocked eels can help improve stocking success by providing specific information related to type of microhabitat and thermal conditions recently stocked eels both seek and require.

Phenotypic and genotypic variability in the American eel

Tuesday, August 19, 2014: 4:00 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Caroline Cote**, Biology, Universite Laval, Quebec, QC, Canada*
Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada
Louis Bernatchez, IBIS, Université Laval

We have conducted the most comprehensive analysis of neutral genetic population structure to date in order to revisit the null hypothesis of panmixia in this American eel. We used these data to provide the first estimates of contemporary effective population size (Ne) and temporal variation in effective number of breeders (Nb). Then, we tested for statistical associations between temporal variation in the North Atlantic Oscillation (NAO) index, effective number of breeders as well as two indices of recruit abundance. A total of 2142 eels from 32 sampling locations were genotyped with 18 microsatellite loci. We have confirmed that the panmixia hypothesis should be definitely accepted for this species. The effective population size Ne was estimated to be around 22 382 and relative abundance between cohorts varied from 473 to 10999. This study also showed that genetically based demographic indices can be used as surrogates for the abundance of breeders and recruits, which were both shown to be positively correlated to high (positive) phases of the NAO. Thus, long term genetic monitoring of American glass eels at several sites would represent a powerful and efficient complement to census monitoring in order to track demographic fluctuations and better understand their causes.

Meta-Population Dynamics in the American Eel and the Importance of Larval Distribution

Wednesday, August 20, 2014: 9:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Marten A. Koops**, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, Canada*

Jennifer A. Young, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, Burlington, ON, Canada
David Cairns, Science Branch, Fisheries and Oceans Canada, Charlottetown, PE, Canada

Modelling the population dynamics of American Eel (*Anguilla rostrata*) is challenging because its life history exhibits marked geographic variation, despite a panmictic breeding system. To assist in conservation efforts, we developed the first species-wide meta-population model that incorporates all life stages. Partitioning the geographic distribution into distinct life history zones with geographically-specific inputs, we used this model to compare population dynamics, sensitivity to perturbations, and responses to anthropogenic harm across larval distribution hypotheses (e.g., maternal effects vs. random distribution). Long-term population sensitivity to changes in vital rates was relatively robust across hypotheses, but expected stage and geographical distributions varied dramatically. Projected transient dynamics (short term fluctuations as abundance approaches long term stability) were influenced by larval distribution. Random larval distribution led to rapid convergence to stability, while strong maternal effects led to decades of (often counterintuitive) delay including apparent growth of a declining population, or an unexpected influence of one zone upon the stock of another. These results highlight the importance of understanding larval distribution mechanisms, consideration of the entire meta-population, and incorporating transient dynamics into management plans.

Application of Bayesian Hierarchical Models to the Development of Precautionary Biological Reference Points for American Eel, Anguilla Rostrata, in Canadian Marine and Freshwater Systems: Constant or Time-Varying Kernel Model Parameter Selections?

Wednesday, August 20, 2014: 10:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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David Cairns, Science Branch, Fisheries and Oceans Canada, Charlottetown, PE, Canada
Kevin Hedges, Arctic Aquatic Research Division, Fisheries and Oceans Canada, Winnipeg, MB, Canada
Ross Tallman, Arctic Aquatic Research Division, Fisheries and Oceans Canada, Winnipeg, MB, Canada

Recent precipitous collapses of American Eel fisheries in Canadian freshwater systems have raised considerable concerns about the sustainability of population production and its susceptibility to anthropogenic activities. Numerous models have been developed to account for the observed dramatic fluctuations, but no quantitative reference points have been put in place to regulate total allowable harvests. In this study, we incorporated fishery-dependent and fishery-independent information collected since the mid-1950s in analyses of the southern Gulf of St. Lawrence (SGSL) as a representative marine area and the upper St. Lawrence River and Lake Ontario (USLR-LO) as a typical freshwater system. The overall objectives of this study were to establish biological reference points and thresholds for harvest control rules by applying Bayesian state-space statistics and generalized surplus production models. We composed four probability-based scenarios in the contexts of constant or time-varying kernel model parameterizations to assess model performance and multi-model inference. The best model in the SGSL was the constant *K* and *r* model (KCRC), while the time-varying *K* and *r* model (KVRV) was the best in the USLR-LO system. Combined with the modeled outputs, a set of adaptive management strategies are discussed in relation to individual population trajectories in the two habitats.

Hormonal Regulation of Upstream Migration in American Glass Eels

Tuesday, August 19, 2014: 10:50 AM
200B (Centre des congrès de Québec // Québec City Convention Centre)
***Mélanie Gaillard**, Océanographie, Université du Québec à Rimouski, Rimouski, QC, Canada*
Céline Audet, Océanographie, UNIVERSITÉ DU QUÉBEC À RIMOUSKI, Rimouski, QC, Canada
Louis Bernatchez, Biologie, Université Laval, Quebec City, QC, Canada

In recent years, freshwater, estuarine, and marine ecotypes have been described in different eel species. The aim of this study was to better understand the physiological regulation of migration at the glass eel stage in American eel, *Anguilla rostrata*. We hypothesized that the hormonal status would differ between glass eels exhibiting different ecotypes. Glass eels were captured when entering river estuaries in Nova Scotia (Mersey River) and Québec (Rivière Saint-Jean, Grande Rivière Blanche). They were transferred to Maurice-Lamontagne Institute (Fisheries and Oceans Canada), where the salinity preference was estimated for groups originating from the different rivers. Glass eels exhibiting freshwater preference, saltwater preference, or brackish water preference were measured, weighed, and their stage of pigmentation quantified; they were then preserved in RNAlater for genomic studies. We compared the expression of genes coding for cortisol, prolactin, growth hormone, and thyroid hormones well as for their respective receptors. The results will be discussed in relation to the zone of capture and salinity preference.

American Eel (Anguilla rostrata) Abundance, Distribution, and Size throughout the Lower Ottawa and St. Lawrence River Systems, Ontario, 2009–2013

Tuesday, August 19, 2014: 10:50 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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***Lucian Marcogliese**, Research Biologist, Ameliasburg, ON, Canada*

In support of Ontario's Species at Risk American Eel Recovery Strategy, a series of quantitative summer electrofishing surveys was conducted in the lower sections of the Ottawa (five reaches), Mississippi (five reaches), and St. Lawrence river systems (two reaches Ontario) and tributaries. These surveys measured density, occurrence, and changes in status of American eels so that efficacy of management and recovery actions can be assessed. Throughout these river systems, 39 indexing locations, each including seven 200-m sites, were quantitatively electrofished annually from 2009 to 2013. Geometric mean density by reach was low in the Ottawa (0.8–2.0 eels·ha^{-1}) and Mississippi (0.0–0.2) and significantly higher (6.2–23.0) in the St. Lawrence (P<0.0001). Small eels were often electrofished in flowing water near barriers and large eels in bays with inflows. Immigrating and emigrating eels often congregated. In 2011, a pulse of small wild eels (89.6·ha^{-1}) was detected below the Moses-Saunders dam, St. Lawrence River but not below Carillon, the first dam on the Ottawa. By 2012, some of these small eels started moving upstream, reaching the Mississippi River. Most eels electrofished were in the lowest reaches, particularly below the Carillon and Moses-Saunders dams, and are now very rare in the upper reaches.

The Role of Culture, Conservation Stocking, and Ecological Insights in Mitigating the Decline of the American Eel (*Anguilla rostrata*)

Thursday, August 21, 2014: 11:50 AM
304B (Centre des congrès de Québec // Québec City Convention Centre)
Courtney V. Holden *, Department of Biology, Queen's University, Kingston, ON, Canada*
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada

The American Eel is showing universal declines. Conservation stocking of eels was conducted experimentally from 2006-2010 in the upper St. Lawrence River in an attempt to mitigate recruitment declines. Microhabitat associations of recently stocked age-one eels electrofished 2008-2010, along with otolith isotopic thermography and controlled rearing experiments, provided ecological insights that can improve stocking success. Otolith $\delta^{18}O$ temperature estimates indicate that microhabitat associations and cover (small rock rubble) are more important than thermal conditions; otolith temperature was 1.5°C cooler than habitat. Young elvers were reared in three replicate controlled temperature experiments over a range (10°C-37°C) simulating midsummer temperatures across the species range. Eels retain a high optimum temperature (28°C) despite living at suboptimal temperatures in the northern part of the range. Microhabitat associations are more important to recently stocked eels than seeking optimal temperatures for growth. Culture enhances survival and stocking provides increased opportunity to study important ecological associations and requirements while maintaining a presence, profiling the need for continued conservation efforts. Culture now plays a major role in worldwide eel production; stocking to enhance fisheries can be compatible with conservation. Importantly, culture and conservation stocking can result in greater habitat utilization, potential for increased escapement, and increases in recruitment.

Kitchisipi Pimisi (Ottawa River Eel): Reviving the Algonquin Connection to the Eel through Aboriginal Traditional Knowledge and Western Science

Tuesday, August 19, 2014: 10:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Ethan Huner*, Algonquins of Ontario, Pembroke, ON, Canada*
Katrinna Demers, Algonquins of Ontario, Pembroke, Canada

The Algonquin and their ancestors have shared their traditional waters with the eel in the Ottawa River Basin since time immemorial. Archaeology and oral tradition provides evidence of the Algonquin relationship to the historical abundance of eel in the Ottawa River Basin. Today, the eel has all but vanished from the Ottawa River Basin and the Algonquin relationship to the eel has suffered greatly as a result. This unique presentation highlights the Algonquin journey to rebuild a cultural connection to eel through Aboriginal Traditional Knowledge (ATK) collections, the application of ATK in eel recovery, and participation in eel recovery initiatives.

Understanding Silver Eel Migration Behaviour at Sea: Insights from Field and Virtual Tracking

Wednesday, August 20, 2014: 10:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Mélanie Beguer-Pon *, Department of Biology, Université Laval, Québec, QC, Canada*
Kyoko Ohashi, Oceanography, Dalhousie University, halifax, NS, Canada
Anna Katavouta, Oceanography, Dalhousie University, halifax, NS, Canada
Jinyu Sheng, Department of Oceanography, Dalhousie University, Halifax, NS, Canada
Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada
Julian Dodson, Department of Biology, Université Laval, Québec, QC, Canada

Anguillid eels are notorious for the remarkable migrations they undertake to oceanic spawning grounds after the onset of reproductive maturation in continental waters. Yet after over a century of research, most information surrounding their migration remains a complete mystery. Neither the exact location of the spawning ground nor the migration routes are known. In this study, two approaches were developed to try to elucidate the mystery of the oceanic migration of the American eel. The first one is actual tracking using miniaturized pop-up satellite archival tags fitted on 33 American eels released in coastal waters. It provided significant pieces of information regarding the behaviour of migrating eels such as diel vertical migrations and trajectories. The second and complementary approach is the development of a coupled biophysical particle-tracking model. Thousands of particles with various horizontal and vertical behaviors were tracked from coastal waters to the pop-up locations and their trajectories were compared to those revealed by the field experiments. It provided interesting insights into eels' behaviours during the early phase of their marine migration.

Using a Coupled Bio-Physical Particle Tracking Model to Improve Our Understanding of Eel Behaviour during the Early Phase of the Marine Migration

Tuesday, August 19, 2014: 2:30 PM
204A (Centre des congrès de Québec // Québec City Convention Centre)
Mélanie Beguer-Pon*, Department of Biology, Université Laval, Québec, QC, Canada*
Kyoko Ohashi, Oceanography, Dalhousie University, halifax, NS, Canada
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Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada

The American eel is a facultative catadromous fish inhabiting continental waters but migrating long distance for spawning in the Sargasso Sea. Despite its status of major concern in Canada, its migration pattern from rivers to the open ocean is poorly documented. Recent field tracking (acoustic and satellite) provided the first data about the migratory pattern of silver eels from the fresh to marine waters of the St. Lawrence system (Canada). These data were used to develop a particle-tracking model which incorporates directed swimming motion. Thousands of particles with various horizontal and vertical behaviours were tracked from the St. Lawrence Estuary to the exit of the Gulf (distance of ca. 800 km). Their effectiveness was compared using the observed data of eels acoustically detected within the Gulf and at its exit during recent field experiments. This modeling approach showed that at least two combined

active behaviours (nighttime selective tidal stream transport and an internal compass) are necessary for eels to move out the Gulf within the observed time window.

Have Fisheries Caused Declines in American Eel Recruitment and Abundance?

Wednesday, August 20, 2014: 9:00 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***David Cairns**, Science Branch, Fisheries and Oceans Canada, Charlottetown, PE, Canada*

This paper evaluates the hypothesis that fisheries reduce American eel populations through intergenerational effects, which occur when a fishery-induced reduction in species-wide spawner output leads to a decline in subsequent recruitment, and through intragenerational effects, which occur when fishing reduces the strength of a local population. In eastern Canada, 93.6% of coastal eel habitat is unfished for eels, and in the US, much of the coastal eel habitat and nearly all freshwater habitat is unfished for eels. On the basis of reported eel densities and habitat estimates, eastern North American saline waters contain 147,538,663 yellow eels, with a biomass of 42,771 t. Mean reported landings for 2000-2010 were 1.5% of this biomass. The high fraction of eel habitat that is unfished and the low estimated exploitation rate suggest that fisheries are unlikely to have substantial impacts on overall spawner output and subsequent recruitment. If fishing reduces eel populations within generations, abundance trends should decline in areas that are heavily fished. However, in five of 10 such cases, abundance trends increased or showed no trend. These findings fail to support the notion that fishing causes eel declines, although they do not exclude the possibility that fisheries reduce populations in some areas.

Early Results on Marine Migration of Stocked and Transported Eels from the St. Lawrence: Insights from a Large-Scale Acoustic Tracking

Tuesday, August 19, 2014: 2:10 PM
204A (Centre des congrès de Québec // Québec City Convention Centre)
***David Stanley**, Ontario Power Generation, Niagara on the Lake, ON, Canada*
Ron Threader, Retired, Ontario Power Generation, Renfrew, ON, Canada
Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada
Mélanie Beguer-Pon, Department of Biology, Université Laval, Québec, QC, Canada

Starting in 2011, migrating silver American eels originating from the trap and transport (T&T) and stocking programs in the upper St. Lawrence River had acoustic transmitters surgically implanted to determine if these eels continue their migration through the St. Lawrence Estuary up to the exit of the Gulf of St. Lawrence. The Ocean Tracking Network (OTN) maintain acoustic receivers covering the Cabot Strait between Nova Scotia and Newfoundland, Canada and could detect the tagged eels. Acoustic transmitters have been implanted in 225 migrating silver American eels to date. Of the 150 American eels implanted with transmitters from 2011 and 2012, at total of 7 T&T and 17 stocked American eels have been detected by the Cabot Strait receivers. It should be noted that wild migrating American eels impanted with transmitters have not been detected. The detections of the migrating T&T and stocked small migrants were the first recorded migrating eels in North America by OTN receivers. While the speed and timing of

migration cannot be compared with wild migrants, the migration speed and timing was similar between T&T and smaller stocked American eels.

Unexpected Outcomes of a Conservation Stocking Experiment May Limit the Effectiveness of Stocking As a Conservation Measure for Eels

Thursday, August 21, 2014: 10:50 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Thomas Pratt**, Fisheries and Oceans Canada, Sault Ste Marie, ON, Canada*
Joshua Stacey, Environmental and Life Sciences Graduate Program, Trent University, Peterborough, ON, Canada
Michael Fox, Biology and Environmental and Resource Science, Trent University, Peterborough, ON, Canada
Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada

Worldwide concerns about declining eel stocks have resulted in the increased use of conservation stocking as a recovery tool. In this experiment, the sex ratio, growth rate and size and age at maturation of American eels (*Anguilla rostrata*) stocked into Lake Ontario from donor areas over 2000 km away with differing life history characteristics were compared with those of naturally recruited eels to assess the effectiveness of a potential stocking program in maintaining a sub-population with unique life history characteristics (largest from across the species range, and exclusively female). Stocked eels exhibited faster annual growth, had a different sex ratio, and matured and outmigrated at smaller sizes and ages than naturally recruited eels. We conclude that stocked eels appear to be following life history patterns comparable to conspecifics in the geographic range of the donor streams where they were collected. These findings cast doubt on the generally accepted hypothesis that the mechanisms driving eel life history variation are environmentally-induced, and suggest that more care be taken in assessing and matching the life history characteristics of donor and recipient sub-populations if conservation stocking is expected to be an important recovery option for eel restoration.

Assessment of Upstream and Downstream Passability for Eel at Dams

Wednesday, August 20, 2014: 1:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Valerie Tremblay**, AECOM, Trois-Rivieres, QC, Canada*
Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada
Claudia Cossette, AECOM, Trois-Rivieres, QC, Canada

The American eel has experienced a marked decline in Canada. Habitat loss resulting from dam construction is one of the factors involved. There are some 5600 dams in rivers draining to the St. Lawrence River system. Their passability for eels migrating upstream and downstream has been assessed using the Québec national dams database. Although the majority of the dams are less than 3 m in height and are made of concrete or earthfill, dams present a great variety of physical characteristics. Passability ranks were assigned to each category of dam based on three assessment criteria: the height

of the dam, the materials used in its construction, and its use. Passability to upstream migrants was also assessed from photographs for a subset of dams. The two methods (statistical analysis and the use of photographs) may yield different results, but the two methods were consistent to identify the impassable dams. This analysis shows overall that the problem of passability is more significant for upstream passage than it is for downstream passage. Once added to a geospatial analysis tool which locates dams and calculates the surface area of habitats lost in each watershed, passability ranks will assist managers in setting priorities for mitigation.

Managing for Seven Generations: Mi'kmaq Knowledge, Eels and the Bras D'or Lakes

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
***Shelley Denny**, Research and Stewardship, Unama'ki Institute of Natural Resources, Eskasoni, NS, Canada*
Angela Denny, Research and Stewardship, Unama'ki Institute of Natural Resources, Eskasoni, NS, Canada
Tyson Paul, Research and Stewardship, Unama'ki Institute of Natural Resources, Eskasoni, NS, Canada

Application of traditional knowledge to eel sustainability is common practice in the eel sustenance fishery of the indigenous Mi'kmaq people in Canada but its use beyond the Mi'kmaq culture is not fully realized. Mi'kmaq ecological knowledge on katew, the American eel, gathered on traditional fishing grounds of the Bras d'Or Lakes, Nova Scotia provide an example of the use of Mi'kmaq knowledge for eel sustainability. Worldview, fishing practices, observations on eels, habitats and population status contribute to traditional management of Bras d'Or Lakes eels.

Critical Assessment of Stocking Experiment on Silver Eel Production and Escapement from the Richelieu River

Thursday, August 21, 2014: 11:10 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Guy Verreault**, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada*
Johanne Dussureault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada

Experimental stocking was initiated in the Richelieu river to increase spawners escapement of American eel (*Anguilla rostrata*) as a short-term option to reverse recruitment decline. Between 2005 and 2008, 2.8 millions glass eels were stocked after being marked. A robust monitoring program was set up to assess growth, maturity, and spawning migration for these individuals. Since 2009, when the first migrating silver eels were caught in the estuary, 275 downstream migrants from the 2005 stocking operations were sampled for analysis. Mean length at silvering was 655.2 mm (SD = 51.2), a size 300 mm smaller than their natural-recruited counterparts and they remained shorter over the five sampled years. The first migrants sampled were 4-years old and exhibited a very rapid growth. Mean annual growth decreased later and was inversely correlated to age at migration. Abundance increased from 2009 to 2012 and remained the same in 2013 indicating that most of the stocked eels were silvering at age 7 and 8 as

opposed to those naturally recruited at age-20. They showed a 20 days delay during the migration season in the estuary, only 500 km from stocking location, which may have implications for reproduction synchrony in the Sargasso, 3500 km further.

Challenges in Monitoring Fish and Marine Mammals in the Megatidal Waters of the Upper Bay of Fundy

Wednesday, August 20, 2014: 9:00 AM
2104A (Centre des congrès de Québec // Québec City Convention Centre)
***Anna M. Redden**, Biology Department, Acadia University, Wolfville, NS, Canada*
Jeremy Broome, Acadia Centre for Estuarine Research, Acadia University, Wolfville, NS, Canada
Freya Keyser, Biology Department, Acadia University, Wolfville, NS, Canada
Peter Porskamp, Acadia University
Kaycee Morrison, Acadia University
Matthew Baker, Acadia University
M.J.W. Stokesbury, Biology, Acadia University, Wolfville, NS, Canada
Jason Wood, Sea Mammal Research Unit Ltd

Tidal energy developments at the FORCE (Fundy Ocean Research Centre for Energy) test site in Minas Passage, Bay of Fundy, have necessitated a monitoring and research program to address the potential risk of turbine – marine biota interactions. Methods used to collect data on fish movements through the test site have included mid-water trawls (with sonar), and acoustic tracking of significant species, including those of high commercial value (American lobster) and endangered (Bay of Fundy striped bass and Atlantic salmon) or threatened species (Atlantic sturgeon and American eel). Tag transmission detections demonstrate that the FORCE test area forms part of the migratory corridor for both lobster and numerous fish species, with some making multiple, near daily passes through the passage. The environmental effects monitoring program also incorporated examination of the seasonal abundance of fishes captured in local intertidal weirs. Schools of Atlantic herring attract harbour porpoises which have been monitored in and around the FORCE site using a series of C-POD hydrophones (autonomous cetacean echolocation click detectors). The biggest challenges faced in sensing both fishes and marine mammals in Minas Passage have been flow-induced noise effects on receiver and hydrophone detections when average water column current speeds exceed 2 m/s.

Hormonal Regulation of Upstream Migration in American Glass Eels

Tuesday, August 19, 2014: 10:50 AM
200B (Centre des congrès de Québec // Québec City Convention Centre)
***Mélanie Gaillard**, Océanographie, Université du Québec à Rimouski, Rimouski, QC, Canada*
Céline Audet, Océanographie, UNIVERSITÉ DU QUÉBEC À RIMOUSKI, Rimouski, QC, Canada
Louis Bernatchez, Biologie, Université Laval, Quebec City, QC, Canada

In recent years, freshwater, estuarine, and marine ecotypes have been described in different eel species. The aim of this study was to better understand the physiological regulation of migration at the glass eel stage in American eel, *Anguilla rostrata*. We hypothesized that the hormonal status would differ between glass eels exhibiting different ecotypes. Glass eels were captured when entering river estuaries in Nova Scotia (Mersey River) and Québec (Rivière Saint-Jean, Grande Rivière Blanche). They were transferred

to Maurice-Lamontagne Institute (Fisheries and Oceans Canada), where the salinity preference was estimated for groups originating from the different rivers. Glass eels exhibiting freshwater preference, saltwater preference, or brackish water preference were measured, weighed, and their stage of pigmentation quantified; they were then preserved in RNAlater for genomic studies. We compared the expression of genes coding for cortisol, prolactin, growth hormone, and thyroid hormones well as for their respective receptors. The results will be discussed in relation to the zone of capture and salinity preference.

American Eel Tracking and Tag Detection Efficiency in High Flow Environments

Wednesday, August 20, 2014: 9:20 AM
2104A (Centre des congrès de Québec // Québec City Convention Centre)
Jeremy E. Broome *, Acadia Centre for Estuarine Research, Acadia University, Wolfville, NS, Canada*
Anna M. Redden, Biology Department, Acadia University, Wolfville, NS, Canada
Rod Bradford, Population Ecology Division, Fisheries and Oceans Canada, Dartmouth, NS, Canada
Michael Stokesbury, Department of Biology, Acadia University, Wolfville, NS, Canada
Edmund Halfyard, Biology, Dalhousie University, Halifax, NS, Canada

A collaborative, multi-year, acoustic telemetry project was developed to investigate fish movements in and near the FORCE in-stream tidal energy test site within Minas Passage, Bay of Fundy, NS. This presentation addresses two sets of data: 1) results of a directed investigation of acoustic receiver detection performance under high flow conditions, and 2) results of two seasons of American eel tracking. Forty-five (45) eels were acoustically tagged during the fall of 2011 and 2012. Twenty-one (21) eels were detected within Minas Passage, of which eight (8) were detected within the FORCE site. Presence within Minas Passage occurred over a short time frame due to the single passage nature of eel out-migration. Little selectivity was shown for a specific migration pathway. Depths of transit through Minas Passage were highly variable among individuals, ranging between surface and 110m. Patterns in movement through Minas Passage, with regards to time of day and tidal stage, that might help inform when eels could be most at risk during the installation and testing of TISEC devices, were not well resolved. Detection efficiency is significantly reduced in high flow environments; therefore, cautious interpretation of animal detection data, in light of instrumentation limitations and flow considerations, is advised.

The Role of Culture, Conservation Stocking, and Ecological Insights in Mitigating the Decline of the American Eel (*Anguilla rostrata*)

Thursday, August 21, 2014: 11:50 AM
304B (Centre des congrès de Québec // Québec City Convention Centre)
Courtney V. Holden *Department of Biology, Queen's University, Kingston, ON, Canada*
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada

The American Eel is showing universal declines. Conservation stocking of eels was conducted experimentally from 2006-2010 in the upper St. Lawrence River in an attempt to mitigate recruitment declines. Microhabitat associations of recently stocked age-one eels electrofished 2008-2010, along with otolith isotopic thermography and controlled rearing experiments, provided ecological insights that can improve stocking success. Otolith $\delta^{18}O$ temperature estimates indicate that microhabitat associations and

cover (small rock rubble) are more important than thermal conditions; otolith temperature was 1.5°C cooler than habitat. Young elvers were reared in three replicate controlled temperature experiments over a range (10°C-37°C) simulating midsummer temperatures across the species range. Eels retain a high optimum temperature (28°C) despite living at suboptimal temperatures in the northern part of the range. Microhabitat associations are more important to recently stocked eels than seeking optimal temperatures for growth. Culture enhances survival and stocking provides increased opportunity to study important ecological associations and requirements while maintaining a presence, profiling the need for continued conservation efforts. Culture now plays a major role in worldwide eel production; stocking to enhance fisheries can be compatible with conservation. Importantly, culture and conservation stocking can result in greater habitat utilization, potential for increased escapement, and increases in recruitment.

Recent Contributions of Genomics Towards a Better Understanding of Anguilla's Biology: Relevance for the Conservation of a Threatened Genus

Monday, August 18, 2014: 1:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Louis Bernatchez**, Biologie, Université Laval, Quebec City, QC, Canada*

Conservation genetics is the application of genetics to preserve species as dynamic entities capable of coping with environmental change. Here, molecular data can play two fundamental roles: 1) Inventorial, which pertains to documenting patterns and has driven much of what we have accomplished until recently, 2) Mechanistic, which refers to deciphering evolutionary processes underlying those patterns, and still in its infancy. This is where we put big hopes in the use of high throughput genomics methods that are currently revolutionizing the field of population genetics. Ultimately, we aim at finding causal relationships between genetic variation, phenotypes and environment to predict future dynamics of selectively important variation and potential for adaptation to new conditions. I will illustrate the progress that has been made towards this end in Anguilla, with an emphasis on Atlantic eels. In particular, recent studies provided; i) a detailed view of whole genome divergence between European and American eels; ii) definite evidence for panmixia in both species; iii) strong support for spatially varying selection associated with temperature, habitat use and pollution, iv) suggestive evidence that such selection is responsible for generating genetically-based local phenotypic differences. I will discuss the relevance of these new findings for eel conservation strategies.

Mi'kmaq and Maliseet Ecological Knowledge on Species at Risk in the Estuary and Gulf of St. Lawrence

Monday, August 18, 2014: 3:40 PM
303A (Centre des congrès de Québec // Québec City Convention Centre)
Catherine Lambert Koizumi , Mi'kmaq Maliseet Aboriginal Fisheries Management Association, Gesgapegiag, QC, Canada
***Peter Adam Jerome**, Mi'kmaq Maliseet Aboriginal Fisheries Management Association, Gesgapegiag, QC, Canada*

The Estuary and Gulf of St. Lawrence constitute a rich, complex and fragile ecosystem, hosting several marine species at risk. Mi'kmaq and Maliseet People have relied and acquired knowledge on many of these species since immemorial time, although only a small portion of this precious knowledge has been documented in written. To fill this gap, we aimed to document Mi'kmaq and Maliseet ecological knowledge about fourteen (14) species considered either of special concern, threatened, endangered, or extirpated in the Estuary or Gulf of St. Lawrence. The species were: Atlantic salmon, American eel, striped bass, Atlantic cod, American Plaice, redfish, Atlantic sturgeon, white shark, beluga, blue whale, fin whale, North Atlantic right whale, Atlantic walrus, and the leatherback turtle. Our objectives were to document the species historical presence, their critical habitats, fluctuations in their population and abundance, as well as their importance in the Mi'kmaq and Maliseet cultures, both locally and globally. Interviews were done in the communities of Gesgapegiag, Gespeg, and Viger. Recommendations were also sought from participants regarding the management of these species and their habitats. Results will contribute to the conservation, management and recovery of these species in the Estuary and the Gulf of St. Lawrence.

American Eel Papers—United States

Multi-Jurisdictional, Multi-Fishery Management of a Multi-Million Dollar Species

Thursday, August 21, 2014: 2:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Kate Taylor**, Atlantic States Marine Fisheries Commission, Washington, DC*

American eel (*Anguilla rostrata*) occupy a significant and unique niche in Atlantic coastal habitats and fishing communities. Since 2000, the Atlantic States Marine Fisheries Commission (Commission) has coordinated interstate management of American eel from in the territorial seas and inland waters along the U.S. east coast from Maine to Florida. In 2012, the Commission completed a benchmark stock assessment for American eel and found the stock is depleted due to a combination of factors including historical overfishing, habitat loss, predation, turbine mortality, changing climatic conditions, contaminants, and disease. Successful restoration of current U.S. east coast American eel populations requires cooperative management among 19 state and federal regulatory authorities, across three distinct fisheries each targeting different life stages, on a species that remains mysterious and elusive. The glass, yellow, and silver eel fisheries each present unique examples of the competing interests and data limitations challenging the development of new regulations. Effective management needs to consider the historical composition of the fishery and current economic factors, as well as be flexible to future conditions and encompasses the entire range of American eel.

An 11-Year Series of Passage Counts of Upstream Migrant American Eels at the Millville Dam Eel Ladder, Lower Shenandoah River, USA

Thursday, August 21, 2014: 9:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Stuart Welsh**, USGS, WV Cooperative Fish and Wildlife Research Unit, Morgantown, WV*

Steve Hammond, Environmental Health, Anne Arundel County Department of Health, Annapolis, MD
Heather Liller, Gene Conservation Laboratory, Alaska Department of Fish and Game, Anchorage, AK
Jennifer Zimmerman, Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV
Melissa Braham , Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV
Joni Aldinger , Division of Forestry and Natural Resources, West Virginia University, Morgantown, WV

Upstream dam passage of American Eels is a current management concern for Atlantic coastal rivers of North America. Eel ladders have been used successfully to pass American Eels upstream at hydroelectric dams, but few studies have examined long-term datasets of upstream passage counts. We examined an 11-year time series of passage counts (2003–2013) of yellow-phase American Eels at an eel ladder at a hydroelectric dam on the lower Shenandoah River (Potomac River drainage), USA. Time series of daily American Eel counts were modeled with generalized estimating equations (GEE) by fitting time-varying environmental covariates of lunar phase, river discharge, and water temperature, including one- and two-day lags of each covariate. Over 22,000 yellow-phase American Eels were counted at the ladder during the 11-year time series. Passage counts were positively associated with river discharge and negatively associated with lunar illumination. Also, large spikes in river discharge, such as those associated with hurricane-induced rainfall during fall, were associated with mass upstream migration events. Our data support long-term success of upstream eel passage of an eel ladder on the lower Shenandoah River, and also emphasize the management utility of an eel ladder for monitoring upstream eel migration.

Reconnecting American Eels to the Upper Roanoke Basin

Tuesday, August 19, 2014: 2:10 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
Prescott Brownell, Habitat Conservation Division, National Marine Fisheries Service (retired), Charleston, SC
John Ellis, Ecological Services, U.S. Fish and Wildlife Service, Raleigh, NC
Joseph Hightower, U.S. Geological Survey, NC Cooperative Fish and Wildlife Research Unit, NC State University, Raleigh, NC
R. Wilson Laney, South Atlantic Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service, North Carolina State University, Raleigh, NC
Arthur “Bud” L. LaRoche, III, Virginia Department of Game and Inland Fisheries (retired), Vinton, VA
Dan Michaelson, Virginia Department of Game and Inland Fisheries, Farmville, VA
Kathy Rawls, Division of Marine Fisheries, North Carolina Department of Environment and Natural Resources, Elizabeth City, NC
***Fritz Rohde**, Habitat Conservation Division, National Marine Fisheries Service, Beaufort, NC*
Garry Wright, Division of Marine Fisheries, North Carolina Department of Environment and Natural Resources, Washington, NC
Bennett Wynne, Division of Inland Fisheries, North Carolina Wildlife Resources Commission, Kinston, NC

One indication of watershed health is diversity of aquatic fauna. American eels spawn in the Atlantic Ocean, and their offspring use rivers from maritime Canada to northern South America as nursery areas.

They were historically largely eliminated from the upper Roanoke River Basin due to flood control and hydropower dam construction, consequently reducing upstream native fish diversity as well as eel production. As part of the Federal Energy Regulatory Commission relicensing process with Dominion/North Carolina Power, the National Marine Fisheries Service issued a Section 18 fishway prescription requiring safe, timely and effective passage be provided for eels reaching the Dominion dams. We sampled eels in the river's bypassed reach and in the tailrace below Roanoke Rapids Dam from 2005 – 2008 to assess the abundance and distribution of eels below the dam. Large collections in conventional elver traps within the bypassed reach documented seasonal and horizontal distribution patterns and led to construction of high-capacity eelways at the north and south ends of the bypassed reach in 2009-2010. Well over a million eels have been passed upstream during 2010-2013. We will discuss observed patterns of eel abundance and upstream migration, eelway design considerations, and other factors involved in eel restoration.

Declining Abundance and Recruitment of American Eels at the Extremities of the Range: From the Upper St. Lawrence River to the Upper Mississippi River

Wednesday, August 20, 2014: 9:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***John Casselman**, Dept. of Biology, Queen's University, Kingston, ON, Canada*
Lucian Marcogliese, Research Biologist, Ameliasburg, ON, Canada
Rob MacGregor, Ontario Ministry of Natural Resources (retired)
Peter Thompson, Department of Fisheries and Ocean (retired)
Ken Able, Rutgers Marine Field Station, Rutgers University, Tuckerton, NJ
Keith D. Clarke, Science Branch, Fisheries and Oceans Canada, St. John's, NF, Canada
Heather Corbett, N.J. Division of Fish and Wildlife, U.S. Bureau of Marine Fisheries
J. Christopher Taylor, Center for Coastal Fisheries and Habitat Research, NOAA National Ocean Service, Beaufort, NC
Quinton Phelps, Big Rivers and Wetlands Field Station, Missouri Department of Conservation, Jackson, MO

American eels have declined dramatically in some regions over the past several decades, best documented in the upper St. Lawrence River-Lake Ontario, where the species is now classified as endangered; some have suggested that this has a local explanation. We examined changes in abundance across the range from the upper St. Lawrence River along the Atlantic Seaboard, Gulf of Mexico, and Caribbean to the upper Mississippi River–19 datasets, encompassing two to five decades, 12 locations. Changes in fisheries-independent indices that are short term or near the source of recruitment (southern, Gulf Stream) are less apparent, often with no significant trends. Comparison of long-term glass eel recruitment for NJ and NC shows significant decreases in abundance and delays in ingress with extremity, both showing decreased size. Recent increases in recruitment in some locales are not appreciably greater than seen in the past few decades and might be explained by oceanic changes (North Atlantic Oscillation Index) and possible management actions. If recruitment and abundance data are from the extremities and long enough, declines are apparent, widespread, and consistent with overall species decline, emphasizing the need for universal action to reverse these trends. We consider this panmictic species threatened and the resource endangered.

Stock Assessment of Atlantic Coast American Eel

Wednesday, August 20, 2014: 8:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Laura Lee**, NC Division of Marine Resources, Morehead City, NC*
Genevieve Nesslage, Atlantic States Marine Fisheries Commission, Arlington, VA
Jeffrey Brust, NJ Division of Fish and Wildlife
Bradford C. Chase, Massachusetts Division of Marine Fisheries, New Bedford, MA
John Clark, DE Division of Fish and Wildlife
John Sweka, U.S. Fish and Wildlife Service, Lamar, PA
Keith Whiteford, MD Department of Natural Resources

The status of American eel (*Anguilla rostrata*) on the Atlantic Coast of the United States was assessed using trend analyses and depletion-based stock reduction analysis. Thirty-three fishery-independent surveys conducted over at least the last 10 years were standardized to generate relative abundance indices and grouped into six geographic regions: Gulf of Maine, Southern New England, Hudson River, Delaware Bay & Mid-Atlantic Coastal Bays, Chesapeake Bay, and South Atlantic. The Mann-Kendall test for temporal trends applied to all surveys showed most indices from Delaware Bay & Mid-Atlantic Coastal Bays increased in recent years, whereas all other regions exhibited declining trends. ARIMA modeling performed on surveys conducted ≥20 years showed increasing trends in Chesapeake Bay and decreasing trends in the Hudson River. Depletion-based stock reduction analysis estimated a median biomass trend using historical landings from 1880 to 2010. Biomass declined from a peak of approximately 18,000 metric tons in 1880, rose to a subsequent lower peak of approximately 5,400 metric tons in 1974, and then declined steadily through to the present. Results will be used to further develop the existing interstate eel management plan and to inform the upcoming finding on the petition to list American eel under the Endangered Species Act.

Status and Biology of American Eel in the Ouachita and White Rivers, Arkansas, USA

Tuesday, August 19, 2014: 9:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Casey Cox, Department of Biology, University of Central Arkansas, Conway, AR
S. Reid Adams, Biology, University of Central Arkansas, Conway, AR
Ginny B. Adams, Department of Biology, University of Central Arkansas, Conway, AR
Lindsey Lewis, Ecological Services, U S Fish and Widlife Service, Conway, AR
***Jeffrey W. Quinn**, Arkansas Game and Fish Commission, Little Rock, AR*

The American eel has experienced declines from historical population sizes in parts of their range, but limited data exist for rivers discharging into the Gulf of Mexico. Our objectives were to describe demographics of American eels in rivers of the Ouachita River basin, and we documented migratory phenology of eels migrating from the White River into the Arkansas River Navigation System at Norrell Lock and Dam. From June 2011 – 2013, we collected eels by boat and backpack electrofishing. We collected 264 eels during the study, which doubles the total number of occurrences for the State of Arkansas. Mean total length was 395 mm (236 - 940 mm). Mean CPUE was 27 eels/hour with a range of

0 to 78. In both the White and Ouachita rivers, eels collected in tailwaters were significantly smaller than eels collected from main channel sites, and the greatest CPUE was observed in tailwaters. Potentially, small eels collected directly below dams were attempting upstream migration but were impeded by barriers. American eels were only present below Norrell Dam within a defined temperature (18-27 °C) and discharge range (55,000-10,000 cfs), indicating upstream migration in the Arkansas River System may be coupled to these two environmental cues.

Early Infection of Newly Recruited American Eels By an Invasive Swimbladder Parasite in a South Carolina Estuary

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
Jennifer L. Hein, South Carolina Department of Natural Resources, Charleston, SC
***Stephen A. Arnott**, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC*
William A. Roumillat, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC
Bill C. Post, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC
Isaure de Buron, Biology, College of Charleston, Charleston, SC

South Carolina is one of only two U.S. states that have permitted the harvest of American eel (*Anguilla rostrata*) juvenile stages in recent years. However, little is known about the infection status of juvenile eels by the invasive swim bladder parasite *Anguillicoloides crassus*. This study examined *A. crassus* infection over a ten month period in more than 400 glass and elver eels collected from a dammed creek near Charleston, SC. Parasite prevalence varied significantly with eel size (total length) and time of year. From March to July, the smallest eels (~30 mm) were uninfected, but parasite prevalence increased to ~100% in eels greater than 130 mm. From August – December, when fewer eels were found, parasite prevalence was generally lower and it was less dependent on eel size (although the smallest eel sizes were uninfected, as before). In mid-summer, water temperatures rose above 30°C, which has been shown to be lethal for other infected Anguillid eels. At present, it is unknown whether the lower parasite prevalence later in the year was related to emigration of infected eels, mortality, or clearance of the parasite by host eels.

Infection of American Eels By the Invasive Swimbladder Parasite Anguillicoloides Crassus in South Carolina

Wednesday, August 20, 2014: 1:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Jennifer L. Hein**, South Carolina Department of Natural Resources, Charleston, SC*
Stephen Arnott, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC

William Roumillat, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC
Dennis M. Allen, Baruch Marine Field Laboratory, Georgetown, SC
Isaure de Buron, Biology, College of Charleston, Charleston, SC

A year-round survey of American eels, *Anguilla rostrata*, was performed in South Carolina (SC), USA 15 years after the first infection by the nematode *Anguillicoloides crassus* was reported from Winyah Bay, SC. Prevalence, intensity, and abundance of *A. crassus* were determined. Overall, infection levels were higher than previous reports for eels in SC but comparable to more recent reports from other areas in North America. An integrative analysis was performed to determine if infection parameters varied with biotic and abiotic factors including time of year, sampling locations, eel total length, and salinity. The lack of seasonal effects on infection by the adult worm stage contrasts with studies from higher latitudes in North America and Europe and may be due to the warmer winter temperatures in southern latitudes. Significant variation in infection among localities reflects possible differences in abundance of intermediate and/or paratenic hosts and highlights the importance of identifying such hosts in North America.

Sustainable River-Basin Designs: Siting Hydropower to Benefit American Eels and Energy Production in the Roanoke River Basin

Wednesday, August 20, 2014: 11:30 AM
304B (Centre des congrès de Québec // Québec City Convention Centre)
***Henriette Jager**, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN*
Michael Kelly, Mathematics, University of Tennessee / National Institute of Mathematical and Biological Synthesis, Knoxville
Ariel Cintron-Arias, Department of Mathematics and Statistics, East Tennessee State University, Johnson City, TN
Ryan McManamay, Oak Ridge National Laboratory, Oak Ridge, TN
Chris DeRolph, Oak Ridge National Laboratory, Oak Ridge, TN

What is the best way to arrange dams within river basins to benefit society? Hydropower development has never been planned with the goal of providing society with a portfolio of ecosystem services into the future. We synthesized a review of river basin design around four spatial decisions, *Is it better to build fewer mainstem dams or more tributary dams?, Should dams be clustered or distributed among distant subbasins?*, *Where should dams be placed along a river?,* and *At what spatial scale should decisions be made?*. Four principles emerged from this review: 1) At the scale of large river basins, 2) concentrate dams within a few tributary watersheds and avoid downstream mainstems, 3) disperse freshwater reserves among the remaining tributary catchments, and 4) ensure that habitat provided between dams will support and retain production. We developed a simple model for the American eel (*Anguilla rostrata*) in the Roanoke river basin and located dams to maximize two objectives: power generation and eel survival. Results demonstrated trade-offs between designs favoring the two objectives. This analysis illustrates that we can do better as a society in deciding how to develop river basins for sustainable hydropower production.

Distribution and Speed of Migration for Upstream Migrating American Eels Tagged at the Beauharnois Power Dam and Recaptured at the Moses-Saunders Power Dam

Thursday, August 21, 2014: 9:00 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Scott Ault**, Kleinschmidt Associates, Inc., Strasburg, PA*
Ron Threader, Ontario Power Generation, Renfrew, Ontario, ON, Canada
Ben Lenz, New York Power Authority, White Plains, NY
Lee Harper, Riveredge Associates, Massena, NY
Jean Caumartin, V-P Exploitation des Équipements de Production, Hydro-Québec, Montréal, QC, Canada

A total of 8,610 juvenile American eels were tagged with passive integrated transponders at the Beauharnois Power Dam (BPD) on the St Lawrence River from 2011-2013. Eels were collected as they exited the Beauharnois eel passage facility and released a short distance upstream after tagging. Recaptures (tag detections) occurred at two eel passage facilities located on either end of the Moses-Saunders Power (MSPD), 80 km upstream. A total of 2,289 recaptures were recorded in 2011-2013; 1,264 on the west end of the dam and 1,025 on the east end. Eels tagged and recaptured in the same year were more likely to be recaptured at the west end of MSPD, whereas eels recaptured in the second or third year after tagging were generally recaptured at about equal proportions on each end of the MSPD. Average transit time between BPD and MSPD was 20.3 days for eels tagged and recaptured in the same year. Minimum transit time to traverse the 80 km was 7.6 days (a rate of 10.5 km/day) and maximum time was 70.9 days. Additional analysis will provide insights to upstream movement dynamics and estimates of population size in Lake St Francis.

Evaluation of Bar Rack Spacing and Approach Velocity for Preventing Entrainment of Silver American Eels at Hydropower Projects

Thursday, August 21, 2014: 3:10 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Stephen V. Amaral**, Alden Research Laboratory, Inc., Holden, MA*
Tresha Melong, Worcester Polytechnic Institute, Worcester, MA
Paul Mathisen, Worcester Polytechnic Institute, Worcester, MA
Daniel Giza, Alden Research Laboratory, Inc., Holden, MA
Paul T. Jacobson, Electric Power Research Institute, Glenelg, MD

State and federal resource agencies have been prescribing restrictive intake bar spacing and approach velocities for downstream passage of silver American eels at hydropower projects in the U.S. These criteria could result in significant costs and lost generation at many projects. To determine the applicability of eel-specific criteria versus those used for other species, we conducted a laboratory evaluation of bypass efficiency for silver eels exposed to a bar rack oriented 90° to the flow with clear spacings of 19 and 25 mm, approach velocities of 0.46 and 0.61 m/s, and a full-depth bypass. Bypass efficiencies were higher for the smaller bar spacing and decreased slightly with increasing approach velocity for both spacings. An analysis of morphometric measurements indicated that eels with lengths greater than 930

mm would be physically excluded from entrainment through 19-mm clear bar openings and eels greater than 1,135 mm would be excluded by 25-mm spacing. The results of this study can be used to assess the relative effectiveness of various bar rack spacing and approach velocity criteria to develop site-specific designs for silver eels that balance biological effectiveness and impacts to project operation.

Population Dynamics of the American Eel in South Carolina Estuaries, As Determined By a Long-Term Electrofishing Survey

Tuesday, August 19, 2014: 11:10 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Stephen A. Arnott**, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC*
Jennifer L. Hein, South Carolina Department of Natural Resources, Charleston, SC
John Archambault, South Carolina Department of Natural Resources
William A. Roumillat, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC

Few long-term datasets exist for American eels, *Anguilla rostrata*, in the South Atlantic Bight region of the U.S. This study presents twelve years of data from an ongoing, stratified-random electrofishing survey of five South Carolina estuaries. The survey was used in the most recent U.S. stock assessment of eels, and additional life history work was initiated in 2012 in response to assessment research requests. In each of the five estuaries, approximately five 15-minute sets are performed per month (> 300 sets/year total) in salinities from 0-8 psu. The American eel is the eighth most abundant of the ~125 fish species encountered. Eel numbers typically peak during spring (April-June) and autumn (October-November), and decline during summer and winter. A wide range of eel lengths are caught (44-890 mm, n = 7,167), with major peaks occurring at ~320 mm and ~520 mm. Life history studies on eels captured during 2013 revealed that the majority of eels were female. However, the proportion of males increased during autumn, when maturing silver eels were present. Further studies are underway to determine seasonal age structure in each estuary, age- and size-at-maturity, and infections levels of the invasive parasite *Anguillicoloides crassus*.

Dispersal Pathways of American Eel Larvae from the Sargasso Sea

Wednesday, August 20, 2014: 10:50 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Irina Rypina**, Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, MA*
Joel Llopiz, Biology, Woods Hole Oceanographic Institution, Woods Hole, MA
Lawrence Pratt, Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, MA
Susan Lozier, Earth and Ocean Science, Nicholas School, Duke University

At the end of their life cycle, American eel migrate to the Sargasso Sea from freshwater habitats along the east coast of North America to spawn planktonic eggs. The eggs develop into larvae that then have to reach freshwater habitats along the American coast within their first year of life. The exact spawning location in the Sargasso Sea and details of the larval journey are poorly understood. Here, a coupled biological-physical model was used to study how potential behavioral adaptations influence the ability of eel larvae to reach near-coastal waters. Several swimming behaviors are investigated: passive drift,

random-walk swimming, and directional navigation with and without a preferred direction. Directional swimming with a randomly chosen direction improved larval success rates by >2 orders of magnitude compared to passive drift, and swimming primarily to the northwest further doubled these rates. Success rates also substantially increased for larvae with swimming abilities even slightly above an estimated average. Directional swimming resulted in a reasonable distribution of larvae along the shelf break, whereas other scenarios left gaps where no larvae reached the shelf, including near the Gulf of Maine where juvenile eels are abundant. Directional swimming yielded transit times of ~1 year, in agreement with observations. The model supported the southwestern Sargasso Sea as the probable spawning area.

The Development of a Non-Lethal Maturity Index for American Eels

Wednesday, August 20, 2014: 8:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Sarah J. Mount**, State University of New York, College of Environmental Science and Forestry, Syracuse, NY*
Karin E. Limburg, Department of Environmental and Forest Biology, State University of New York, College of Environmental Science and Forestry, Syracuse, NY
Robert E. Schmidt, Mathematics, Science and Computing, Bard College at Simon's Rock, Great Barrington, MA
Christopher H. Bowser, Earth And Atmospheric Sciences, Cornell University, Water Resource Institute, Ithaca, NY

In recent decades eel populations have declined across the globe, making them of increased research and conservation interest. The catadromous, semelparous and panmictic nature of eels make them difficult to study and manage. The sexually mature life stage (silver eel) is relatively understudied, yet the transition to a silver eel is critical for species perseverance. Previous research suggests eels need to reach a minimum fat content before maturity. The recent use of bioelectrical impedance analysis (BIA) in fisheries science to measure the composition and condition of fish, including fat content, may help in developing a non-lethal index of maturity in eels. BIA readings can be taken easily in the field without harming subject animals. A non-lethal index of silvering could be a powerful management tool for future research of catadromous eels. We collected BIA readings and morphometrics such as head length, eye diameter and fin length on eels caught in tributaries to the Hudson River to correlate with internal characteristics of maturity such as total lipid content and gonad, stomach and liver weight. We repeatedly surveyed one tributary and PIT tagged eels after taking measurements, then caught emigrating eels during the fall migration season to re-assess biometric characteristics.

The Distribution of Growth-Phase American Eels in Saline Waters of the East Coast of North America

Tuesday, August 19, 2014: 8:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Luke Poirier, MSc** , Biology, University of Prince Edward Island, Charlottetown, PE, Canada*
David Cairns, Science Branch, Fisheries and Oceans Canada, Charlottetown, PE, Canada
Louis Bernatchez, Biologie, Université Laval, Quebec City, QC, Canada

Trevor S. Avery, Biology, Acadia University, Wolfville, NS, Canada

Despite intense conservation interest in the American eel (*Anguilla rostrata*), there exists no robust data source from which to assess population status across a broad spatial area in saline waters. Eel distribution in saline waters was evaluated by compiling eel count and presence/absence data from 25 saline surveys involving ca. 238,000 data points spanning 1959 to 2012. Eel captures were classified based on exposure to the sea as defined in a habitat atlas compiled by Cairns et al. (2012) that examined eel habitat compiled from eel fisheries data. Trends showed that the majority of eels occupy sheltered and semi-exposed saline waters; in particular, those waters of large bays and sounds in the USA. Canadian coastal surveys indicated a virtual absence of captures in open saline waters; however, US surveys had greater and variable numbers of eels. Mean depths and distance-to-land indicate that eels are most prevalent in shallow, near-shore waters. Trends and modeling, in their current state, provide compelling evidence of broad spatial and temporal habitat usage in saline environments primarily in sheltered coastal waters and semi-exposed bays. Data compilation and analyses presented here provide a methodology for investigating spatial and temporal habitat use patterns for other geographically widespread organisms.

Passage Method, Turbine Mortality, and Migratory Delay of Silver American Eels (*Anguilla rostrata*) at Five Hydroelectric Dams on the Shenandoah River

Thursday, August 21, 2014: 2:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Sheila Eyler** , Maryland Fishery Resources Office, U.S. Fish and Wildlife Service, Annapolis, MD*
Stuart Welsh, USGS, WV Cooperative Fish and Wildlife Research Unit, Morgantown, WV
David Smith, Leetown Science Center, U.S. Geological Survey, Kearneysville, WV
Mary Mandt, USGS - Leetown Science Center, Kearneysville, WV

Hydroelectric dams can impact downstream migrations of silver American Eels (*Anguilla rostrata*) through migratory delays and turbine mortality. A radio-telemetry study on American Eel was conducted to determine impacts of five hydroelectric dams located over a 195km stretch of the Shenandoah River in Virginia and West Virginia. American Eels migrated downstream during all months of the year except July, with most individuals migrating during fall through spring and at night. The median time to pass all five dams was 18 days. Migratory delays at dams were generally less than 1 hour and nearly all individuals passed downstream within 10 d of first detection at a dam. Turbine mortality occurred at all five dams. Implementation of a seasonal nighttime turbine shutdown period reduced cumulative mortality for eels passing all five dams from 63% during regular operation to 7% during shutdowns. Nighttime shutdowns were an effective method to protect downstream migrants, and the seasonal timing for implementation for the shutdowns in the Shenandoah River encompassed 67% of the total downstream passage events in the study. Turbine mortality of downstream migrants could be reduced by extending the three month nighttime shutdown period, particularly by inclusion of spring months.

American Eel Population Characteristics and Environmental Life History in the Mississipi River

Tuesday, August 19, 2014: 9:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Quinton Phelps *, Big Rivers and Wetlands Field Station, Missouri Department of Conservation, Jackson, MO*
Sara Tripp, Big Rivers and Wetlands Field Station, Missouri Department of Conservation, Jackson, MO
Gregory W. Whitledge, Center for Fisheries, Aquaculture, and Aquatic Sciences, Southern Illinois University, Carbondale, IL

American eels inhabit a broad spatial extent and because of this are subject to a host of deleterious anthropogenic influences. Specifically, commercial overharvest and habitat degradation (e.g., channelization, damming, and leveeing) in many locations has negatively influenced American eel populations. Because of these aforementioned issues, American eel throughout their range may be in jeopardy and have recently received increased interest by the United States Fish and Wildlife Service. However as it relates to the Mississippi River, the American eel population has not been thoroughly evaluated. Due to the paucity of information, we examined baseline population demographics and environmental life history information in the Mississippi River. During 2011-2014, we collected American eels under the auspices of the Long Term Resource Monitoring Program , an element of the U.S. Army Corps of Engineers' Upper Mississippi River Restoration—Environmental Management Program. Based on these collections, we have determined that American eels in the Mississippi River exhibit a broad size and age distribution and time of freshwater Mississippi River entrance occurs early in life. We believe the information provided in this study will further our understanding of American eel population in the Mississippi River and provide insight for future management efforts.

It Doesn't Get Any Better Than This: The Distribution, Biomass, and Abundance of American Eel in Headwaters of the Undammed Delaware River

Thursday, August 21, 2014: 10:50 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Mari-Beth DeLucia*, The Nature Conservancy, New Paltz, NY*
Barry P. Baldigo, U.S. Geological Survey, New York Water Science Center, Troy, NY
George E. Schuler, The Nature Conservancy, New Paltz, NY

The American eel (*Anguilla rostrata*) stock has declined across its range over the past four decades due to dams, overfishing, and other stressors. The Nature Conservancy and US Geological Survey quantified fish assemblages in tributaries of the Delaware River (in NY, NJ, and PA) during 2002-08 to evaluate the present-day status and potential effects of impoundments on eel distribution and fish communities. American eel were extirpated from sites upstream of large dams, whereas, eel density ranged from 0.001-0.130 eel m^{-2} and biomass ranged from 0.01-11.82 g m^{-2} at downstream sites. Density and biomass of eels were often comparable to, or greater than that of salmonids at sites that included small high elevation trout streams. The loss of eels at sites located upstream of major impoundments provides insight into the

direct and indirect effects of dams on this important species as well as the entire fish assemblage in regulated rivers. The distribution, abundance, and biomass of American eel in some undammed headwater reaches of tributaries to the Delaware may represent near-reference conditions for the species across its range and this type of information could be used to inform the effectiveness of eel-management and restoration efforts in other areas.

21st Century Improvements in American Eel Upstream Passage on St. Lawrence River

Thursday, August 21, 2014: 8:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Benjamin Lenz**, New York Power Authority, White Plains, NY*
Ron Threader, Retired, Ontario Power Generation, Renfrew, ON, Canada
Jean Caumartin, V-P Exploitation des Équipements de Production, Hydro-Québec, Montréal, QC, Canada

The two mainstem Saint Lawrence River hydroelectric power dams, Beauharnois (est. 1930) and Moses-Saunders (est. 1958), both have upstream passage facilities for juvenile American eel, *Anguilla rostrata*. The first dam encountered by upstream migrants, Beauharnois, has two eel ladders constructed on each side of the facility in 2002 and 2004. Moses–Saunders also has ladders at each end of the combined facility with operations starting in 2006 and 1974, respectively. Approximately 600,000 eels have passed upstream of Beauharnois and 300,000 at Moses-Saunders since 2001. The range of individuals passing in a single season at Beauharnois was ~22,500 in 2013 to ~88,000 in 2008. Comparatively, the range of the combined total at Moses-Saunders was ~14,000 in 2007 to ~52,000 in 2012. Eel passage at Beauharnois shifted entirely to one of the two ladders in 2007. Greater use of one of the two Moses-Saunders ladders occurred during 2007-2010, shifting to an even distribution of use in 2012 and 2013.

Downstream Passage and Movements of Silver-Phase American Eels at Three Hydroelectric Projects on the Shetucket River, Connecticut

Thursday, August 21, 2014: 2:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Alex Haro**, Conte Anadromous Fish Research Branch, U.S. Geological Survey, Turners Falls, MA*
Theodore Castro-Santos, S.O. Conte Anadromous Fish Research Center, U.S. Geological Survey, Turners Falls, MA
Melissa Grader, New England Field Office, U.S. Fish and Wildlife Service, Sunderland, MA

Traditional downstream bypass structures installed at hydroelectric projects have not been well studied for effectiveness of passage of adult downstream migrant eels. We quantified downstream movement and passage of telemetered migrant, silver-phase American eels at three consecutive hydroelectric projects on the Shetucket River, Connecticut, over two migratory seasons. Downstream migration frequently occurred during significant flow events, often well after time of release. Eels usually progressed downstream rapidly in reaches between dams, but could be delayed at dams, depending on flow and operation characteristics. Passage routes selected by eels were also variable; increased numbers of eels passed via spillways during periods of significant spill flows, but the majority of fish passed through turbines. Although all three projects operate as run-of-river, hydropeaking operation of a fourth project

further upstream may have influenced migration rate, timing, and activity, route selection, and use of bypasses. Passage via bypasses depended on project intake configuration, bypass entrance siting, and approach velocities. An angled bar rack with 2.5 cm clear spacing and low approach velocity generally passed a higher proportion of eels via the bypass than more traditional sluice bypasses at trashracks oriented perpendicular to the flow.

Timing, Size, and Movement of Upstream Migrating American Eels in the Santee-Cooper Basin, South Carolina

Thursday, August 21, 2014: 10:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
David Coughlan *, Normandeau Associates, Denver, NC*
Bill Post, South Carolina Department of Natural Resources, Charleston, SC
Allan Hazel, South Carolina Department of Natural Resources, Charleston, SC

Over recent years, upstream migrations of juvenile American Eel in South Carolina portions of the Santee-Cooper Basin have been monitored at several locations. Glass eels were collected in Goose Creek (~ 40 rkm from the ocean). These eels averaged 55 mm TL with peaks generally occurring in March. Elvers were collected at the USACE St. Stephen Dam on the Santee Rediversion Canal (~92 rkm from the ocean). Elvers typically measured 100 mm TL and were collected at variable times. Spring peaks occurred in April and all collected elvers were passed upstream into Lake Moultrie. Finally, year round monitoring occurs at the Wateree Dam (~229 main channel rkm further upstream) where low numbers of elvers and eels (> 150 mm TL) were collected. One late-April to early-May collection peak occurred at the Wateree Hydro. From 2010 to 2013, elvers at St. Stephen were implanted with visible elastomer tags in order to monitor travel to upstream dams. Of 7,469 tagged elvers, two were collected in 2013 at the Wateree Dam and indicated that the fastest travel time was approximately one year. Low catches of eels upstream of the Santee-Cooper reservoirs is intriguing and worthy of additional research.

Assessing the Link Between American Eel and the Eastern Elliptio Mussel in the Chesapeake Bay Watershed

Tuesday, August 19, 2014: 1:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Heather Galbraith*, Northern Appalachian Research Laboratory, USGS, Wellsboro, PA*
Carrie Blakeslee, Northern Appalachian Research Laboratory, USGS, Wellsboro, PA

American eels (*Anguilla rostrata*) have declined dramatically in the Susquehanna River, a major tributary of the Chesapeake Bay, since construction of several mainstem dams in the early 1900's. Evidence suggests that the historically abundant eastern elliptio mussel (*Elliptio complanata*) has also declined in much of the Susquehanna basin. Freshwater mussels are obligate ectoparasites on one or more host fish species to complete their metamorphosis from larvae to juveniles. Recent recruitment by the eastern elliptio mussel has been shown to be limited or entirely absent in parts of its range and may be linked to the loss of its primary host fish, the American eel. Because freshwater mussels perform important functions in stream ecosystems, efforts have been made to restore eel populations around native mussel

beds through experimental stocking. Effects of stocking on eel and mussel population dynamics are being assessed along with alternative methods for restoring eel populations to the basin. Pheromones may be used as a sustainable tool in guiding successful eel passage and restoring native communities linked to the historic abundance of this fish in the Chesapeake Bay.

Comparison of Reproductive Characteristics of Stocked and Naturally Occurring American Eels

Thursday, August 21, 2014: 11:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
Nicole Balk, Biology, University of Massachusetts, Dartmouth, MA
***Ken Oliveira**, Department of Biology, University of Massachusetts Dartmouth, North Dartmouth, MA*

The discovery of smaller and younger downstream migrating female American eels in the St Lawrence River (SLR) resulting from the stocking of glass eels has raised questions about the ecological impact of stocking. In this study we made comparisons of reproductive life history traits (age, total length, body composition, energy density (kJ/g bw), and parental investment (proximate composition of ovulated eggs) of female silver eels collected while migrating from rivers in Massachusetts, Nova Scotia and the SLR (both stocked and non-stocked). Age, total length, and total energy (kJ) were greater in naturally occurring St Lawrence eels. Energy density (kJ/g bw) was greatest in the stocked eels and parental energy investment in the eggs was similar for all eels. Age and length of stocked eels were similar to eels from Nova Scotia and Massachusetts locations and to other locations in the species range with similar habitat conditions. We hypothesize that transplanting eels to the upper SLR system creates localized habitats that are similar to densely populated coastal river systems and the resulting female traits are consistent with this scenario.

Young-of-the-Year American Eel Monitoring on the U.S. Atlantic Coast

Tuesday, August 19, 2014: 9:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Bradford C. Chase**, Massachusetts Division of Marine Fisheries, New Bedford, MA*

The American eel Fishery Management Plan of the U.S. Atlantic States Marine Fisheries Commission (ASMFC) requires that all Atlantic coast States conduct annual abundance surveys of newly recruited glass eels also called young-of-year (YOY). The YOY life stage provides an opportunity to assess the annual recruitment of each year's cohort since YOY result from the previous winter's spawning activity and represent eels of the same age. The individual States follow ASMFC protocols for monitoring site selection, gear deployment and data collection to provide fishery independent indices of YOY eel abundance over a wide geographic region. Thirteen U.S. States have maintained YOY surveys beginning in 2000 or 2001. Thirty-one YOY surveys on the Atlantic coast were evaluated for the ASMFC American Eel Benchmark Stock Assessment in 2012 and sixteen were accepted as annual indices of abundance. Standardized General Linear Models (GLM) were developed from regional and coast-wide combinations of the accepted indices. A summary of the ASMFC YOY monitoring effort, GLM analyses, and abundance trends will be presented. Sampling effort and water temperature were included as covariates in the coast-

wide GML. In addition, analyses will be presented from individual sites related to environmental influences on YOY migrations and abundance.

Improvements to Fishery-Dependent Monitoring of American Eel in North Carolina

Tuesday, August 19, 2014: 11:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Stephanie McInerny**, North Carolina Department of Environment and Natural Resources, North Carolina Division of Marine Fisheries, Morehead City, NC*

The commercial harvest of American eel (*Anguilla rostrata*) has been monitored by the NC Division of Marine Fisheries Trip Ticket Program (NCDMF) since 1994. Eels harvested by commercial fishermen are held in pens across multiple trips before being sold to the dealer. This practice results in an underestimation of the actual number of trips taken by eel fishermen. Lack of effort data resulted in a requirement that ASMFC partner states institute a reporting system to ensure that annual effort and landings of eel are reported by harvesters and/or dealers. As a result, NCDMF developed the state's only commercial fisherman logbook program. Implementation of the program has been challenging due to issues with enforcement, variable participation, and data access. Roughly 93% of eel logs were matched to trip tickets after extensive reconciliation efforts. Catch per unit effort (CPUE) calculated as pounds per trip was compared across years. CPUEs based on trip tickets were larger than those from eel logs. Highest CPUE values occur in the fall for both reporting programs. Success in logbook monitoring of this species will provide useful effort information for future stock assessments.

Turbine Survival of Silver Eels: What Do We Know and How Can We Improve It?

Thursday, August 21, 2014: 2:10 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Stephen V. Amaral** , Alden Research Laboratory, Inc., Holden, MA*
Celeste Fay, Alden Research Laboratory, Inc., Holden, MA
George Hecker, Alden Research Laboratory, Inc., Holden, MA

Due to relatively high mortality rates, turbine entrainment of silver eels is a major issue that is being addressed by hydro project owners and resource agencies throughout the world. Eels have unique morphological, physiological, and behavioral characteristics that differentiate them from other species with respect to turbine mortality and the effects of various injury mechanisms (e.g., strike, pressure, shear). Consequently, existing turbine survival field data and established strike probability and mortality models used to estimate turbine survival of more typical teleost species generally are not applicable to silver eels. Available field and laboratory data from turbine survival studies conducted with eels indicate they have higher survival rates for their size than would be expected for other species. We are currently conducting an assessment of these data and alternative predictive methods for estimating eel turbine survival to provide a better understanding of how turbine design and operation affect eel injury and mortality rates. Based on this assessment, potential design and operational modifications will be identified and eel-specific theoretical approaches for predicting strike probability and mortality will be developed.

Modeling Migration of Silver Eels to Forecast Critical Intervals of Risk

Tuesday, August 19, 2014: 4:40 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Douglas Sigourney**, Integrated Statistics, Falmouth, MA*
Joseph D. Zydlewski, U.S. Geological Survey: Maine Cooperative Fisheries and Wildlife Research Unit, Orono, ME

Populations of eels are in decline worldwide. One potentially significant source of mortality may occur at hydroelectric facilities during the downstream migration of adult silver eels. To help mitigate this mortality, a tool that can forecast migratory events could be of great use to managers that aim to reduce dam mortality while minimizing disruption of power generation at hydroelectric facilities. A number of studies have demonstrated relationships between downstream movements of silver eels and environmental events; however, there have been few attempts to summarize this available information into a predictive framework. Herein, we assess the utility of Bayesian hierarchical modeling methods to forecast the probability of migratory events of silver eels. We compare two approaches that combine information on daily counts of migrating eels with information on environmental conditions to predict migration. We apply our modeling approach to multiple datasets of migrating eels and assess the ability to forecast migration in systems that are both data rich and data poor. The hierarchical framework we adopt combines information from a number of sources to provide robust estimates of the probability of eel migration and provides a flexible forecasting tool to aid managers in making decisions in regards to reducing turbine mortality.

Beyond Anadromy: Ecological Influences of Dams and Their Removal on Resident Fish and Benthic Macroinvertebrates

Tuesday, August 19, 2014: 3:40 PM
202 (Centre des congrès de Québec // Québec City Convention Centre)
***William Harbold** , Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, MD*
Patrick Graves, Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, MD
Scott Stranko, Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, MD
Ron Klauda, Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, MD
Jay Kilian, Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, MD

While the negative influence of dams as barriers to anadromous fishes is widely documented and accepted, impacts to other aspects of lotic ecosystems have received less attention. Staff from the Maryland Department of Natural Resources explored these other impacts in two studies. The first study focused on the impacts of sediment movement following the removal of Simkins Dam on the Patapsco River. When Simkins Dam was removed, fine sediment stored behind it was allowed to erode freely into the river channel. These sediments buried coarse substrate habitats downstream while uncovering coarse

substrate habitats upstream, causing concomitant changes in the distribution and abundance of burrowing invertebrates, EPT taxa, and benthic fishes. The second study examined trophic dynamics upstream from dams that exclude the catadromous American Eel from certain Maryland streams. The American Eel is a top predator in many Atlantic coastal streams. Its absence upstream of large dams resulted in top-down trophic effects on stream fish and benthic macroinvertebrate densities. Benthic fishes were significantly higher and benthic macroinvertebrates significantly lower in density upstream from dams where eels were absent compared to where they were present.

Genetic Barcoding of Gut Contents: From Partially-Digested Tissue to Species Identity

Thursday, August 21, 2014: 8:20 AM
303B (Centre des congrès de Québec // Québec City Convention Centre)
Matthew B. Ogburn *, Smithsonian Environmental Research Center, Edgewater, MD*
Rob Aguilar, Smithsonian Environmental Research Center, Edgewater, MD
Lee Weigt, Smithsonian Institution, National Museum of Natural History
Amy Driskell, Smithsonian Institution, National Museum of Natural History
Anson H. Hines, Smithsonian Environmental Research Center, Edgewater, MD

Genetic barcoding has the potential to substantially reduce the proportion of unidentified, partially-digested tissue in gut content analyses and improve information on trophic interactions. The focus of our study is to understand the trophic impacts of non-native Blue Catfish (*Ictalurus furcatus*) in upper Chesapeake Bay (CB). The Blue Catfish is a large, long-lived, moderately salt-tolerant top predator that often feeds extensively on important fishery and prey resources. To investigate trophic dynamics of Blue Catfish in upper CB, tidal fresh areas within the Nanticoke River, Patuxent River, Sassafras River and Susquehanna Flats were sampled during summer/fall 2013 and 2014 using boat electrofishing. Gut contents were initially identified using standard morphological methods. Unidentified vertebrate tissue was subsequently analyzed using genetic barcoding (sequencing of the cytochrome c oxidase 1 gene) and compared against a DNA barcode library of Chesapeake Bay fishes to determine species identity. To date, genetic barcoding has provided identifications for 21 fish species including several species of management concern (Striped Bass, American Eel, River Herring, Menhaden) and one bird. Genetic barcoding is a powerful tool for species-level identification of partially-digested gut contents that can improve the quality of data underpinning food web models and management decisions.

The Acushnet River Restoration Project: Restoring Diadromous Fish Populations to a Superfund Site in Southeastern Massachusetts

Wednesday, August 20, 2014: 11:30 AM
2105 (Centre des congrès de Québec // Québec City Convention Centre)
John Sheppard*, Diadromous Fisheries Biology & Management, Massauchsetts Division of Marine Fisheries*
Steven M. Block, Restoration Center, National Oceanic and Atmospheric Administration, Gloucester, MA
Lee Becker, Federal Programs Manager/Vice President, EA Engineering, Science, and Technology, Inc, Lincoln, NE

Dick Quinn, DQ Engineering, Walpole, MA

The Acushnet River has been the focus of a large-scale effort to restore river herring and American eel populations by improving access into the primary spawning and nursery habitat. Restoration efforts included the construction of a Denil fishway at the New Bedford Reservoir dam in 2002 and the installation of nature-like fishways at two downstream dams in 2007. Monitoring of river herring and juvenile eel (elver) populations was conducted pre- and post-construction using census counting and abundance estimation, respectively. Numbers of adult river herring returning to the reservoir during pre-construction were low and declining numbers of elvers served as a baseline to determine the effectiveness of the new fishways. Results from post-construction monitoring indicated an increasing trend of spawning adult river herring returning to the reservoir with a total count in 2013 representing an increase of 1870% over baseline conditions. Post-construction monitoring also suggests increased elver recruitment into the river, as well as increased numbers of elvers accessing habitat in the upper watershed. Monitoring results suggest that the fish passage improvements to the three dams on the river have improved passage for both elvers and river herring, thereby increasing the probability of restoring these populations to the Acushnet River.

Respect Your Elvers! Migration Monitoring for Both Conservation and Constituency-Building

Tuesday, August 19, 2014: 10:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Chris Bowser**, Earth And Atmospheric Sciences, Cornell University, Water Resource Institute, Ithaca, NY*

Diadromous fish managers face twin challenges of protecting eel populations while also educating decision-makers and the public about a fish that is often misunderstood or ignored. At twelve sites along the Hudson River Estuary, researchers and trained citizen-scientists monitor juvenile eel migration according to ASMFC protocols. Volunteers come from a wide range of demographics and backgrounds, from urban youth to college interns, and from laypersons to environmental professionals. The project employs three types of collection gear (fyke nets, “eel mops”, trap-and-pass ramps) to monitor eels along urban shorelines, tributary mouths, and below dams. Species-selective gear, adequate training, clear collection methods, and daily sampling over the migration period help ensure a robust data set of YOY eel numbers, supported by basic environmental data. Use of volunteers means built-in local support and a very low cost thanks to thousands of hours of donated time. The result is a richer picture of eel migration along the tidal Hudson, both temporally and spatially, plus significant public attention to eels through print and online media, classroom programs, and social networking. This project can be replicated in coastal areas from the Caribbean to Canada, effectively combining migration data collection with public awareness and stewardship.

American/European Eel Papers

Sexually Maturing American and European Silver Eels: Is Reproductive Capacity of Declining Eels Disrupted By Contaminants?

Wednesday, August 20, 2014: 10:50 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)

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Gersende Maugars, UMR BOREA, Biologie des ORganismes et Ecosystèmes Aquatiques, Muséum National d'Histoire Naturelle, CNRS-7208, IRD-207, UPMC, 7 rue Cuvier, CP 32, Paris, France
Sarah Bureau du Colombier, Irstea UR EPBX, Institut de recherche en sciences et technologies pour l'environnement et l'agriculture, Unité Ecosystèmes estuariens et poissons migrateurs amphihalins, 50 avenue de Verdun, Cestas, France
Fabien Pierron, UMR EPOC, Environnements et Paléoenvironnements Océaniques et Continentaux, Équipe Ecotoxicologie Aquatique, Station Marine d'Arcachon, CNRS-5805, Université de Bordeaux, Place du Docteur Bertrand Peyneau, Arcachon, France
Patrick Lambert, Irstea UR EPBX, Institut de recherche en sciences et technologies pour l'environnement et l'agriculture, Unité Ecosystèmes estuariens et poissons migrateurs amphihalins, 50 avenue de Verdun, Cestas, France
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Sylvie Dufour, UMR BOREA, Biologie des ORganismes et Ecosystèmes Aquatiques, Muséum National d'Histoire Naturelle, CNRS-7208, IRD-207, UPMC, 7 rue Cuvier, CP 32, Paris, France
Patrice Couture, Institut national de la recherche scientifique – Centre Eau Terre Environnement, 490 rue de la Couronne, G1K 9A9, Québec, Qc, Québec, QC, Canada

Several reasons may account for the decline of American (*Anguilla rostrata*) and European (*Anguilla anguilla*) eel populations. This study aims at developing a better understanding of eel reproductive biology, and to investigate the effects of contaminants on their reproductive capacity. Eels bioaccumulate contaminants during their long continental growth phase, then once they initiate their reproductive migration, fasting silver eels will exclusively rely on their energy stores and constituents for swimming and gonad development. Sexually maturing eels may therefore become particularly vulnerable to contaminant effects. We have undertaken artificial maturation of female downstream migrants from various locations in Quebec and France, and measured ovarian development together with neuro-endocrine parameters, body energy reserves, and contaminant levels. In this presentation, we examine and compare for both eel

species the relative expression of genes encoding for cerebral releasing hormones (GnRH1, GnRH2), pituitary gonadotropins (LHβ, FSHβ), ERα estradiol receptor and hepatic vitellogenin, as measured by quantitative PCR. We will discuss the role of the brain-pituitary-gonadal-hepatic axis in eel ovarian development, as well as the possible influence of contaminants on these endpoints.

The Draft Genome of the American Eel (Anguilla rostrata)

Thursday, August 21, 2014: 8:20 AM
205A (Centre des congrès de Québec // Québec City Convention Centre)
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Jérémy Gaudin, Institut de Biologie Intégrative et des Systèmes (IBIS)
Eric Normandeau, Département de Biologie, Institut de Biologie Intégrative et des Systémes (IBIS), Quebec, Canada
Louis Letourneau, Génome Québec Innovation Centre, McGill University
Sébastien Boisvert, Faculty of Medecine, Université Laval
Jacques Corbeil, Faculty of Medecine, Université Laval
Céline Audet, Océanographie, UNIVERSITÉ DU QUÉBEC À RIMOUSKI, Rimouski, QC, Canada
Louis Bernatchez, Université Laval, Québec, QC, Canada

American eel (*Anguilla rostrata*) reproduce in a single panmictic population in the Sargasso Sea in the Atlantic Ocean. After hatching, they migrate as leptocephali to a large diversity of salt, brackish, and freshwater habitats in Eastern North America. Despite panmixia, there are extreme differences in morphology, growth rate, and sex ratio by rearing habit resulting in the contradiction of a panmictic species that also seems to exhibit phenotypic attributes of locally adaptation. There is tremendous conservation concern, because some of these unique rearing groups are in steep decline. Also, due to their complex life history, it is not possible to economically produce the full life cycle in a fish farm, so every fish consumed has a wild origin. We sequenced 100X coverage with paired-end reads and in addition 2kb and two 4.5kb insert mate pair libraries including one Nextera library. The resulting assembly and scaffolding indicated a total genome size of 1.5 Gb, which is in line with estimates by more direct methods. There are 398,895 contigs, the largest of which is 72,008 bp and the contig N50 is 5,818 bp. There are 121,797 scaffolds, the largest of which is 866,215 bp and the scaffold N50 is 74,883 bp.

How Do American and European Eels Migrate to the Sargasso Sea?

Wednesday, August 20, 2014: 9:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Shiliang Shan**, Department of Oceanography, Dalhousie University, Halifax, NS, Canada*
Mélanie Beguer-Pon, Department of Biology, Université Laval, Québec, QC, Canada
Keith R. Thompson, Department of Oceanography, Dalhousie University, Halifax, NS, Canada
Martin Castonguay, Institut Maurice-Lamontagne, Pêches et Océans Canada, Mont-Joli, QC, Canada
Julian Dodson, Department of Biology, Université Laval, Québec, QC, Canada
Jinyu Sheng, Department of Oceanography, Dalhousie University, Halifax, NS, Canada

Given the paucity of observations on the spawning migration of American and European eels, a numerical modelling approach is used to explore the movement of eels from the coast to the Sargasso Sea. The positions of “virtual” eels are calculated using a newly developed particle tracking program that includes background ocean currents and various migratory behaviors. Ocean currents are simulated using a realistic model of the North Atlantic (NEMO, 1/4° resolution). The eel is tracked in a quasi three dimensional fashion to include diel vertical migration and energy expenditure calculation. Sensing the Earth’s magnetic field is parameterized in two ways: true navigation and compass orientation. Three migratory behaviors are examined: passive drift, true navigation and compass orientation. The above behaviors are ranked according to (i) the probability of arriving at a spawning area, and (ii) energy expenditure. The ranked assessments show oriented migratory behavior is needed for both American and European eels to reach the Sargasso Sea although it is argued that the energy expenditure is not a critical limiting factor. The top-ranked behaviors and associated migratory path are discussed. The particle tracking program could be a useful tool that can complement ongoing field tracking experiments.

Assessing anguillid eels for the IUCN Red List of Threatened Species - Process, Challenges and Progress

Thursday, August 21, 2014: 1:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Hyojin Ahn, Fisheries Laboratory, Kinki University, Uragami, Japan
John Casselman, Dept. of Biology, Queen's University, Kingston, ON, Canada
Vicki Crook, TRAFFIC International, Cambridge, United Kingdom
Mari-Beth DeLucia, The Nature Conservancy, New Paltz, NY
Kenzo Kaifu, Faculty of Law, Chuo University, Tokyo, Japan
Tagried Kurwie, Mahurangi Technical Institute, Warkworth, New Zealand
Pierre Sasal, CRIOBE (EPHE-CNRS)
Anders Silvergrip, ?, Stockholm, Sweden
Susanne Turnock, IUCN, ?, United Kingdom
Kazuo Uchida, National Research Institute of Aquaculture Fisheries Research Agency, ?, Japan
Alan Walker, CEFAS, Lowestoft, United Kingdom
David Jacoby, Zoological Society of London, London, United Kingdom

From 1st - 5th July 2013, a workshop was convened in London by the IUCN Anguillid Specialist Sub-Group (ASSG), where global eel experts assessed 13 of the 16 anguillid species under the IUCN Red List Categories and Criteria. Prior to the workshop only five anguillids had been globally assessed and it was widely agreed that a full assessment of these fishes was required. Following the workshop, an external review process was carried out for each species to ensure the assessments were as robust as possible. Once expert input had been collated, assessments were revised – and in some cases, the Category changed – before submission to the IUCN Red List Unit. It was clear prior to the workshop that there would be challenges in assessing the anguillids relating to their life history, available data and the policy and economics associated with these species. Key data gaps were identified as part of the process, which included (dependent on the species): range, escapement and spawning stock metrics, relative

importance of non-freshwater populations, and influence of oceanographic processes. The challenges of applying the criteria, how they were addressed, consensus building during the review process, and recommendations for conservation actions will be presented.

Eveel (Evolutionary ecology based model for Eel): A Model to Explore the Role of Phenotypic Plasticity As an Adaptive Response of Three Temperate Eels (Anguilla anguilla, A. japonica and A. rostrata) to Spatially Structured Environments

Tuesday, August 19, 2014: 3:40 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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Christian Rigaud, Irstea UR EABX, Cestas cedex, France
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Anguilla anguilla, *A. japonica* and *A. rostrata* are three largely distributed catadromous and semelparous species characterized by a long and passive oceanic larval drift between their marine spawning grounds and their nursery areas in continental waters. Their large and environmentally contrasted environment combined with population panmixia and long and passive larval drift impair the possibility of local adaptation and favour the development of phenotypic plasticity. In this context, we develop EvEel, a model that aims at exploring the role of phenotypic plasticity as an adaptive response of eels. Results suggest that the spatial patterns in terms of sex-ratio, length-at-silvering and habitat use observed at both the distribution area and the river catchment scales may actually be the result of three adaptive mechanisms to maximize individual fitness in spatially structured environment. We think that considering phenotypic plasticity as a paradigm is required to develop appropriate models for this species.

A Decision Analysis Framework for Integrated Management of American Eel

Tuesday, August 19, 2014: 1:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Mitchell Feigenbaum, American Eel Sustainability Association, Norristown, PA
***Brian Jessop** , Fisheries and Oceans Canada, Retired, Bedford Institute of Oceanography, Dartmouth, NS, Canada*

I have chosen this topic to address the organizers' interest in "the integrated inter-jurisdictional governance and effective conservation management of scattered stocks." Simply put, this document will use a flow chart, matrix or similar mechanism to identify in a logical sequence the major decision points facing managers in both the U.S. and Canada. In the framework, I will endeavor to identify the widest variety of reasonable items in the manager's toolkit. Specifically, I will outline the advantages and disadvantages of these different options in the context of range-wide stock status, individual ecosystem considerations, knowledge gaps, enforceability, socio-economic factors and legal/political feasibility.

Genomic Footprints of Adaptive Responses - Across Species and Environments

Tuesday, August 19, 2014: 1:50 PM
205A (Centre des congrès de Québec // Québec City Convention Centre)
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Anne-Laure Ferchaud, Department of Bioscience, Aarhus University
Magnus Jacobsen, Department of Bioscience, Aarhus University
Jose-Martin Pujolar, Department of Bioscience, Aarhus University

Genome-wide patterns of variation and differentiation provide information about selection and demographic features of populations and species. Using RAD sequencing we have studied two very different systems, 1) Atlantic eels (European [Anguilla anguilla] and American eel [A. rostrata]) and 2) three-spine sticklebacks (Gasterosteus aculeatus), represented by populations in temperate (Denmark) and Arctic (Greenland) environments. We analyze genome-wide divergence between the two Atlantic eel species that are assumed to have diverged a few million years ago and are both characterized by panmixia and high effective population sizes. Moreover, we analyze genomic footprints of selection within European eel sampled in different localities and environments and assess the possibility of spatially and temporally varying selection, in spite of the species being panmictic. In three-spine sticklebacks, we analyze adaptive divergence between freshwater and marine populations in temperate and Arctic settings. Arctic freshwater ecosystems are much simpler and less variable than in a temperate region like Denmark. We therefore test the hypothesis that adaptive responses in different Arctic freshwater lakes are more similar and predictable than in lakes from temperate regions. We discuss the potential for the different species and populations to invoke adaptive genetic responses to environmental change, such as ongoing climate change.

Are Leptocephali Assemblages Confined By Oceanographic Features? – Investigating Distributional Patterns Across the Subtropical Convergence Zone of the Sargasso Sea

Tuesday, August 19, 2014: 2:50 PM
2104A (Centre des congrès de Québec // Québec City Convention Centre)
***Daniel Ayala**, Oceanography and Climate, DTU Aqua - Denmark's National Institute of Aquatic Resources, Charlottenlund, Denmark*
Peter Munk, Oceanography and Climate, DTU Aqua - Denmark's National Institute of Aquatic Resources, Charlottenlund, Denmark
Lasse Riemann, Section for Marine Biology, Copenhagen University, Helsingør, Denmark

We examined species assemblages of leptocephali across part of the Subtropical Convergence Zone (STCZ) of the Sargasso Sea. Three cross-frontal transects along the STCZ were sampled in spring 2007. About 20 species from nine families were collected at 8 stations. Four species were abundant, the two catadromous eels, *Anguilla anguilla* and *A. rostrata*, as well as the shelf species *Ariosoma balearicum* and the oceanic *Nemichthys scolopaceus*. While the two Anguillids and the Congrid, *A. balearicum*, exhibited substantially elevated abundances within the confines of the STCZ's bordering frontal zones, the oceanic Nemichthid, *N. scolopaceus* showed somewhat less dichotomous cross-frontal abundances. The leptocephali-abundance patterns were inversely-mirrored in species assemblages of several

common non-leptocephali fish larvae, indicating structuring of larval fish assemblages on small geographic scales. Further studies will emphasize the physical and biological background of such structuring, as well as investigate assemblage changes across larger geographic scales.

Changes in Abundance of Anguillid Leptocephali in the Sargasso Sea

Wednesday, August 20, 2014: 9:40 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Reinhold Hanel**, Thünen Institute of Fisheries Ecology, Hamburg, Germany*
Michael J. Miller, Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan

The decrease in recruitment of European eel *Anguilla anguilla* in recent decades has led to a series of action plans, culminating in the European Council Regulation No 1100/2007 that is only targeting an increase in the number of silver eels to escape from European inland waters to the sea. Such a focus implicitely supports two hypotheses: the increase of continental mortality regarded as the major driver for the decline of the stock and also a spawner-recruitment relationship for European eel. Both hypotheses are yet unproven and do not account for recent literature pointing at the influence of atmospherically driven oceanic condition variation as a contributor to declines and fluctuations in glass eel recruitment. To test whether the relative abundance in European eel leptocephali significantly changed compared to collections in 1983 and 1985, two sampling surveys for anguillid leptocephali were conducted in 2011 and 2014 in the central Sargasso Sea. The sampling design based on Isaacs-Kidd Midwater Trawl (IKMT) catches deployed in the style of double oblique tows in the upper 300 m was chosen to directly compare to collections made in the same way in previous surveys of the spawning area in 1983 and 1985.

Interpretation of Monitoring Data - Aspects and Prospects

Tuesday, August 19, 2014: 2:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Anders Silfvergrip**, Stockholm, Sweden*

The present study estimates the decline in abundance of the American eel (*Anguilla rostrata*) using monitoring data series and contrasts these with the decline of the European eel (*Anguilla anguilla*). The declines are estimated using several different parametric and non-parametric statistics for both species. Irrespectively of the statistics used to estimate the declines, the study finds very strong declines for both species and where the European eel shows the stronger decline; as such these results reconfirm previous estimates. While the data sets demonstrate declines, there are differences in the estimates depending on the method used and which data subsets are included. These differences may be relevant as they may relate to *a priori* criteria set out by national and/or international conservation bodies. The study examines these differences and also provides estimates of the performances of the different methods using simulated data under a range of parameter settings. Finally, the study discusses the prospect for estimating future abundance levels and what is needed to identify a recovery of the species. One conclusion is that well-defined criteria for conservation actions should be agreed upon as early as possible, beforehand and not in hindsight.

Do Late-Stage Anguillid and Other Leptocephali Use Swimming to Reach Their Recruitment Habitats?

Wednesday, August 20, 2014: 10:30 AM
200A (Centre des congrès de Québec // Québec City Convention Centre)
Michael J. Miller, *Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan*

The larvae of eels have various unusual morphological features such as extreme lateral compression and transparency, and large size, but little is known about their behavior. Leptocephali are generally considered to drift with ocean currents, but various types of evidence indicates that some species must swim at critical times to successfully reach their metamorphosis and recruitment areas. Active directional swimming seems to be the only way American eel leptocephali can cross the Gulf Stream, while European eel larvae remain within the current, and the larvae of the American conger, and a subpopulation of *Ariosoma balearicum* must also cross the current after spawning in the western Sargasso Sea. Leptocephali of both anguillid species disappear from the Sargasso Sea gyre at sizes of > 60 mm, which also suggests active swimming occurs at large sizes. Similar factors are present for anguillids and congrid eels in the Pacific, and some taxa of marine eel leptocephali show greater levels of larval retention than others, which may be achieved through swimming, even at small sizes. It is unclear if there are physiological constraints on long-term swimming in leptocephali, but evidence indicates that they may use swimming at key times during their larval stage.

Caribbean, Central and South American Eel Papers

Distribution of the American Eel in the Antilles and Central and South America

Tuesday, August 19, 2014: 9:00 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
José Benchetrit, *Département de biologie, Université Laval, Quebec, QC, Canada*
James McCleave, School of Marine Sciences, University of Maine, Orono, ME
Amanda Moeser, 1 Long Wharf, Antioch University New England, Portland, ME

The American eel is facultatively catadromous and distributed in inland and coastal waters throughout eastern North America, the Antilles, Central and northern South America. Research in recent decades advanced our understanding of its biology and ecology but was concentrated in Canada and the United States – in the northern half of the geographic range. Few studies were reported to the south. Eastward and southward through the Antilles and southward from Mexico to northern South America, there is decreasing available information regarding the species' presence and abundance. Our objective was to determine historical and current distribution of the American eel in its southern range. Specimen records were compiled from primary literature, reports, museum collections, and anecdotal reports. Our findings confirm the current presence of the American eel in most areas but also highlight the difficulty in determining whether recruitment to the south is regular, occasional or absent. Recent records from Puerto

Rico, Martinique, Trinidad, Honduras, Panama, Colombia and Venezuela suggest that limited sampling efforts are partly responsible for the paucity of information. Because the American eel is panmictic, knowledge of its abundance in the south is critical to conservation efforts, particularly given the increasing evidence of glass eel fisheries developing there.

European Eel Papers

Is Restocking an Efficient Measure to Sustain Eel Populations? Three Years of Glass Eels Restocking in France

Thursday, August 21, 2014: 9:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
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Fabien Charrier, Fish Pass, Laillé, France
Virgile Mazel, Fish-Pass, Laillé, France
Jérémie Souben, Association pour le Repeuplement en Anguilles, France, Paris, France
Laurent Beaulaton, Pôle GEST'AQUA, ONEMA, Rennes, France
***Eric Feunteun** , UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France*

As part of the French Eel Management plan, extensive glass eel restocking was operated since 2010 in French rivers from the Belgium to the Spanish borders. From 34 km to 960 kgs of glass eels were restocked during 29 different operations, totalling 6900 kgs of glass eels. A total of 18 catchments were restocked including lakes, marshes, small and large rivers, according to a national methodology aiming to select most suitable habitats (reduced mortality, low density, good environmental quality). In sites without natural recruitment, glass eels were not marked. When natural recruitment occurred, between 7% and 70% of them were marked using alizarine red. Mortalilty of glass eels was analysed in aquaria and in the field in order to test effects of marking. Electrofishing surveys were then operated in each site, 6 months, 12 months and 3 years after restocking. Eels were sampled to search for marks and cohort analysis were undertaken to analyse the effects of restocking of the eel populations. Here we present the first analysis of the restocking surveys in order to assess the effect of restocking as a measure to enhance the European eel population. Methodological and management perspectives will be discussed.

An Eel`s Life: Stock Assessment and Estimation of Silver Eel Escapement in a German Eel Management Unit with Intense Stocking

Tuesday, August 19, 2014: 4:40 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Uwe Brämick**, Institute for Inland Fisheries Potsdam-Sacrow, Potsdam Sacrow, Germany*
Erik Fladung, Institute for Inland Fisheries Potsdam-Sacrow, Potsdam, Germany
Janek Simon, Institute for Inland Fisheries Potsdam-Sacrow, Potsdam, Germany

A combined methodological approach, including analyses of fishery datasets, field surveys, stocking experiments, and monitoring of local sub-stocks, was applied to estimate population parameters as recruitment, growth, and mortality rates to aid eel stock assessment in a tributary to German EMU Elbe. In the study area recruitment has been dominated strongly by stocking of 4.4 Mio. young eels as opposed to an estimated natural immigration of 33,000 elvers per year on average. Natural mortality was estimated to account for 86% of total yearly losses in the stock. With 13%, fishing (including angling) ranked highest among anthropogenic mortality causes. When parameterizing the German Eel Model by estimates obtained from our studies, the current number of annually produced silver eel was computed to reach 44,000 individuals, corresponding to 0.4 kg ha^{-1}. This compares to a silver eel escapement estimate of 19,000 specimens from a mark-recapture-study. Possible reasons for this deviation are discussed.

Organic and Metallic Pollutants Reduce the Diversity of Life-History Traits in European Eel: The End of an Evolutionary Advantage?

Wednesday, August 20, 2014: 11:10 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Thomas Trancart, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Clarisse Boulenger, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
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Elsa Amilhat, UMR 5110 CEFREM, University of Perpignan, Perpignan, France
Claude Belpaire, Research Institute for Nature and Forest, Belgium
Adrian Covaci, University of Antwerp, Wilrijk, Belgium
Paddy Gargan, Inland Fisheries Ireland, Dublin, Ireland
Javier Lobón-Cerviá, Department of Evolutionary Ecology,, National Museum of Natural Sciences, Madrid, Spain
Russell Poole, Ireland Dept Mar Res, Ireland
Håkan Wickström, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden

Alan Walker, CEFAS, Lowestoft, United Kingdom
David RIghton, CEFAS, Lowestoft, United Kingdom

During EELIAD project, we examined effects of contamination by metals, POPs (including PCB) and introduced parasites on life history traits of 450 silver eels sampled across Europe. Our results showed a positive relationship between age and latitude, while size & weight at silvering were correlated to catchment characteristics. Growth rate was linked to catchment productivity, habitat preferences and migratory patterns experienced during the growth stage. Fat content was highly variable between individuals but no geographical pattern was depicted. This suggests that eels adjust their life history to an incredible range of environmental conditions to ensure breeding success. This confers an undeniable evolutionary advantage to European eels that were able to survive to a number of major environmental crisis since at least 30 MY. Contamination is likely to trick this advantage: metallic and parasite loads were negatively correlated to age and size at silvering. PCBs were present in every single eel at high concentrations in some catchments, and a negative low but significant correlation was found with GSI and fat content. These results strongly suggest that the winning breeding strategy of eels has recently been impacted, fattest, largest and oldest, ie the most potentially successful eels, been more impacted than others…

Long Term Cooperation Between Freshwater Traditional Commercial Fishermen and Researchers about Silver European Eel Knowledge and Management : The Best Way for Best Results on Eel Populations of the Loire River France

Wednesday, August 20, 2014: 2:10 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Catherine Boisneau Sr., IPAPE, UMR CITERES, University of Tours, Tours, France
Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Eric Feunteun, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France

The professional fishery of Loire River has always existed as archaeological remains revealed. This creates a huge diversity of fishing practices, gears and knowledge on river functioning and fish ecology. In the thirties, 15 fisheries imported anchored stownet techniques from the Netherlands in order to focus on silver eel captures. During the eighties, these fishermen decided to become partners for management and research on silver eel populations. They provided long term series on yields and daily CPUE of silver eel captures which now constitutes one of the most robust data set on silver eels in a large river system of Europe. These data were used in a number of fundamental studies. A cooperative study with scientists and the French Electricity Board (EDF) enabled to provide a migration predictive model used to mitigate the effects of turbine mortality. Collaboration on the EELIAD project enabled to provide eels for a set of satellite tagging experiments. A collaboration with the French Muséum and the University of Tours, as part of INDICANG project, enabled to produce a unique monitoring of silver eel production by the Loire River. This long term cooperation is now threatened because of a lack of political support.

Looking for Protein Expression Signatures in European Eel Peripheral Blood Mononuclear Cells after in Vivo Exposure to Perfluorooctane Sulfonate and a Real World Field Study

Wednesday, August 20, 2014: 10:50 AM

2104B (Centre des congrès de Québec // Québec City Convention Centre)

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Claude Belpaire, Research Institute for Nature and Forest, Belgium

Marc Dieu, Unit of Research in Cellular Biology, University of Namur, Namur, Belgium

Martine Raes, Unit of Research in Cellular Biology, University of Namur, Namur, Belgium

Frédéric Silvestre, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium

The decline of European eel population can be attributed to many factors such as pollution by xenobiotics. Perfluorooctane sulfonate (PFOS) is a compound of a particular concern in Europe. This study aimed at evaluating the toxicological effects of PFOS in eel peripheral blood mononuclear cells (PBMC) at the protein expression level. To identify proteins whose expression was modified by PFOS, we performed a proteomic analysis on the post-nuclear fraction of PBMC after a chronic exposure of yellow eels to 0, 1 or 10 µg/L PFOS. This *in vivo* study was completed by a proteomic field study on eels sampled in Belgian rivers presenting different PFOS pollution degrees. On the 28 spots that were significantly affected by PFOS in the *in vivo* experiment, a total of 17 different proteins were identified. In the field experiment, 18 significantly affected spots conducted to the identification of 16 different proteins. Interestingly, three proteins were found in common between these experiments. Comparing the results with a previous study, plastin-2 and alpha-enolase were also been found to be affected after *in vitro* exposure of PBMC. Potential use of these proteins as biomarkers of PFOS exposure in eel could indicate early warning signals.

Management of European Eel Spawner Escapement in an Irish River Used for Hydroelectricity Generation

Thursday, August 21, 2014: 11:50 AM

207 (Centre des congrès de Québec // Québec City Convention Centre)

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Jonathon Grennan, Ryan Institute and School of Natural Sciences, National University of Ireland, Galway, Galway, Ireland

Dariusz Nowak, Ryan Institute and School of Natural Sciences, National University of Ireland, Galway, Galway, Ireland

Ruairi MacNamara, Center for Fisheries, Aquaculture & Aquatic Sciences, Southern Illinois University, Carbondale, IL
Anne Bateman, Ryan Institute and School of Natural Sciences, National University of Ireland, Galway, Galway, Ireland
Colin Lawton, Ryan Institute and Scool of Natural Sciences, National University of Ireland, Galway, Galway, Ireland
Dennis Doherty, Fisheries Conservation, ESB Electricity Ireland, Ardnacrusha Co Clare, Ireland

The Irish Eel Management Plan (EMP) contributes to recovery of the European eel spawning stock by conservation measures that include closure of commercial fisheries and mitigation of hydropower impacts. The conservation strategy for the hydropower-regulated River Shannon (mean annual discharge 186m^3s^{-1}) is largely focused on silver eel trap and transport (T & T). Annual monitoring of this conservation action provides information on silver eel population structure and dynamics. Together with mark-recapture estimation of population size and acoustic telemetry, these data contribute to long-term studies on: silver eel production rates, downstream route selection, turbine passage mortality and estimation of spawner escapement biomass. In the 2009–2012 migration seasons, mean annual silver eel production was 65.2 t and mean escapement was 58.1 t (89% of production). The proportion of non-captured silver eels migrating via the hydropower dam varied (56.8–98.9%). Regulating weir spillage, which facilitated migration via the safe river by-pass, and variation in river discharge affected route selection by eels. Hydropower dam mortality varied annually from 5.5–9.1 t. EMP –specified targets for T & T (30% of spawner production) were exceeded in each season. The contributions of fishery closure, T & T and spillage, to improved spawner escapement were evaluated.

The Role of Mediterranean Lagoons in the European Eel (Anguilla anguilla) Stock Recovery Process

Wednesday, August 20, 2014: 8:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Fabrizio Capoccioni, CRA-PCM (CRA PCM), Roma, Italy
Marcello Schiavina, Elettronica e Informazione, Politecnico di Milano, Milano, Italy
Juan Terràdez, Bioscience, Università degli Studi di Parma, Parma, Italy
Chiara Leone, Biologia, Università di Roma "Tor Vergata", Roma, Italy
Eleonora Ciccotti, Biologia, Università di Roma "Tor Vergata", Roma, Italy

We performed a comprehensive stock assessment of the European eel in Mediterranean coastal (MC) lagoons (so far a missing gap in European eel stock assessment) and estimated pristine and current escapement. Through an extensive review of both peer-reviewed and grey literature spanning the period 1950-2012, we collected yield, climatic, geographical and other environmental and fishery data for 82 MC lagoons corresponding to roughly 80% of the overall lagoon area in the Mediterranean. Our analysis showed that eel catch declined by over 80% over the entire distributional range, while total catch across all fisheries including species other than eel also declined but less sharply. We used linear mixed-effect

models to determine that variability in productivity per hectare was partially explained by latitude, longitude, lagoon area, and salinity type in addition to the temporal trend. Using an age-structured model to simulate eel population dynamics, we estimated that current escapement is <3,000 metric tons per year, corresponding to only 10% of the estimated escapement under pristine conditions. Our analysis showed that the MC lagoons contribute a small but significant fraction of total spawning stock, and effective restoration of the Mediterranean sub-population will substantially contribute to the recovery of the overall *Anguilla* population.

Acute Loss of European Silver Eel Fitness By Introduced (vs native) Parasitic Helminths Threatening Spawning Success

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)

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Elsa Amilhat, Centre de Formation et de Recherche sur les Environnements Méditerranéens, Université de Perpignan Via Domitia, Perpignan, France
Elisabeth Faliex, Centre de Formation et de Recherche sur les Environnements Méditerranéens, Université de Perpignan Via Domitia, Perpignan, France
Laure Virag, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Eric Feunteun, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France

Helminth parasites were studied in 149 silver eels from five sites in northern Europe. In total, 88% were infected by 12 species including Monogena, Cestoda, Nematoda, and Acanthocephala. *Anguillicoloides crassus* was most common (56%), then *Acanthocephalus clavula* (30%) and *Pseudodactylogyrus* spp. (17%). The body condition (BC) was negatively influenced by the abundance of the introduced *Pseudodactylogyrus* spp. but not by the other parasite taxa. However, the introduced *A. crassus* was considered as a severe pathogen based on previous data, whereas the native *A. clavula* was supposed to have limited impact. Eels from Stockholm Archipelago (Sweden) were the less parasitized (30% vs ≥ 90% for other sites) with no parasites in gills. Burrishoole (Ireland) differed by absence of *A. crassus* and high prevalence of *A. clavula* (84%) but without consequences on BC. Gudenaa (Denmark), Corrib (Ireland) and Frémur (France) were close due to high prevalence of *A. crassus* (≥ 89%). Gudenaa and Corrib were the most similar because *Pseudodactylogyrus* spp. was also highly prevalent (≥ 60%) whereas absent in Frémur. Our results suggest that introduced parasites may threaten the spawning success of migrant silver eels from Gudenaa, Corrib and Frémur, but not of those from Stockholm Archipelago and Burrishoole.

Is Restocking an Efficient Measure to Sustain the Freshwater Eel Populations? Results of a 6 Years Experimental Study in a Natural Freshwater Marsh in Southern Europe

Thursday, August 21, 2014: 9:00 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Olivier Gimenez, UMR 5175, Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Montpeliier, France
Isabelle Lebel, Association Migrateur-Rhône-Méditerranée, Arles, France
Marine Pascal, Association les Amis du Vigueirat, Mas Thibert, France
Eric Feunteun, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Alain J. Crivelli, Station Biologique de la Tour du Valat, Arles, France

Even though restocking is one of the principal measures proposed to sustain the freshwater eel populations, few studies attempted to demonstrate its efficiency. Here we considered that restocking is useful when stocked eels yield more silver eels than natural migrants and with at least equal reproductive potential. To test this, a restocking experiment was conducted since 2007 in the freshwater marsh "Vigueirat" in south east of France. Individually marked elvers and yellow eels from different habitats (freshwater, brackhish) were stocked between October 2007 and February 2008. Furthermore since 2008, every January, a significant number of glass eels were added in the marsh. The yield per recruit (number of silver eel per recruits) was estimated for each cohort using a Capture Mark Recapture model (estimates of survival and life stage transitions with E-surge). To evaluate the quality of silver eels produced, we considered pathogen (*Anguillicoloides crassus),* fat level and the concentration of contaminants (PCBS and heavy metal). Quantity and quality of spawners were then compared between the different stocked cohorts and the natural cohort to assess the efficiency of the stocking experiment and determine the most suitable stocked cohort.

In 35 Years of Monitoring, Lipid Levels of Eels (*Anguilla anguilla*) Have Not Declined, Nor Can Negative Effects of PCBs on Eels be Demonstrated

Wednesday, August 20, 2014: 11:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Michiel Kotterman**, Fish, IMARES Wageningen UR, IJmuiden, Netherlands*
Stefan Van Leeuwen, Food Safety, RIKILT Wageningen UR, Wageningen, Netherlands
Stijn Bierman, Fishery, IMARES Wageningen UR, IJmuiden, Netherlands

In this presentation we show that shifts in eel sexe-ratio can have large effects on both the observed bioaccumulation of POPs and on the lipid content. Without accounting for eel ecology, bioaccumulation levels can be misinterpreted both environmentally (comparing pollution levels between locations and

years) and in alleged eco-toxicological effects of PCBs. In the long term monitoring programme of IMARES, 25 yellow eels with lengths between 30 and 40 cm are used for composite samples, in which PCBs, sum-TEQ, OCPs and lipid content were analysed. In 2011, an additional 25 yellow eels of 30-40 cm length and 25 yellow eels of lengths above 40 cm were captured at two locations; these were analysed individually. Sexe ratio between these locations were different. Male eels contained more lipids than females at similar lengths, but at higher lengths females reached the same lipid contents (up to 30%). POP levels were positively correlated with lipid content in all eels. The observed decrease in lipid content in the composite sample over the years in some locations could be correlated to decreasing numbers of males. Neither lipid contents in yellow or silver eel, nor the sex ratio were influenced by PCB or sum-TEQ levels.

German Eel Model (GEM III) -a Size and Age-Structured Model for Describing the Dynamics of Male and Female Eel Stock, Anguilla Anguilla (L.), in the River Elbe System

Thursday, August 21, 2014: 10:50 AM
2105 (Centre des congrès de Québec // Québec City Convention Centre)
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The eel, *Anguilla anguilla* (L.), stock of the river Elbe severely decreased during the last decades. Detailed knowledge of the stock dynamics in freshwater and especially of the impact and mortality factors is necessary to take effective measures for stock conservation and improvement. The dynamics of the male and female eel stock are modelled based on immigration, stocking, natural mortality and mortalities caused by fishing, angling, cormorants and hydropower plants. In addition, the effect of “catch & carry” in barrier-free water bodies is taken into account. The model estimates the number and biomass of emigrating eel. Moreover, it enables to study the sensitivity of the estimates related to the uncertainty of the source data of the different influencing factors. The model may be used to develop management strategies and to assess the efficiency of different management options.

Migration Dynamic of Silver Eel in the Rhine River: Importance of Eel Origin and Release Locations

Thursday, August 21, 2014: 9:40 AM
2105 (Centre des congrès de Québec // Québec City Convention Centre)
***Eric De Oliveira**, LNHE, EDF R&D, Chatou, France*
Stephane Tétard, LNHE, EDF R&D, CHATOU, France

The European eel population has been declining since the 1980s. Hydro stations have been identified by the European Council as one of the causes of the stock decline. The aim of this study is to analyse the migration dynamic of the silver eel according to environmental parameters and to estimate the migration routes distribution on a river with hydro stations. The monitored river is the French part of the Rhine River, 100 km long and equipped with 10 hydropower plants. Upstream, Rhine River is divided in 2 parallel

sections, one with 4 hydropower plants and one without any obstacle. Eels are monitored with the NEDAP trail system, based on RFID technology, well adapted to large rivers. Downstream the confluence, an antenna compares the migration dynamics in the 2 sections. At the most upstream hydro station, every migration routes are covered (i.e. power house, locks, dam). Environmental parameters, such as temperature, turbidity and conductivity are measured at 4 positions. From 2010 to 2013, around 400 eels, caught in the Rhine River and 2 tributaries, have been monitored. We analyze the migration dynamics according to environmental parameters, origins of eels and locations of release points

Orientation and Navigation of the European Eel Using the Earth's Magnetic Field and Its Possible Implications for Management

Wednesday, August 20, 2014: 8:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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Howard Browman, Marine Ecosystem Acoustics, Institute of Marine Research, Storebø, Norway
Hans Stockhausen, Fisheries Dynamics, Institute of Marine Research
Anne Berit Skiftesvik, Marine Ecosystem Acoustics, Institute of Marine Research, Storebø, Norway
John Phillips, Virginia Polytechnic Institute and State University
L. Asbjørn Vøllestad, Centre for Ecologial and Evolutionary Synthesis, Department of Biology, University of Oslo, Oslo, Norway

Little is known about the orientation cues used by eels to guide their short- and long-distance migrations. The Earth's magnetic field can provide directional and positional information to an individual that possesses magnetosensitivity. Magnetosensitivity has earlier been reported in salmon and tuna, and was recently demonstrated in yellow and silver eels. Eels oriented in a manner that was related to ambient temperature and to a transitory displacement immediately before the test. Their ability to position themselves relative to the Earth's magnetic field can be used for orientation along a river axis (to learn the direction of the main flow) and in the open sea (to maintain a compass heading). Eels may derive positional (map) information from the Earth's magnetic field and use it to navigate to distant spawning grounds. This would involve imprinting the location of the spawning grounds by larvae. We discuss this possibility with regards to secular variation and the physical properties of the geomagnetic field over the course of their hypothetical migratory route. Understanding the eel's orientation and navigation mechanisms is crucial to evaluating the potential effectiveness of current management measures which typically involve translocating juvenile eels 100s to 1000s of km.

Contrasted Demographic Parameters (growth and survival) of Eel Populations in Two Small Coastal Rivers of Western France: The Role of Habitat and Management Implications

Wednesday, August 20, 2014: 2:10 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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Julien Tremblay, INRA U3E, Rennes, France
Fabien Charrier, Fish Pass Bureau Expert Gestion Piscicole, Laillé, France
Eric Feunteun, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France

Despite intensive research on eels, their population dynamics in continental waters remain poorly documented which creates serious gaps in planning the restoration of the European eel population. We selected two European sub-populations of western France, at same latitude and separated by 67 km that vary substantially in degree of human development. The Oir is a river characterized by a high water quality and connected habitats, whereas the river continuum of the Fremur is impeded by many dams and characterized by poor water quality. Over a 6-year period (2008-2013), we completed a comprehensive population assessment, including abundance estimates and mark-recapture studies (1753 PIT-tagged fish) of growth and survival. Different population dynamics patterns were observed with a total abundance twice higher in the Fremur R. than in the Oir R. (respectively 0.22 and 0.09 eel. m^{-2}) despite a significant drop through the years in both rivers. While estimated annual growth rates were equivalent (approximately 20 mm/year), survival rates appear to have different trends with an inter-annual variation in the Fremur contrary to the Oir where survival rates were stable. Determining whether these differences are natural inter-annual fluctuations or whether they are caused by anthropic changes must be a priority for conservation.

Assessment of Eel Production in England and Wales in Light of the EU Recovery Plan

Tuesday, August 19, 2014: 5:00 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)

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Miran Aprahamian, Environment Agency, Warrington, United Kingdom
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Anna Harlow, Environment Agency, Shrewsbury, United Kingdom
Darryl Clifton-Dey, Environment Agency, Reading, United Kingdom

The European Eel Recovery Plan and ICES international stock assessment requires EU Member States to estimate their present-day silver eel escapement biomass and the potential in the absence of human impacts, their “best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock”, and the lifetime mortality rate due to all anthropogenic impacts on eel in their waters. Here, we describe the development and application of a methodology to derive these stock indicators for the 11 River Basin Districts (RBD) of England and Wales. Without silver eel data, the method is based on yellow eel surveys conducted by the Environment Agency and its predecessors, and produces estimates for ‘today’ and before the recruitment crash in the early 1980s. Yellow eel biomass from the freshwater compartment in ‘eel index’ rivers is extrapolated to potential silver eel production using an individual-based life history model. Silver eel production per wetted hectare is applied to the RBD and losses due to fishing, abstractions, hydropower, barriers and pumping stations are subtracted to estimate silver eel escapement. This paper concludes with a discussion of the assumptions in this method and how these might be addressed in the future.

Potential Effects of Habitat Use and Geographical Location on the Fecundity of European Eel

Wednesday, August 20, 2014: 9:00 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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T. Kieran McCarthy, National University of Ireland Galway
Håkan Wickström, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden
Patrik Clevestam, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden

Declining recruitment of European eel (*Anguilla anguilla*) has focused attention on the conservation of potential spawners (silver eels) leaving continental waters. However, stock recovery is complex, as *A. anguilla* display considerable variation in biological characteristics across habitat types and range. In this regard, knowledge of silver eel fecundity is incomplete, with few estimates available from wild *A. anguilla*. Furthermore, there has been no systematic investigation of the effects habitat use and geographical location have on silver eel fecundity. To assess the former, we estimated the fecundity of silver eels which had predominantly been resident in either freshwater (Lake Mälaren, Sweden) or brackish (Baltic Sea) habitats. Despite Lake Mälaren silver eels generally being larger, there was no difference in the fecundity-body size relationship between these habitats. Secondly, we determined if fecundity differed geographically between Baltic region (Lake Mälaren and Baltic Sea), eastern Mediterranean (Vistonis Lake, Greece) and north-west European (River Shannon, Ireland) sub-populations. No latitudinal trend was apparent, but Baltic region and eastern Mediterranean silver eels were more fecund than those from north-west Europe. Consequently, though many factors affecting eel reproductive potential differ between freshwater and brackish residents, integration of fecundity in spawner stock management should primarily reflect geographic origin.

Science for Glass Eel Fisheries Management: How to Define TAC in France?

Tuesday, August 19, 2014: 9:00 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Agnès Bardonnet, Aquapôle quartier Ibarron, Pôle GEST'AQUA, INRA, St Pée sur Nivelle, France

To tackle the low level of European eel stock, the European Union Council has adopted in 2007 a regulation for establishing measures for the recovery of the stock of European eel. In application of this regulation France established an eel management plan that includes, among others, measures to decrease glass eel fisheries mortality by 60% in 2015. It has been decided to set up a total allowable catch system to achieve this mortality target.

A scientific experts panel has been constituted to estimate TAC given the management target and the expected recruitment level. We describe methods used (i) to estimate mean exploitation rate during reference period using catch and recruitment series and (ii) to predict future recruitment level. A Bayesian model has been designed to cope with the variability in past exploitation rate due to environmental and economic conditions and with the uncertainty in recruitment prediction, particularly the possibility of alternative future (unchanged decreasing trend or regime shift and possibly increasing trend). The TAC really adopted and the actual recruitment and exploitation rate level are compared to the prediction made. We finally discuss the role of scientists, managers and fishers and the importance of exchanges between them in this management process.

Stock abundance and estimation of European eel stocks in Estonian waters

Tuesday, August 19, 2014: 4:20 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Markus Vetemaa, Estonian Marine Institute, Tartu University, Tartu, Estonia
Maidu Silm, Centre for Limnology, Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia

European eel (*Anguilla anguilla*) stock has been in decline for decades and the fixtures for eel catches in the Baltic Sea show a steady diminishing rate. European Union has stated that serious measures have to be implemented concerning the decline of the eel stock (Council Regulation No 1100/2007). Furthermore this regulation requires all member states to elaborate local eel management plans (EMPs). These EMPs must include an overview of the status of both stocked and natural eel stock. While stocked populations of eel in Estonia have been studied in detail the natural populations which inhabit the coastal waters are far less examined. Most of the data available comes from professional and recreational fishermen catches with only a small fragment being collected scientifically. This study gives an overview of the degression of eel stocks in Estonian waters relying on professional and recreational fisheries data.

Reservoirs and Dams Impact the Migration Success of Silver Eels. A Telemetry Approach on the Frémur River, France

Tuesday, August 19, 2014: 2:10 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
Marc Besson, UMR 7208 BOREA, Service des Stations Marines, Muséum National d'Histoire Naturelle, Dinard, France
Thomas Trancart, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Virgile Mazel, Fish-Pass, Laillé, France

***Eric Feunteun**, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France*

River management is known to have severely fragmented river continuity. The steep decline of temperate eels is caused by a set of factors including dams that reduce accessibility to growth habitats and induce turbine mortality. We studied effects of dams and reservoir on downstream migration behaviour of silver European eels. We used an acoustic telemetry design on the Frémur catchment, France, comprising 5 hydrophones set along the river from upstream the reservoir to downstream two major dams used for freshwater facilities. Despite exceptionally favourable environmental conditions, only one third of these silver eels managed to move downstream the river. Migration speed was much lower in the Reservoir than in non-obstructed rivers (0.097km.day-1 vs. 1.91km.day-1). The main dam (14m high) was the major obstacle to downstream migration: eels were only able to pass over the crest when the reservoir was full. Four different downstream migration behaviours occurred. They were not related to biological traits, suggesting an individual flexibility of silver eels. This study provides useful information to manage eel populations in such water basins that are very likely to be applied to all reservoirs and dams, which are widespread through the distribution range of European eels.

Inter-Annual Trend in Recent Years (2001-2012) of Population Size and Reproductive Potential of Silver-Phase European Eels in the Loire River

Tuesday, August 19, 2014: 1:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)

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The Loire River is one of the largest rivers in Western Europe. Its privileged situation with regard to the Gulf Stream leads to high levels of recruitment by glass eels and probably to among the highest level of silver eel biomass in Europe. However, no study attempted to estimate both number and reproductive potential of silver eels produced by the Loire R. In collaboration with professional fishermen, number of silver eels migrating from upstream part of the Loire watershed was estimated for six downstream migration seasons (2001-2004, 2008 and 2012) by a mark-recapture technique. Calculations conducted with pooled data (Petersen estimate) revealed a drop in silver eel numbers between the periods 2001-2003 (approximately 330 000 fish) and 2004-2008 (150 000 fish), whereas estimation for the last year is still in progress. The exploitation rate by the commercial fishermen observed during the period was on average 14.3 ± SD 4.3 %. To evaluate the quality of silver eels, we considered pathogens (*A. crassus*), fat level and the concentration of chemical contaminants (PCBS and heavy metals). Finally, the contribution to the spawning stock of the Loire silver eels that are mainly represented by females (> 98%) of 1 kg is discussed.

Yellow Eel Stock Assessment Oriented By the Colonisation Process to Evaluate Impacts of Obstacles

Wednesday, August 20, 2014: 2:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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Assessing the yellow eel stock in a river catchment is required to quantify the impact of anthropogenic pressures and to prioritize management actions. EDA model (Eel Density Analysis), coupling a GIS approach and a statistical eel distribution model, was used as the standard tool during for French national Eel Management Plan implementation. We propose an alternative model named TABASCO for "spaTialised Anguilla Basin colonization assessment model" to overcome some of the limitations of EDA, especially regarding the modelling of weirs impacts. TABASCO is halfway between strictly statistical approaches and mechanistic models. Two versions of the model were developed in parallel. The first one is based on the spreading of a Gaussian distribution through a graph to model a diffusive process. The second implements a more mechanistic and more rigorous vision of the diffusion, simulated with a transition matrix. Both approaches are tested on the Garonne-Dordogne Basin (South west of France). Comparison of simulations with or without obstacles highlights the relative impact of migration barriers in that area.

Monitoring of Sexual Maturation in Silver Eels Using Ultrasonography

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Understanding and control of eel maturation has strong interest for scientific and commercial purposes. To progress in this area, possible improvement of sex determination and maturation monitoring using ultrasonography was investigated in silver eels (*Anguilla anguilla*). Ninety six fish were scanned for sex determination using portable ultrasound equipment. Part of them was then subjected to artificial induction of maturation for monitoring of gonad growth at the individual level, and estimation of ovary mass and then gonadosomatic index (GSI) in females. A linear model based on estimations of gonad length and cross-sectional areas at different times of maturation was defined and used for calculation of ovary mass. Ultrasonography resulted in 100 % success in sex determination and good estimation of ovary mass

(97% correlation with true values). Ultrasonography made possible the detection of early inter-individual differences in maturation in female silver eels, and has great potential for use in eel both for conservation and aquaculture.

An Experimental Test of the Impact of the Thermic Shock Encountred during the Diel Vertical Migrations of Silver Eels Anguilla Anguilla during Oceanic Spawning Migration

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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European eels (*Anguilla anguilla*) undertake a ~5000-km spawning migration from Europe to the Sargasso Sea (Tesch 1977). As details of this marine migration remain unknown, the EELIAD project was built to access the oceanic biology, ecology and movements of eels. This project showed that the eels travelled up to 50 km per day and exhibited a consistent diel vertical migration (DVM), ascending to warmer shallower waters at dusk and descending into deep, colder water at dawn, from ~200–900m and 14–8°C every day (Aarestrup 2009). To date, the causes of these DVMs remain unknown. Aarestrup et al. (2009) hypothesized that the observed DVMs reflects thermoregulation: “The daily ascent into shallower warm water may serve to maintain sufficiently high metabolism and swimming activity, whereas descent to deeper waters may permit the eels to keep their average temperature below 11°C, delaying gonadal development until reaching the Sargasso Sea”. To corroborate this assumption, we need to know the impact of the abrupt changes in temperature linked to these DVMs on the eel respiratory metabolism. A strong effect of the DVMs on this metabolism would lead to conclude at a strong hidden gain for the eels.

Glass Eel Recruitment Dynamics in a Southern Europe Estuary (Oria, Spain), 2003-2012

Tuesday, August 19, 2014: 9:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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The spatio-temporal migration patterns of European glass eel were studied in a long-standing tradition glass eel fishery estuary, the Oria. Catch logbooks were collected during nine fishing seasons (2003-2012) and fishery-independent experimental surveys were carried out at two sampling points during the

fishing season from 2005 to 2012. Environmental local variables potentially related to glass eel recruitment were recorded during the whole study period. Glass eel used the tidal front to move. At the river mouth, migration started in the deep layers coinciding with the salinity increase. Upstream, as the water was mixed, glass eel were distributed along the whole water column and migration started with current rise. Although a high daily variability was found in glass eel abundance, the general trends showed different behavior along the fishing season in the sampling points: a significant density decrease in the river mouth and an increase upstream. Statistical analysis of the relationship between environmental variables and glass eel density variability is being carried out.

Long Term Stocking Efficiency of European Eel in Estonian lakes

Thursday, August 21, 2014: 9:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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The construction of the Ivangorod HPS in the early 1950s blocked totally the natural upstream migration of young eel from the Baltic Sea to the Narva River basin. Due to the rather permanent introduction of glass eels or farmed eels into L. Võrtsjärv (since 1956) and four small lakes (since 2003), it has become one of the most important commercial fish in this lakes. The stocking rate with glass eels in L. Võrtsjärv has been relatively low: annual average in 1956-2001 was about 35 ind.ha^{-1}yr^{-1}. The peak of stocking with glass eels occurred in the early 1980s (84 ind.ha^{-1}yr^{-1}). As a result the mean catch of eel constituting 2.5 kg ha^{-1} yr^{-1}. The maximum catch of this fish in L. Võrtsjärv was recorded in 1988 (104 t or 3.7 kg ha^{-1}). According to reported catch data the recapture for glass eel was 3-6% and for farmed eel 10-15%. The natural status of eel stock before the construction of HPS was not very abundant (annual catch 1,8 tons L. Võrtsjärv and 3-6 tons L. Peipsi). According to tagging and recapture results HPS is not obstacle for downstream migration.

Testing Three Methods to Reinforce Eel Population in a Southern European River (Oria, Spain), 2011-2013

Wednesday, August 20, 2014: 2:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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The presence of obstacles restricts the eel distribution to the lower part of the Oria river (NE Spain). Thus, three different ways of moving eels upstream within the same basin were tested to encourage the entire eel habitat colonization in the river. Firstly, in June 2011, the migration of 5.1 kgs of elvers from a trap

located in the tidal limit to a tributary upstream was assisted. Secondly, in January 2012, 3.2 kg of wild glass eel fished in the estuary were transported directly to the upper part of the Oria´s main course. Finally, 1.7 kg of glass eels cultured for 45 days were released in an upper tributary in March 2012. All the release points had good water and habitat quality and released eels will be able to migrate downstream during flooding in autumn once they mature. Electrofishing surveys have been made at the beginning of the first summer after the release and then, yearly in September. The recapture rate has remained constant in the elvers from the trap, and has decreased with the other two methods. All the released eels were able to grow, although grow rate and condition factor of cultured glass eels were the lowest.

Managing Conflicts Between Eel Fishery and Conservation in a Protected Area: The Case of Santo André Lagoon (SW Europe)

Thursday, August 21, 2014: 2:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Isabel Domingos**, Centre of Oceanography, Lisbon, Portugal*
Vera Lopes, Centre of Oceanography, Lisbon, Portugal
José Lino Costa, Centre of Oceanography, Lisbon, Portugal

Over the last decades the eel fishery in Santo André Lagoon experienced a dramatic decline due to the implementation of stricter rules, namely integration of the lagoon in a protected area, creation of an area of professional fishing and more recently, the establishment of a Closed Season (October to December). Because professional fishermen can fish eels for a very short period in this protected area, a conflict between fishermen and managers started. This study was conducted during the fishing season 2011/2012 and it engaged several stakeholders namely the fisher organization, fisheries resource managers, protected area managers and academics. Questionnaires on the fishing activity and management measures in force were made to around 60% of fishermen (n=20) and logbooks distributed to 10% of fishermen who volunteered to cooperate (n=5). The results of this work identified the needs of fishermen that did not conflict with the purpose of conservation: the limits of the area of professional fishing; changes in the fishing hours and fishing season and the number of fyke nets permitted. The research demonstrated the benefits of extending the participatory management process, once some changes to management measures proposed by fishermen were introduced in the edict of the following fishing seasons.

Escapement Rate and Population Size of Silver European Eel in Ichkeul Lake (Northern Tunisia)

Tuesday, August 19, 2014: 2:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Pierre Elie, Association "Santé Poissons sauvages", Bouches-du-Rhône, France

The stock of European eel has faced a dramatic decline over the three last decades. Thus, this species is currently considered endangered (CITES, 2007; IUCN, 2010). It seems necessary to quantify the escape rate of silver eels to assess the stock status of these future broodstocks in its distribution area.

Unlike some European countries, little information is available on the downstream migrating fractions in the south part of its distribution area, especially North Africa. We propose here to provide preliminary information regarding Tunisian eel population. A mark-recapture experiment was conducted in Ichkeul Lake (Tunisia) during the migration season 2013/2014. The size range of the downstream migrating eels is between 33 and 79 cm with 585g mean weight, and composed by 97% females. The size of the population considered was estimated to 404858 silver eels, corresponding to a mean biomass of 2367 Tons, with a density of 28 kg/ha. The commercial fishing rate is estimated to 17%, which allows estimating an escapement rate of 83%. This rate represents the double of the European Commission recommended level, which corresponds to 40% of the pristine biomass. This first estimation shows thereby the good operational management of the eel stock in this Lake.

A Long Way Down – Escapement Success of European Silver Eels from a German River System

Thursday, August 21, 2014: 11:10 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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Rainer Oeberst, Thünen Institute of Baltic Sea Fisheries, Rostock, Germany
Reinhold Hanel, Thünen Institute of Fisheries Ecology, Hamburg, Germany

The direct monitoring of silver eel escapement from rivers is challenging and managing authorities are therefore usually reliant on estimates and model outputs. In order to validate the reliability of escapement numbers that were used for the German Eel Management Plan (EMP) we assessed the total silver eel downstream migration in a German drainage system (Schwentine River) during a three-year monitoring. The observed numbers were compared to estimated escapement values from the EMP of the respective river basin district and to the output of the widely used German Eel Model II (GEM II). In addition, we analyzed potential environmental triggers for the onset of downstream migration and assessed the benefit of fish protecting devices for the passage and survival of eels at a hydropower station. Results indicate that the annual silver eel escapement from the Schwentine River is far below estimated values that underlie the EMP of the respective river basin district. This highlights the need for a careful consideration of indirect estimations which include multiple assumptions and uncertainties. In contrast, GEM II predictions were close to monitored escapement numbers, indicating the potential of the model to accurately calculate silver eel escapement when system-specific input data are carefully assessed.

Baltic Eel Recruitment and Escapement; Quantitative Estimates from Survey Data

Tuesday, August 19, 2014: 4:00 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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***Håkan Wickström**, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden*

Two scientific surveys where eel is a by-catch - the Baltic International Trawl Survey and herring larvae monitoring in Kattegat – allows estimates of time series of silver eel abundance in the Baltic from 1992 and glass eel abundance in the Sound from 1981. With the assumption that the integrated number of juvenile eels and silver eels represent an accumulation of eels migrating into and out from the Baltic respectively the total natural recruitment of new eels and the escapement of migrating eels can be estimated. The result shows a varying recruitment, declining from more than 600 to less than 100 million eels/year. This is large compared to the stocking in the Baltic area. The proportion of stocked to naturally recruited eels is approximately 10%. The escapement shows no significant trend after 1992 and averages 3 million silver eels/year. Without anthropogenic mortality the escapement predicted from the recruitment estimate, applying a 12 year age at silvering, should have been approximately 10 times higher. This analysis is based on several uncertain assumptions. The main advantage is that the data are fishery independent and give quantitative estimates not available in other ways.

Restocking Eel - an Appraisal of the Effects on Fish, Stock and Fishery

Thursday, August 21, 2014: 8:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Willem Dekker, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden

Restocking of young eel (*Anguilla anguilla* (L.)) - translocated within countries or imported from abroad - has been applied to enhance the stock and fishery since the mid 1800s. The ongoing decline of the stock to critical levels has drastically changed the context, recently. The European recovery plan (known as the EU Eel Regulation) emphasized the importance and use of restocking as a stock enhancement measure. Past research focused on technical issues (transport, packaging and holding), on effectiveness of restocking (survival, growth), and on production maximisation (density, frequency, recipient habitats). Following the adoption of the Eel Regulation, the contribution of restocked eels to the spawning stock has been questioned, and research now focuses on the condition of silver eels and their ability to migrate successfully to the spawning place. Our review of restocking and related research covers aspects of biological effectiveness and stock dynamics, both from a regional and a population-wide standpoint. Does restocking contribute to the local stock, to the spawning population, and what net benefit is obtained by relocation? Our aim with this review is to provide a thorough basis for the heavily politicised discussions on restocking issues.

Québec 2003 – Québec 2014: A Decade of Science on and Management of European Eel

Monday, August 18, 2014: 3:40 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Willem Dekker, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Drottningholm, Sweden

The 2003 symposium in Québec issued the “Québec declaration of concern”[1] on *Anguilla* species, marking the onset of a period of political decisions. Returning to Quebec in 2014, we review a decade of protective actions on European eel. In 2007, the European eel has been listed by CITES (Appendix II) and at the same time, the European Union adopted a Regulation “establishing measures for the recovery of the [eel] stock”. This ‘Eel Regulation’ sets objectives in terms of silver eel escapement. Much work has been done to assess/model silver eel escapement at basin level and to compare these models. Additional work is in progress to develop eel-specific biological reference points. This includes assessment at the population level of recruitment, spawner biomass and the relationship between them. The first reporting by EU Member States in 2012 enabled post-evaluation of management measures, for which a unique post-evaluation framework has been developed. The interaction between science and management is discussed, and suggestions for further developments are given.

[1] Dekker W., Casselman J.M., Cairns D.K., Tsukamoto K., Jellyman D., Lickers H. & many others 2003. Québec Declaration of Concern: worldwide decline of eel resources necessitates immediate action. Fisheries 28: 28–30.

What Factors Explain the Yellow Eel Density in Coastal Waters?

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Beside habitat criteria the colonization of yellow eels (*A. anguilla*) in coastal waters might be also influenced by density driven mechanism. To obtain a better understanding of factors influencing the settlement of eels in coastal waters the density and the size distribution of yellow eels were analyzed along a 180 km transect in southern German Baltic Sea. The fished section ranges from open coastal waters till the estuary of the Odra River providing various habitats for eels during their continental life phase. Using a standardized enclosure fishing system 117 sampling points were fished between 2008 and 2012. Significant higher yellow eel densities were detected in the most exposed area compared to the other stations. Along the fished transect decreasing eel densities were observed with the lowest values in the estuary of the Odra River. Further, the fished station differed regarding the length distribution of the yellow eels. By including habitat related data we aim to identify the main factors responsible for the observed variation of the eel density and length distribution.

Estimation of the Resident European Eel Stock in the Lesse River, Sub-Basin of the Belgian River Meuse, and Evaluation of the Physiological and Immunological State of Fish Using Non Invasive Methods

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Patrick Kestemont, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium

Since the beginning of the 1980s, scientists have observed a huge decline of the European eel population. The species is now considered outside safe biological limits for population survival. In response to its precarious state, the European Commission has taken protection measures in order to restore the eel stock. In order to provide effective management plans, knowledge of the status of stocks present in watersheds is necessary. As the information is missing in Wallonia, the main objective of this European project is to estimate the resident stock of eels in the Lesse river. The stock is estimated by the method of capture-recapture sampling and densities are calculated according to the Petersen method. The eels captured are individually tagged with passive integrated transponders. Morphometric measurements (total length, weight, length of pectoral fins and eye diameters) allowed us to determine the stages of eels (according to Durif et al., 2003). Blood samplings are also made on each fish in order to evaluate the physiological and immunological state of the stock. For that, thyroid, growth and gonadotropic hormones are measured as well as immunological parameters (lysozyme, immunoglobulins and complement). Results will give us some indications on the health state of eels.

Climbing Back up What Slippery Slope? the Dynamics of the European Eel Stock and Its Management in Historical Perspective

Monday, August 18, 2014: 2:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Few fish stocks are as influenced by (intentional and inadvertent) human impacts as the European eel, all across the continent. The dynamics of our stock, however, are poorly understood - neither the causes of the historically low abundance, nor minimal protection levels are beyond discussion. Rather than analyzing contemporary processes, this paper turns back in time - two centuries - unraveling time series and distribution patterns; reviewing historical actions and objectives; and discussing technical developments and scientific advice. Picturing the slippery slope the eel stock has come down, we evaluate hypotheses on the causes of stock decline and discuss the adequacy of protective actions (type and magnitude). The first claim, that the continental stock was in decline, dates from the early 1800s; stock-enhancement actions were initiated shortly after. Diffuse objectives, technical innovations, eternal

optimism and - above all - no quantification impede the evaluation of historical reports. After 1950, when quantification improved, a slow but consistent decline was observed. But it is only two decades after the crash in recruitment from the ocean (in 1980), that protection plans addressed the bad status of the stock. A slippery field, full of pitfalls - and yet, we now observe the first recovery?

Faire Mieux Que La Nature – the History of Eel Restocking in Europe

Thursday, August 21, 2014: 8:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Young eels, recruiting from the ocean towards Europe, are most abundant along the Atlantic coast of France. Since 1840, attempts have been made to redistribute them from their areas of highest abundance to other areas/countries and further inland. This 'restocking' has been troubled by technical constraints (mode of transport, maximum distance covered alive), by wars (Franco-Prussian war, World War I and II), and in recent decades by shortage of supply due to the general decline of the eel stock all across Europe. Though objectives and procedures changed considerably over the decades, the recurring aim has been to improve production, and in that way: to do better than nature. We review the historical development and contrast the achievements to the objectives. Except for the period 1952-1990 in Eastern Europe, restocking has probably added a relative small quantity to the natural production. As successful as restocking might have been for some areas, it has not markedly changed the overall trends and distribution patterns or halted the decline of the stock and fisheries. Poor post-evaluation, frequent technical innovations, and a constant renewal of the countries and people involved, have kept the promise for a better future alive for 175 years.

Long Term Evolution of Silver European Eel Indicator of Abundance in the Loire Watershed (France) (1987-2013), a Unique Data Set for Europe

Tuesday, August 19, 2014: 1:30 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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The Loire River is one of the largest rivers in Western Europe and the less impacted by big dams. A stownet silver eel fishery exists since the thirties and this fishery started cooperation with scientists, in the eighties, in order to contribute to research and to participate to eel management programs. These fisheries provided long term series on yields and daily CPUE of silver eel captures which now constitutes one of the most robust data set on silver eels in a large river system of Europe. These data were used to produce a silver eel abundance index. Calculations were conducted with pooled data of four representative fisheries, during 26 years combining daily efforts and catches from October to February.

The analysis reveals a strong quality of the data and large interannual variations. Although yields and efforts are decreasing since the beginning of the period (1987), the trend of the index is stable till 2010. The very recent drop of this index is discussed because this situation of the Loire basin is inconsistent with the situation in Europe and the decrease of the other eel stages in the river Loire.

Status and Trends in European Eel (*Anguilla anguilla* L.) Stocks and Mismatches with Recruitment

Tuesday, August 19, 2014: 3:40 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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European eel stock and silver eel escapement fishery-independent and CPUE data, comprising 39 time series and 16 intermittent datasets from NW Europe, are analysed and compared to published recruitment time series data. Inter-annual and inter-site variabilities are high and geographical differences exist but analyses indicate that stock and escapement overall have fallen relatively steadily by about 40-50% since 1960. No clear relationship is however shown with recruitment, which rose to a peak around 1980 and then fell by >90% until recent years. Historical data suggest that whilst recruitment has fluctuated widely, stocks have tended to be more stable over the long term, indicating that the European eel does not exhibit standard stock-recruit relationships. Possible reasons are discussed, including sampling factors, depensation, effects of ocean-climate change on larval survival and density-dependent survival, migrations, growth and sex determination (leading to relative increases in numbers of females and hence fecundity). The latter factors may represent adaptive strategies that help maintain stability of continental populations. Implications for monitoring, modelling and management are discussed.

Current Status of Protection of Silver Eels at Hydro Power Stations in Germany

Thursday, August 21, 2014: 11:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
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According to the *Council Regulation of 18 September 2007 establishing measures for recovery of the stock of European eel*, the Member States must significantly improve both upstream directed migration of juvenile eels as well as protection and downstream migration of Silver Eels at hydropower plants. Since then, various measures have been implemented in some rivers and hydro installations: mechanical fish protection systems with a flow rate up to 70 m^3/s, special bypass systems, trap and truck as well as eel friendly turbine management with early warning systems on large hydropower plants and modified turbine runners. The contribution discusses the different methods and shows the overall survival rates that can be achieved in individual river systems.

Gerem (Glass-Eel Recruitment Estimation Model) : A Model to Estimate Glass-Eel Recruitment at Different Nested Spatial Scales

Tuesday, August 19, 2014: 8:40 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
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Laurent Beaulaton, Pôle GEST'AQUA, ONEMA, Rennes, France

Despite the importance of reliable recruitment estimates to assess eel stocks and enforce appropriate management measures, few analytical tools have been developed to estimate yearly glass-eel recruitments. Among existing models, large-scale models generally rely on strong assumptions regarding fishing activity while other models generally estimates recruitment at the river catchment scale. In this context, we develop GEREM model that aims at estimating glass-eel recruitment at different nested spatial scales. More specifically the model estimates yearly recruitments at the river catchment level and at the eel management units scale, which are two relevant spatial scales for management, and at the distribution area scale, which is consistent with the stock biological scale. The model has been applied to France and Europe on data-series lasting from 1970 to 2012 and provides trends that are consistent with current knowledge, and absolute recruitment estimates that are consistent with expert knowledge on exploitation rates.

The Effect of Stocking Eel in Selected Marine and Freshwater Habitats of Denmark

Thursday, August 21, 2014: 10:30 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Michael Ingemann Pedersen**, DTU Aqua, Section for Freshwater Fisheries Ecology, Danish Technical University, Silkeborg, Denmark*

The effect of eel stock enhancement was studied in a semi closed brackish fjord and in the upper parts of River Gudenå. At both locations the seed stock used was glass eels imported from France on-grown in heated culture to a size of 3 and 9 gram. Prior to release the stocked eels were tagged with coded wire tags. In collaboration with fishermen on the fjord catches were examined in the years from 2000 -2006 and a total of 1834 tagged eel were recaptured. The stocked eel did well with growth rates in the range of 3 - 7 cm annual, sex ratios on yellow eel were ca. 1/3 mails and 2/3 females. Survival of the stocked cohort was estimated to be 18 %. In River Gudenå post stock monitoring was done using a Wolf trap catching migrating silver eels. The first silver eel arrived in the trap in 2007 seven years after stocking. Until year 2013 a total of 339 silver eels have been trapped of which 50 % were females. So far less than 1 % of the stocked cohorts have emigrated from River Gudenå suggesting marine areas are more cost-effective to stock.

Selectivity of Water Dams on Glass Eel : Transcriptomics Approach

Thursday, August 21, 2014: 9:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Tomasz Podgorniak**, Gironde, Irstea Bordeaux, Cestas Gazinet, France*

Physical obstacles to upstream migration such as dams are a major impairment of natural colonization and dispersion of eels. Dams and obstacles also increase the energy demand of fish, even if there is a fish friendly device to allow them to swim across the obstacle. Besides, local accumulation of eels below dams may increase the mortality associated with predation. Obstacle to eel migration may select on different trait of life history. While quantitative impact of dams is subjected to numerous studies, little is known about their intra-specific selectivity. Even the fishway efficiency analyses are scarcely hinting at their potential selective effect (Castro-Santos 2004; Noonan, Grant & Jackson 2012). The main issue of this study is to pinpoint phenotypic traits that predisposed glass eels to dams successful passage. The approach we adopted is individual-centred and without any a priori hypothesis on traits involved by the putative dams selective pressure. We analyzed the expression of 15000 known eel genetic sequences based on previous studies (Coppe et al. 2010; Pujolar et al. 2012). Transcriptome analysis of three main tissues (brain, liver and muscle) from individuals sampled on three successive forebays separated by dams indicate different gene expression profiles in brain between the two upstream forebays. The functional role of the overall set of regulated genes strongly suggests cytosqueletal and neural changes as well as synaptic plasticity. Their interpretation at higher phenotypic level and further research perspectives are discussed.

A Great Past, but What Future? – A Social-Ecological Analysis of Swedish Coastal Small-Scale Fishery on Eel

Wednesday, August 20, 2014: 1:50 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Emma Björkvik**, Department of Aquatic Resources, Swedish University of Agricultural Sciences, SLU, Stockholm, Sweden*

The small-scale fishery for eel on the Swedish east coast stands on the brink of extinction. In this presentation, I focus on the social-ecological perspective: how did the current situation arise and what keeps it going. During the 1960s, fishers invested in new fishing gear, expecting a return on investments within years. But in the same period, eel abundance started to decline, frustrating their expectations. The conjunction of increased investments with lower returns led to bankruptcy among the fishers. The present situation, in which the remaining fishers are trapped, is a result of the development in the 1960s. Sustainable management of the eel stock and fishery can only be achieved, if long-term interactions between eel dynamics and fishers socio-economic position are taken into consideration.

Migration Dynamic of Silver Eel in the Rhine River: Importance of Eel Origin and Release Locations

Thursday, August 21, 2014: 9:40 AM
2105 (Centre des congrès de Québec // Québec City Convention Centre)
***Eric De Oliveira**, LNHE, EDF R&D, Chatou, France*
Stephane Tétard, LNHE, EDF R&D, CHATOU, France

The European eel population has been declining since the 1980s. Hydro stations have been identified by the European Council as one of the causes of the stock decline. The aim of this study is to analyse the migration dynamic of the silver eel according to environmental parameters and to estimate the migration routes distribution on a river with hydro stations. The monitored river is the French part of the Rhine River, 100 km long and equipped with 10 hydropower plants. Upstream, Rhine River is divided in 2 parallel sections, one with 4 hydropower plants and one without any obstacle. Eels are monitored with the NEDAP trail system, based on RFID technology, well adapted to large rivers. Downstream the confluence, an antenna compares the migration dynamics in the 2 sections. At the most upstream hydro station, every migration routes are covered (i.e. power house, locks, dam). Environmental parameters, such as temperature, turbidity and conductivity are measured at 4 positions. From 2010 to 2013, around 400 eels, caught in the Rhine River and 2 tributaries, have been monitored. We analyze the migration dynamics according to environmental parameters, origins of eels and locations of release points

Estimation of the Resident European Eel Stock in the Lesse River, Sub-Basin of the Belgian River Meuse, and Evaluation of the Physiological and Immunological State of Fish Using Non Invasive Methods

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
***Kathleen Roland**, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium*
Patrick Kestemont, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium

Since the beginning of the 1980s, scientists have observed a huge decline of the European eel population. The species is now considered outside safe biological limits for population survival. In response to its precarious state, the European Commission has taken protection measures in order to restore the eel stock. In order to provide effective management plans, knowledge of the status of stocks present in watersheds is necessary. As the information is missing in Wallonia, the main objective of this European project is to estimate the resident stock of eels in the Lesse river. The stock is estimated by the method of capture-recapture sampling and densities are calculated according to the Petersen method. The eels captured are individually tagged with passive integrated transponders. Morphometric measurements (total length, weight, length of pectoral fins and eye diameters) allowed us to determine the stages of eels (according to Durif et al., 2003). Blood samplings are also made on each fish in order to evaluate the physiological and immunological state of the stock. For that, thyroid, growth and

gonadotropic hormones are measured as well as immunological parameters (lysozyme, immunoglobulins and complement). Results will give us some indications on the health state of eels.

Looking for Protein Expression Signatures in European Eel Peripheral Blood Mononuclear Cells after in Vivo Exposure to Perfluorooctane Sulfonate and a Real World Field Study

Wednesday, August 20, 2014: 10:50 AM
2104B (Centre des congrès de Québec // Québec City Convention Centre)
***Kathleen Roland**, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium*
Patrick Kestemont, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium
Robert Loos, Instit ute for Environment and Sustainability, European Commission - Joint Research Centre, Ispra, Italy
Simona Tavazzi, Institute for Environment and Sustainability, European Commission - Joint Research Centre, Ispra, Italy
Bruno Paracchini, Institute for Environment and Sustainability, European Commission - Joint Research Centre, Ispra, Italy
Claude Belpaire, Research Institute for Nature and Forest, Belgium
Marc Dieu, Unit of Research in Cellular Biology, University of Namur, Namur, Belgium
Martine Raes, Unit of Research in Cellular Biology, University of Namur, Namur, Belgium
Frédéric Silvestre, Unit of Research in Environmental and Evolutionary Biology, University of Namur, Namur, Belgium

The decline of European eel population can be attributed to many factors such as pollution by xenobiotics. Perfluorooctane sulfonate (PFOS) is a compound of a particular concern in Europe. This study aimed at evaluating the toxicological effects of PFOS in eel peripheral blood mononuclear cells (PBMC) at the protein expression level. To identify proteins whose expression was modified by PFOS, we performed a proteomic analysis on the post-nuclear fraction of PBMC after a chronic exposure of yellow eels to 0, 1 or 10 µg/L PFOS. This *in vivo* study was completed by a proteomic field study on eels sampled in Belgian rivers presenting different PFOS pollution degrees. On the 28 spots that were significantly affected by PFOS in the *in vivo* experiment, a total of 17 different proteins were identified. In the field experiment, 18 significantly affected spots conducted to the identification of 16 different proteins. Interestingly, three proteins were found in common between these experiments. Comparing the results with a previous study, plastin-2 and alpha-enolase were also been found to be affected after *in vitro* exposure of PBMC. Potential use of these proteins as biomarkers of PFOS exposure in eel could indicate early warning signals.

Installation of a Pilot Plant with Mechanical Barrier for Fish Protection

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
***Uli Dumont**, Floecksmuehle Consultants, Aachen, Germany*

According to the European Water Framework Directive, all hydropower plants in Germany have to be modified within a certain period so that they do not cause damage to the fish populations in the waters in the future. The necessary technical solutions such as fish protection systems and fish-friendly turbines

are not yet available and are currently being developed. Therefore, the Government of the State of North Rhine-Westphalia has built a pilot plant with a 10 mm bar screen and various bypass systems for salmon, eel and potamodromous fish species. The plant has a design flow of 28 m^3/s. The screens are equipped with three different bar profiles as well as special cleaning systems. Furthermore, extensive facilities for monitoring downstream migrating fish have been installed. A biological and technical monitoring will be performed to examine the use of the system to other locations.

Pacific Eel Species Papers

Primary Biological Parameters for Conservation of Tropical Eels in the South Pacific Ocean

Tuesday, August 19, 2014: 2:50 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Shun Watanabe**, College of Bioresource Sciences, Nihon University, Fujisawa-shi, Japan*
Mari Kuroki, The University of Tokyo
Michael J. Miller, Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan
Jun Aoyama, Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan
Tim Pickering, Secretariat of the Pacific Community
Pierre Sasal, CRIOBE (EPHE-CNRS)
Katsumi Tsukamoto, College of Bioresource Sciences, Nihon University, Fujisawa, Japan

Freshwater eel populations worldwide are under threat of serious declines, so understanding their biological parameters is essential. Evaluations of the population structures of tropical anguillids (*Anguilla marmorata*, *A. megastoma*, *A. obscura,* and *A. reinhardtii*) in the western South Pacific Ocean using total number of vertebrae indicate there are likely different types of population structures among the species that are distributed across a wide area from eastern Australia to French Polynesia and north to Micronesia. *Anguilla marmorata* is the most widely distributed species and likely has several spawning populations. *Anguilla megastoma* may have eastern and western populations in the western South Pacific, with *A. obscura* and *A. reinhardtii* apparently having less regional divergences. Research on the silver eel migrations and early life history characteristics of leptocephali and glass eels of each species or population will help to understand their reproductive ecology and recruitment mechanisms. Information about the specific biological characteristics of the anguillid eel populations in each area of the region are important to provide a scientific basis to guide conservation and management efforts for these species that are mostly only distributed on islands and this information will also increase understanding of the speciation and evolution of anguillid eels.

Aquaculture Production of Glass Eels As a Possible Conservation Measure for Freshwater Eels

Monday, August 18, 2014: 4:20 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Katsumi Tsukamoto**, College of Bioresource Sciences, Nihon University, Fujisawa, Japan*

Japan consumes 70% of the freshwater eels eaten worldwide, but is also striving to conserve the Japanese eel in East Asia. Artificial production of Japanese eels is one unique effort now being intensively conducted. If trials succeed in mass production of glass eels, the human impact on wild glass eels can be reduced to help its future population recovery. The first larvae were obtained from artificially matured adults in 1973, and the first glass eels were produced artificially in 2003. Second generation eels were produced in 2010 and the resultant juveniles are now being reared for further breeding to produce domestic strains. At present, one experimental hatchery in Japan can produce about 1000 glass eels per year, possibly 2000 at most, which cost tens of dollars each to produce. Although recent nitrogen isotopic ratio analyses indicate that food for wild eel leptocephali in the ocean is abundant mid-water marine snow, the problem in the aquaculture process is the semi-liquid slurry-type diet for larvae that mainly includes *Squalus acanthias* shark egg yolk, which pollutes rearing tanks. Intensive research is developing a new type of larval diet to minimize tank pollution for achieving high-density culture and mass production of glass eels.

Effects of NEC Transport and Bifurcation Latitude on Japanese Eel Larval Migration

Wednesday, August 20, 2014: 11:10 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Chen-Tien Hsu**, School of Marine Sciences, University of Maine, Orono, ME*
Huijie Xue, School of Marine Sciences, University of Maine, Orono, ME
Fei Chai, School of Marine Sciences, University of Maine, Orono, ME

Numerical lagrangian experiments were conducted to study the effects of current strength and position on Japanese eel larval migration in the western North Pacific. Particles were released from the grid points that cover Japanese eel spawning area and from different depths during the spawning seasons of 19 years (1991-2009) and the percentages of particles that reach the coastal areas of Taiwan and Japan were calculated at the end of one-year simulation. The percentages of particles that reach Japan are related to, but lower than, those that reach Taiwan. More Particles reach Taiwan when the transport of the North Equatorial Current (NEC) is stronger and when NEC bifurcates at more southern latitudes, because the particles are able to travel through NEC and to enter the Kuroshio more quickly. When the NEC transport is strong, high percentages of particles that reach Taiwan come from the northern part of the spawning area, while when the transport is weak, they come more evenly from the entire spawning area. Since the NEC transport and bifurcation latitude are controlled by wind forcing in the tropical western Pacific, the interannual and decadal variability of successful Japanese eel larval migration are thus related to the climate variability.

Progress Report on the Artificial Glass Eel Production in Korea for the Last Ten Years

Wednesday, August 20, 2014: 11:50 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Sungchul C. Bai**, Department of Marine Bio-materials and Aquaculture, Pukyong National University, Busan, South Korea*
Erfan Shahkar, Dept. of Marine Bio-materials and Aquaculture, Pukyong National University, Busan, South Korea
Hyenho Yun, Dept. of Marine Bio-materials and Aquaculture, Pukyong National University, Busan, South Korea

This review will summarize a decade of aquaculture and allied stream research conducted to develop the artificial production of glass eel, *Anguilla japonica* in the Rep. of Korea. After a series of efforts, Korea got the breakthrough to produce two individual glass eel 2nd time in October, 2012 after Japan in 1973 in the world. Other Korean scientists found that by rearing the Eel for a period of 3 months, maturation and vitellogenesis process can be shortened as well as the efficiency of salmon pituitary extract (SPE) injection could be significantly improved. In their another study, it was demonstrated that artificial maturation could be successful only during May (spring) to January (winter) when female brood stock eel (400-600g) were subjected to intramuscular injection of SPE (20 mg/fish) by weekly. Among other phenomenal Eel research, the final maturation in female eel was found to be induced through intraperitoneal administration of Freund's incomplete adjuvant containing SPE (20 mg pituitary powder/fish) using water-in-oil (W/O) type emulsion. Likewise, several other phenomenal research conducted by Korean scientists to produce the artificial glass eel including the nutritional research on broodstock will be reviewed and discussed.

Characteristics of a Stocked Eel Population in a New Zealand Hydro Reservoir

Thursday, August 21, 2014: 8:20 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Jacques Boubée**, National Institute of Water and Atmospheric Research, Hamilton, New Zealand*
Erica Williams National Institute of Water and Atmospheric Research, Wellington, New Zealand
Ken Oliveira, Department of Biology, University of Massachusetts Dartmouth, North Dartmouth, MA

Juvenile eels have been transferred annually into the seven hydro-electric reservoirs upstream of Karapiro Dam on the Waikato River, New Zealand, since the summer of 1993-94. The total numbers of elvers transferred as well as the commercial harvest of eels (>220 g) from each of the developed hydro-reservoir fisheries has been monitored. Records appear to indicate that the transferred juveniles have a limited survival rate. To elucidate the issue, an intensive survey and tagging study of the sub-adult eel population in one of the hydro-reservoirs, Lake Arapuni has been ongoing since 2011. The results to date show that only 5% of the transferred elvers develop to a harvestable size. Growth rates are extremely variable and have declined significantly over time. Males now dominate the populations in the reservoir and may be out-migrating before reaching a harvestable size. This is in contrast to the surrounding tributaries where large females dominate the population.

Impact of El Nino 1997/1998 on the Successful Recruitment and Recovery of the Tropical Glass Eels (Anguilla spp) in the Poigar River Estuary, North Sulawesi Island, Indonesia

Wednesday, August 20, 2014: 11:30 AM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Hagi Yulia Sugeha**, Research Center for Oceanography, Indonesian Institute of Sciences, Jakarta, Indonesia*
Michael J. Miller, Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan
Zainal Arifin, Research Center for Oceanography, Indonesian Institute of Sciences, Jakarta, Indonesia

Impact of El Nino 1997/1998 was recorded during recruitment of the tropical glass eels (*Anguilla* spp*)* in the Poigar River estuary, North Sulawesi Island, Indonesia. The glass eels recruited in the estuary with peak in 1997 and drastically decreased in 1998 before gradually increased from 1999 to 2002. Three species of the tropical glass eels were identified to enter the estuary. Two species of the Pacific tropical eels (*Anguilla marmorata* and *A. bicolor pacifica*) and one species of the Indonesian native tropical eel (*A. celebesensis*). In 1997, *A. celebesensis* was the most dominant species (73.6%) and followed by *A. marmorata* (25.2%) and *A. bicolor pacifica* (1.3%), respectively. However, species dominancy was replaced by *A. marmorata* from 1998 to 2002 with small increasing of *A. bicolor pacifica* from 1997 to 2002. Since the EL NINO phenomenon in 1997/1998 was reported to resulting higher SST in the Pacific Ocean, it was triggering a great oceanic migration escapement of the Pacific tropical eel leptocephali from unconvinient environment into their recruitment area in the tropical estuaries. The decreasing of the Indonesian native tropical eel, *A. celebesensis,* into the estuary after a great recruitment in 1997 were reflecting a long impact of EL NINO phenomenon on the successful recruitment and recovery of the tropical anguillid eels in the region.

Opportunities for Indigenous Mâori Knowledge to Contribute to Information on Anguilla Australis (New Zealand Shortfin) and Anguilla Dieffenbachii (New Zealand Longfin) and the Management of the New Zealand Eel Fishery

Tuesday, August 19, 2014: 2:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Doug Jones**, Te Wai Maori Trust and Te Ohu Kaimoana (NZ), Wellington, New Zealand*
Dr Mick Kearney, Te Whare Wananga o Awanuiarangi Indigenous University, Auckland, New Zealand

Mâori are concerned that data collection programmes used to assess New Zealand's native freshwater eel fishery exclude indigenous knowledge, monitoring and customary practices of local tribes and sub-tribes. There is an opportunity for Mâori to contribute to the management of the shortfin and longfin fishery. In 2013, an international review panel assessed information available on the status of the New Zealand eel population. The panel agreed that longfin has been substantially reduced relative to its pristine numbers; however populations have been relatively stable in recent years with examples of increases in standardised catch rates. The panel also recommended improvements on current monitoring methods such as data collection at a finer scale and more information on spawner escapement.

The ability of Mâori to monitor at a finer spatial scale and provide information on spawner escapement during traditional harvest highlighted how indigenous knowledge can complement the management tools and structures currently being utilised. Customary harvest results for one catchment during spawner escapement had an estimated catch of 3 to 4 tonnes over 7 days. Other iwi projects showed an increase in Longfin elver recruitment; population surveys varied with some areas showing close to 50:50 species ratio over a 2 year time series.

Upstream and Downstream Passage of Eels in New Zealand, 20 Years on – Lessons Learned

Wednesday, August 20, 2014: 1:30 PM
207 (Centre des congrès de Québec // Québec City Convention Centre)
***Jacques Boubée**, National Institute of Water and Atmospheric Research, Hamilton, New Zealand*
Erica Williams, National Institute of Water and Atmospheric Research, Wellington, New Zealand

Since about 1993 there has been increasing efforts made in New Zealand to provide upstream passage for shortfin (*Anguilla australis*) and longfin eels (*A. dieffenbachii*) at hydro-electric dams scattered around the country. Most sites now operate some form of upstream passage mitigation activity with fourteen sites currently providing annual records. The numbers of elvers using these upstream transfer facilities peaked at over 10 million nationwide during the 2012-13 migration season, with numbers varying markedly between seasons and sites. Species composition has also varied markedly between seasons and sites. Because of the variation observed in the age of elvers arriving at each sites, nationwide trends in recruitment and the underlying causes for the variation observed have been difficult to discern. What is clear however is that the mitigation activities have re-established eel populations upstream of these barriers, and in some cases have created new fisheries. There is now a concentrated effort at some locations to provide downstream passage for the adults. The success of the solutions installed to date has been variable, and more research is required to determine their effectiveness.

Eel Fishery and Stock Management and Conservation in China: Past, Present and Future

Thursday, August 21, 2014: 2:10 PM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Shuozeng Dou**, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China*

The Japanese eel *Anguilla japonica* has been exploited commercially or in aquaculture for several decades in East Asia. As elsewhere in its distribution, the eel population in Chinese waters has been in rapid decline in recent years, due to overfishing on both the glass eels as well as the freshwater resident eels, and as a consequence of habitat destruction caused by human activities, all of which reduce the recruitment to the eel population. Meanwhile, eel aquaculture is still high-profit, so the demand for wild glass eels is increasing year on year, further decimating the wild eel population. This creates a dilemma for eel stock management: profit from eel aquaculture *vs*. sustainable wild eel stocks? Based on the information on eel population and fisheries from literature and public statistical data, this paper tentatively outlines the history and current status of the eel fishery, aquaculture, stock management and

conservation in China. The anthropogenic impacts likely causing or contributing to the decline of the eel stock are also investigated. Furthermore, protective measures to monitor, conserve and restore the eel stocks are proposed, hopefully providing knowledge for better understanding of the eel population dynamics and stock conservation in East Asia.

The Japanese Eel Does Not Climb Back up

Tuesday, August 19, 2014: 10:50 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Wann-Nian Tzeng**, Department of Environmental Biology & Fisheries Science, National Taiwan Ocean University, Taipei, Taiwan*

Taiwan is the first station of Japanese eel *Anguilla japonica* recruitment to the eastern Asian countries, which provides the advantage in monitoring the recruitment level of the eel. The long-term catch data of the glass eel from Taiwan in relation to the number of sunspot during the period from 1972-2014 were used to monitor the population status of Japanese eel by trend analysis, autocorrelation and cross-correlation. Results indicated that the recruitment of glass eel exponentially decreased [Catch = a *exp(b*Year), b = -0.03, R^2 = 0.12 and p = 0.014], with a 11-year cyclic change (p = 0.0204). The maximal number of sunspot is well-known to occur every 11.2 year. The glass eel catch was found positively cross-correlated with the number of sunspot at alag of -1, 0 and 1 year, respectively (p = 0.0268, 0.006 and 0.01). The peak catches of glass eel corresponding to the maximal sunspot decreased from 40 tons in 1979, through 31.3 tons (1990), 18.3 tons (2001), and to 6.7 tons in 2014. The decrease in peak catch implies that the Japanese eel population is still in the status of slippery slope.

Did a “Perfect Storm” of Oceanic Changes and Continental Anthropogenic Impacts Cause Northern Hemisphere Anguillid Recruitment Reductions?

Tuesday, August 19, 2014: 8:20 AM
206B (Centre des congrès de Québec // Québec City Convention Centre)
***Michael J. Miller,** Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan*
Eric Feunteun, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Katsumi Tsukamoto, College of Bioresource Sciences, Nihon University, Fujisawa, Japan

Attention has focused on two primary possible causes of the declines of anguillid eels in the Northern Hemisphere that include anthropogenic impacts on eels in their growth habitats, such as overfishing, dams, filling wetlands, revetment/channelization of rivers, pollution, and introduction of parasites. The cumulative effects of dams/river alterations and reaching a peak in industrial pollution must have greatly affected eel production in many areas, and contamination by metallic and organic compounds may have contributed to shifts in eel life history traits. Secondly, various ocean-atmospheric changes might reduce feeding success of larvae or disrupt adult spawning or larval transport. Recent research indicates that leptocephali feed on marine snow particles, so if regime shifts such as NAO reduce the production of marine snow, it may affect larval survival. This could be important if the critical time-window is larval first-feeding that requires a specific size range of marine snow particles, because this could result in density-dependent early larval survival for each spawning event. Reduction of spawners from species-range

margins that might spawn outside of peak periods could reduce recruitment further. The possibility that both types of impacts, oceanic and anthropogenic, impacted eel populations simultaneously is discussed along with issues related to population recovery.

Posters

Using Generalized Depletion Model to Access the Elver Fishery in a River of Northeastern Taiwan

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
Yu-Jia Lin, Marine Studies Section, Research Insititute, King Fahd University of Petroleum and Minerals, Saudi Arabia, Dhahran, Saudi Arabia
WN Tzeng, *National Taiwan Ocean University, Taiwan*

We applied generalized depletion model to assess a small-scale elver fishery of the Japanese eel, *Anguilla japonica*, in a river of northeastern Taiwan during the fishing season from 19 Dec, 1980 to 21 Feb, 1981 with complete effort and catch data. Results showed that approximately 160,000 individuals of elvers recruited to the river during this season. We identified seven recruitment waves with population sizes ranging from 781 to 66,185 individuals were identified. The overall exploitation rate was 1.63 % with a range from 0.2 % to 60 %, which reflected low fishing pressure of this river, averagely 2 fishermen per day. The effort response parameter was 1.26, indicating the effort synergy that every additional fish hour yielded a disproportionate increase in catch. The population response parameter was 0.76, suggesting that the elver population exhibited hyperstability that catch per unit effort changed with less magnitude than that of fishing effort. The natural mortality was high, 0.12 per day, which may mix with the emigration rate. Applying generalized depletion model can extract more information about the population and fishery from the historical catch and effort data and therefore lead to better understanding of the elver recruitment trend.

Restoration of American Eels to the Susquehanna River Watershed and Implications for Eastern Elliptio Populations

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
Steve Minkkinen*, Maryland Fishery Resources Office, U.S. Fish and Wildlife Service, Annapolis, MD*
Ian Park, Maryland Fishery Resources Office, U.S. Fish and Wildlife Service, Annapolis, MD
Julie Devers, USFWS, Annapolis, MD

The catadromous American eel occupies a unique niche in estuarine and freshwater habitats along the Atlantic coast. The panmictic population has experienced a range-wide population decline during recent decades. While the Chesapeake Bay watershed supports a large portion of the coastal eel population, a

large percentage of the watershed is inaccessible due to mainstem dams on the Susquehanna River. Future hydropower re-licensing of these dams may consider eel passage. We began developing eel collection techniques 2005. In 2008 we began stocking eels upstream of dams to evaluate the reintroduction of eels. Over 590,000 eels have been stocked to date. Laboratory studies conducted by the USGS, Leetown Science Center indicate that eels are the dominant host for the common freshwater mussel, eastern elliptio (*Elliptio complanata*) in the Susquehanna River. Relative to the adjacent undammed Delaware River where eels are numerous, abundance and recruitment of eastern elliptio in the Susquehanna River is low. Therefore, we believe low abundance and lack of recruitment of eastern elliptio is related to the lack of eels in the Susquehanna River watershed. We are evaluating the effect of eel stocking on recruitment of eastern elliptio and fish species composition in two tributaries to the Susquehanna River.

An Experimental Test of the Impact of the Thermic Shock Encountred during the Diel Vertical Migrations of Silver Eels Anguilla Anguilla during Oceanic Spawning Migration

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)

***Eric Feunteun**, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France*
Thomas Trancart, UMR BOREA 7208, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
Anthony Acou, Service des Stations Marines, Station Marine de Dinard, Muséum National d'Histoire Naturelle, Dinard, France
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European eels (*Anguilla anguilla*) undertake a ~5000-km spawning migration from Europe to the Sargasso Sea (Tesch 1977). As details of this marine migration remain unknown, the EELIAD project was built to access the oceanic biology, ecology and movements of eels. This project showed that the eels travelled up to 50 km per day and exhibited a consistent diel vertical migration (DVM), ascending to warmer shallower waters at dusk and descending into deep, colder water at dawn, from ~200–900m and 14–8°C every day (Aarestrup 2009). To date, the causes of these DVMs remain unknown. Aarestrup et al. (2009) hypothesized that the observed DVMs reflects thermoregulation: “The daily ascent into shallower warm water may serve to maintain sufficiently high metabolism and swimming activity, whereas descent to deeper waters may permit the eels to keep their average temperature below 11°C, delaying gonadal development until reaching the Sargasso Sea”. To corroborate this assumption, we need to know the impact of the abrupt changes in temperature linked to these DVMs on the eel respiratory metabolism. A strong effect of the DVMs on this metabolism would lead to conclude at a strong hidden gain for the eels.

Acute Loss of European Silver Eel Fitness By Introduced (vs native) Parasitic Helminths Threatening Spawning Success

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Helminth parasites were studied in 149 silver eels from five sites in northern Europe. In total, 88% were infected by 12 species including Monogena, Cestoda, Nematoda, and Acanthocephala. *Anguillicoloides crassus* was most common (56%), then *Acanthocephalus clavula* (30%) and *Pseudodactylogyrus* spp. (17%). The body condition (BC) was negatively influenced by the abundance of the introduced *Pseudodactylogyrus* spp. but not by the other parasite taxa. However, the introduced *A. crassus* was considered as a severe pathogen based on previous data, whereas the native *A. clavula* was supposed to have limited impact. Eels from Stockholm Archipelago (Sweden) were the less parasitized (30% vs ≥ 90% for other sites) with no parasites in gills. Burrishoole (Ireland) differed by absence of *A. crassus* and high prevalence of *A. clavula* (84%) but without consequences on BC. Gudenaa (Denmark), Corrib (Ireland) and Frémur (France) were close due to high prevalence of *A. crassus* (≥ 89%). Gudenaa and Corrib were the most similar because *Pseudodactylogyrus* spp. was also highly prevalent (≥ 60%) whereas absent in Frémur. Our results suggest that introduced parasites may threaten the spawning success of migrant silver eels from Gudenaa, Corrib and Frémur, but not of those from Stockholm Archipelago and Burrishoole.

Managing for Seven Generations: Mi'kmaq Knowledge, Eels and the Bras D'or Lakes

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Tyson Paul, Research and Stewardship, Unama'ki Institute of Natural Resources, Eskasoni, NS, Canada

Application of traditional knowledge to eel sustainability is common practice in the eel sustenance fishery of the indigenous Mi’kmaq people in Canada but its use beyond the Mi’kmaq culture is not fully realized. Mi’kmaq ecological knowledge on katew, the American eel, gathered on traditional fishing grounds of the

Bras d'Or Lakes, Nova Scotia provide an example of the use of Mi'kmaq knowledge for eel sustainability. Worldview, fishing practices, observations on eels, habitats and population status contribute to traditional management of Bras d'Or Lakes eels.

What Factors Explain the Yellow Eel Density in Coastal Waters?

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Beside habitat criteria the colonization of yellow eels (*A. anguilla*) in coastal waters might be also influenced by density driven mechanism. To obtain a better understanding of factors influencing the settlement of eels in coastal waters the density and the size distribution of yellow eels were analyzed along a 180 km transect in southern German Baltic Sea. The fished section ranges from open coastal waters till the estuary of the Odra River providing various habitats for eels during their continental life phase. Using a standardized enclosure fishing system 117 sampling points were fished between 2008 and 2012. Significant higher yellow eel densities were detected in the most exposed area compared to the other stations. Along the fished transect decreasing eel densities were observed with the lowest values in the estuary of the Odra River. Further, the fished station differed regarding the length distribution of the yellow eels. By including habitat related data we aim to identify the main factors responsible for the observed variation of the eel density and length distribution.

Multivariate Analysis of Biomarker Responses in European and American Yellow Eels in the Gironde and St. Lawrence Estuaries

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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Guy Verreault, Ministere du Développement durable, de l'Environnement, de la Faune et des Parcs, Riviere-du-Loup, QC, Canada
Hélène Budzinski, UMR CNRS 5805 EPOC - OASU, Université de Bordeaux1, TALENCE, France
Fabien Pierron, UMR EPOC, Environnements et Paléoenvironnements Océaniques et Continentaux, Équipe Ecotoxicologie Aquatique, Station Marine d'Arcachon, CNRS-5805, Université de Bordeaux, Place du Docteur Bertrand Peyneau, Arcachon, France
Magalie Baudrimont, UMR CNRS 5805 EPOC - OASU Station Marine d'Arcachon, Université de Bordeaux1, ARCACHON, France
Patrice Couture, Écotoxicologie, Institut National de la Recherche Scientifique, Centre Eau Terre Environnement, Québec, Canada

This study is part of an international program 'IMMORTEEL' investigating the possible contribution of habitat contamination in the decline of Atlantic eels. Biomarker responses and muscle concentrations of persistent organic contaminants (POPs) were examined in European eels (*Anguilla anguilla*) and American eels (*Anguilla rostrata*) in the Gironde and St. Lawrence Rivers basins. In 2011 and 2012, yellow eels were collected at two reference sites (Certes and Dordogne in France and Rivière Sud-Ouest and Rivière Saint-Jean in Quebec, Canada) and two contaminated sites (Garonne and Gironde in France and Lake Saint-Pierre and Lake Saint François in Quebec). Principal component analysis was useful to discriminate effects of natural ecological gradients and anthropogenic contaminant gradients on biological responses, over a large geographic scale. Patterns of contamination differed markedly between France and Quebec, with higher PCB concentrations relative to other POPs from France. In 2012 but not in 2011, hepatic ethoxyresorufin *O*-deethylase induction and increased density of splenic melanomacrophage centers were detected in eels from Garonne and Gironde compared to reference sites. In Quebec, morphometric characteristics were the major discriminant factors between upstream contaminated and downstream reference sites. Links between biomarker responses, exposure to other groups of contaminants and health impacts will be discussed.

Early Infection of Newly Recruited American Eels By an Invasive Swimbladder Parasite in a South Carolina Estuary

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
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***Stephen A. Arnott**, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC*
William A. Roumillat, Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC
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Isaure de Buron, Biology, College of Charleston, Charleston, SC

South Carolina is one of only two U.S. states that have permitted the harvest of American eel (*Anguilla rostrata*) juvenile stages in recent years. However, little is known about the infection status of juvenile eels by the invasive swim bladder parasite *Anguillicoloides crassus*. This study examined *A. crassus* infection over a ten month period in more than 400 glass and elver eels collected from a dammed creek near Charleston, SC. Parasite prevalence varied significantly with eel size (total length) and time of year. From March to July, the smallest eels (~30 mm) were uninfected, but parasite prevalence increased to ~100% in eels greater than 130 mm. From August – December, when fewer eels were found, parasite prevalence was generally lower and it was less dependent on eel size (although the smallest eel sizes were uninfected, as before). In mid-summer, water temperatures rose above 30°C, which has been shown to be lethal for other infected Anguillid eels. At present, it is unknown whether the lower parasite prevalence later in the year was related to emigration of infected eels, mortality, or clearance of the parasite by host eels.

Monitoring of Sexual Maturation in Silver Eels Using Ultrasonography

Monday, August 18, 2014
Exhibit Hall 400AB (Centre des congrès de Québec // Québec City Convention Centre)
Sarah Bureau du Colombier, IRSTEA, Cestas, France
Louis Jacobs, IRSTEA
Charline Gesset, IRSTEA
Pierre Elie, Unité Ecosystèmes Estuariens et Poissons Migrateurs Amphihalins, IRSTEA, Bordeaux, France
***Patrick Lambert**, IRSTEA, Cestas, France*

Understanding and control of eel maturation has strong interest for scientific and commercial purposes. To progress in this area, possible improvement of sex determination and maturation monitoring using ultrasonography was investigated in silver eels (*Anguilla anguilla*). Ninety six fish were scanned for sex determination using portable ultrasound equipment. Part of them was then subjected to artificial induction of maturation for monitoring of gonad growth at the individual level, and estimation of ovary mass and then gonadosomatic index (GSI) in females. A linear model based on estimations of gonad length and cross-sectional areas at different times of maturation was defined and used for calculation of ovary mass. Ultrasonography resulted in 100 % success in sex determination and good estimation of ovary mass (97% correlation with true values). Ultrasonography made possible the detection of early inter-individual differences in maturation in female silver eels, and has great potential for use in eel both for conservation and aquaculture.

Multivariate Analysis of Biomarker Responses in European and American Yellow Eels in the Gironde and St. Lawrence Estuaries

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