CFRN 2nd AGM

December 6-8, 2011

St. John's, Newfoundland

Student and Project Research Abstracts

2e AGA du RCRP

Du 6 au 8 décembre 2011

St. John's, Terre-Neuve

Résumés de recherche des étudiants et des projets

Canadian Fisheries Research Network

Réseau canadien de recherche sur la pêche

Connectivity and stock structure of American lobster *Homarus americanus* in Atlantic Canada

Graduate students (in order of projects): Marthe Larsen Haarr[1], Brady Quinn[1], Guðjón Már Sigurðsson[1], Kristin Dinning[1], Bryan Morse[1], Laura Benestan[2]

Principal investigators (lead PI and then alphabetically): Rémy Rochette[1], Louis Bernatchez[2], Joël Chassé[3], Michel Comeau[4], Peter Lawton[5], Patrick Ouellet[3], Bernard Sainte-Marie[3], John Tremblay[6]
[1]Biology Department, University of New Brunswick, Saint John. NB. [2]Départment de Biologie, Université Laval, QC. [3]Maurice Lamontagne Institute, DFO, Mont-Joli, QC. [4]DFO Gulf Region, Moncton, NB. [5]St. Andrews Biological Station, DFO, NB. [6]Bedford Institute of Oceanography, DFO, Dartmouth, NS.

Industry partners: Fish Food and Allied Workers Union, Guysborough County Inshore Fishermen's Association, Association des pêcheurs propriétaires des Iles de la Madeleine, Regroupement des pêcheurs professionnels du sud de la Gaspésie, Maritime Fishermen's Union, LFA 30 Fishermen's Association, Richmond County Fishermen's Association, Homarus Inc., Eastern Shore Fishermen's Protective Association, Fishermen and Scientists Research Society, LFA34 Management Board, Fundy North Fishermen's Association, Gulf Nova Scotia Fishermen's Coalition, Northumberland Fishermen's Association, Prince County Fishermen's Association, LFA 27 Management Board.

The *Lobster Node* of the *CCFRN* comprises a 5-year collaboration between industry, government and academia, which aims to elucidate stock structure and connectivity of the American lobster, *Homarus americanus*, in Atlantic Canada. It proposes to achieve this goal by undertaking 5 integrated research activities: (1)assessing the input of larvae into the system by quantifying the abundance and size of egg-bearing females collected by fishermen at 50-75 km intervals along the coastline, and determining whether all larvae can be "treated equal" by quantifying non-genetic maternal effects and population-level genetic effects; (2)using an individual-based bio-physical model to predict the dispersal and settlement of these larvae, and comparing some of these values to the abundance of postlarvae (passive collectors and quadrats), juveniles (research surveys) and adults (fisheries landings); (3)studying the effect of substrate characteristics on settlement behaviour, and investigating the patterns and processes (e.g., larval supply, wind-driven currents) underlying patchiness of settlement at different spatial scales, to further parameterize and validate our dispersal-settlement model; (4)using traditional tagging data and ultrasonic telemetry to quantify the movements (e.g., seasonal migrations) of different size/age lobsters from different regions, and develop a conceptual model of the importance of these movements to connectivity among subpopulations; (5)developing large quantities of small neutral and non-neutral genetic markers (SNPs) to refine our understanding of lobster populations genetics and patterns of local adaptation. This research is expected to inform best management practices, particularly where these depend on the connectivity between lobster management areas. But perhaps more importantly, it is hoped that it will constitute the foundation of a lasting partnership between lobster fishermen, academics and government scientists.

Assessing spatial patterns and patchiness of American lobster (*Homarus americanus*) settlement in the Bay of Fundy

Guðjón Már Sigurðsson[1], Rémy Rochette[1] and M. John Tremblay[2]
[1]University of New Brunswick, Saint John, 100 Tucker Park Road, Saint John N.B. E2L 4L5
[2]Department of Fisheries and Oceans – Bedford Institute of Oceanography, Darthmouth N.S. B2Y 4A2

The objective of this study was to quantify the abundance and spatial pattern of lobster settlement in select coastal habitats of the Bay of Fundy. A spatially nested design comprising 23 sites (300-3000 m^2) with appropriate cobble bottom for lobster settlement was used; two to three sites were nested within 11 areas (0.3-20 km^2), which were nested within one of two geographical regions, Fundy (924 km^2, 6 areas) and SW Nova Scotia (3000 km^2, 5 areas). To estimate settlement, we deployed approximately 400 standardized settlement collectors (15-25 per site) in July of 2009 and 2010, and retrieved these the following October. Lobsters found in the collectors were classified as settlers (≤13 mm CL) or juveniles (≥13 mm). In order to assess patchiness, we calculated variance in the number of settlers (or juveniles) at different spatial scales, and then compared these values to a theoretical distribution obtained by Monte-Carlo simulation and assuming random settlement across sampling units. In both 2009 and 2010, good settlement (≥1 settlers/m^2) was observed in 3/11 areas, medium settlement (~0.4/m^2) in 2/11 areas, and low settlement (≤0.2/m^2) in the remaining 6 areas. Settlement was patchy when contrasted across sampling units separated by 4-80 km, but not at both lower and higher spatial scales. This study has identified important nursery grounds for lobster in the Bay of Fundy, and suggests some inter-annual consistency in spatial variability in settlement. Ongoing work includes similar analyses for 2011, and investigation of the role different physical factors (temperature, wind, tidal current) play in causing these patterns. This work will help: (1) design future settlement studies aimed at developing indices of settlement strength, (2) further parameterize the dispersal-settlement model of the CCFRN Lobster Node, and (3) design future studies to test some of this model's predictions.

Spatial and temporal variation in larval production of American lobster *Homarus americanus* in Atlantic Canada

Marthe Larsen Haarr[1], Rémy Rochette[1], Michel Comeau[2], Bernard Sainte-Marie[3], John Tremblay[4]
[1]Biology Department, University of New Brunswick Saint John, Saint John NB. [2]Gulf Region, Fisheries and Oceans Canada, Moncton NB. [3]Maurice Lamontagne Institute, Fisheries and Oceans Canada, Mont-Joli QC. [4]Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth NS

Industry partners: Fish Food and Allied Workers Union, Guysborough County Inshore Fishermen's Association, Association des pêcheurs propriétaires des Iles de la Madeleine, Regroupement des pêcheurs professionnels du sud de la Gaspésie, Maritime Fishermen's Union, LFA 30 Fishermen's Association, Richmond County Fishermen's Association, Homarus Inc. Eastern Shore Fishermen's Protective Association, Fishermen and Scientists Research Society, LFA34 Management Board, Fundy North Fishermen's Association, Gulf Nova Scotia Fishermen's Coalition, Northumberland Fishermen's Association, Prince County Fishermen's Association, LFA 27 Management Board.

The Lobster Node of the NSERC CCFRN comprises a 5-year collaborative project between lobster harvesters, academics and government scientists on the question of lobster stock structure and connectivity in Atlantic Canada. The project involves five research components, four of which are based on stages of the life cycle: larval production, larval drift, larval settlement, and movement of juveniles and adults. The fifth component aims to elucidate genetic stock structure and tests for evidence of local adaptation. The objective of the first component is to estimate spatiotemporal variation in larval production based on the abundance and characteristics of berried females. Data is being collected by fishermen on the abundance, size, clutch quality and hatch time of berried females with the objective of one fisherman every 50-75 km sampling weekly throughout the fishing season. Data is compiled in an online database. Sampling started spring 2011 with 61 participants from LFAs 3–14, 20–23, 25, 27–32, 36 and 38. There were no participants from LFAs 15–19 (northern Gulf of St. Lawrence), 24 (northern PEI), 26a-b (eastern Northumberland Strait and western Cape Breton), 28 (Bras d'Or Lakes), and 33–35 (NS south shore, southwestern NS and part of Bay of Fundy). Data from LFAs 24-26a will be available from government sampling programs. Preliminary analyses suggest that among areas sampled, berried female abundance, as estimated by catch-per-unit-effort, was highest around eastern Cape Breton, in Chaleur Bay, and some bays in southern Newfoundland. When female size and published size–fecundity curves were integrated to estimate egg production, larval production (mean # eggs per trap) appears highest around Grand Manan in the Bay of Fundy, due to abundant large females. Work is planned to assess potential biases in the data related to sampling design, such as effects of trap design on catch-per-unit-effort and size composition of the berried female catch. This first year of sampling was hugely successful thanks to this unprecedented tri-partite collaboration. Planning for the second year of sampling is underway.

CANADIAN CAPTURE FISHERIES RESEARCH NETWORK PROJECT 1.4: SOCIO-ECOLOGICAL COMPLEXITY AND DYNAMICS OF HARVESTED FISH STOCKS

Project 1.4 Collaborators[1,2,3,4,5]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road E., Guelph, ON Canada N1G 2W1
2. Ontario Commercial Fisheries' Association, Box 2129, 45 James Street, Blenheim ON Canada N0P 1A0
3. Ontario Ministry of Natural Resources, Lake Erie Management Unit and Aquatic Research and Development Section, 320 Milo Rd., RR 2, Wheatley, ON Canada N0P 2P0
4. Department of Fisheries and Oceans, Canada Centre for Inland Waters, 867 Lakeshore Road, Burlington, ON L7S 1A1 and Maurice Lamontagne Institute, 850 Route de la Mer, P.O. Box 1000, Mont-Joli, QC Canada G5H 3Z4
5. Great Lakes Fishery Commission, 2100 Commonwealth Blvd, Suite 100. Ann Arbor, MI, USA 48105

POSTER ABSTRACT

Project 1.4 had its genesis as the Decision Analysis and Adaptive Management (DAAM) Project for Great Lakes Fisheries. Regulators and industry disagreed about quotas for Lake Erie walleye and yellow perch. From the outset, key uncertainties were identified, and research topics co-constructed, by academics and industry. A high degree of collaboration remains integral to Project 1.4, better ensuring both a good fit with industry's priority needs and industry's capacity to exploit the results. The timely emergence of the CCFRN provided opportunity for (re)newed engagement with managers and researchers in provincial, federal and bi-national, multi-agency bodies with responsibilities, directly and indirectly, for managing commercial and sport fisheries. To better achieve "built in" knowledge transfer, individuals from each serve on a Liaison Committee. By 2011, 8 HQPs were trained: 1 postdoctoral fellow, 3 research associates, 2 undergraduates (UoGuelph) and 2 graduate students (Virginia Tech). By 2012, 4 PhD students and a part-time postdoctoral fellow will have joined Project 1.4 at UoGuelph, with backgrounds in fish ecology and behaviour, population assessment, spatial population and food web ecology, and fish genetics and evolution. From January 2011-January 2012, from ongoing research, the DAAM Project produced 8 papers and 11 conference presentations. Our research about the ecological and economic risks associated with various harvest control rules enhanced the knowledge base for policy development. In 2011, regulators introduced a structured decision-making process, with greater stakeholder participation, to set quotas for Lake Erie walleye, responding to industry's need for improved transparency and 2-way knowledge transfer. Whether these and future developments result in direct economic benefit depends further on whether regulators, stakeholders and researchers learn to manage to reduce uncertainties that, in many ways, may represent the greatest of all threats to sustainable fisheries.

THE COMPENSATORY IMMIGRATION FRAMEWORK: FISHERIES BENEFIT FROM ADJACENT PROTECTED AREAS

Katrine Turgeon[1,2] and Donald L. Kramer[2]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road East, Guelph, ON Canada N1G 2W1
2. Department of Biology, McGill University, 1205 Docteur Penfield Avenue, Montreal, QC Canada H3A 1B1

POSTER ABSTRACT

Protected areas and fisheries area closures are generally controversial because they may be implemented with a great deal of uncertainty about their benefits to stocks, while fisheries bear the costs of decreased access to resources. Recent modeling efforts have suggested that fish immigration from protected areas to local populations experiencing high natural or human induced mortality is a more sustainable and stable harvesting strategy in the presence of uncertainty than removing a fixed fraction or a fixed number of individuals from the available population each year. However, there is very limited evidence for the mechanisms leading immigration from protected area, on the factors that could increase or decrease immigration or on the impact of immigration on the stock dynamics. For this reason, models have often unrealistically assumed that migration does not occur, is restricted to fish larvae or follows a diffusion pattern. These assumptions concerning fish mobility do not include complex density dependence patterns and cannot incorporate multiple mobility limitations to immigration from physical properties of the landscape. Here, we propose a new theoretical framework, 'the compensatory immigration framework' that allow the simulation of six alternative scenarios that varied in the roles of potential limiting factors to immigration such as the size of the protected population (N), properties of the landscape (relative habitat quality and functional connectivity; M) affecting the rate of replacement of harvested individuals and behavioral interactions that could lead to complex density dependence patterns (θ). The model predicts that immigration from protected areas can contribute importantly to the total yield and consequently can significantly affect demography in protected areas. Immigration and total yield can show complex non-linear relationships in response to harvest as the size of the protected area, rate of replacement of harvested individuals, mobility and behavioral interactions covary. To predict the influence of protected areas on fisheries benefits and viability of both the harvested and protected populations, additional research is needed to explore how species and landscape characteristics affect the spatial influence of fishing on adjacent protected areas and how density-dependent processes affect the probability of emigration from protected areas.

FACTORS AFFECTING VARIATION IN STOCK-RECRUITMENT RELATIONSHIPS OF LAKE ERIE YELLOW PERCH (*Perca flavescens*)

Fan Zhang[1], Tom Nudds[1], Kevin Reid[1,2]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road E., Guelph, ON N1G 2W1
2. Ontario Commercial Fisheries' Association, Box 2129, 45 James Street, Blenheim, ON Canada N0P 1A0

POSTER ABSTRACT

The relative importance of factors affecting variation in stock-recruitment relationships remains a long-standing question for fisheries research and management. Corresponding to the desire of ecosystem-based fisheries management in recent years, a better understanding of the stock-recruitment mechanism involving explicit effects of biological and ecological factors is badly required. Yellow Perch (*Perca flavescens*) comprises a significant proportion of the food web, as well as the total value of all harvested species in Lake Erie. I propose to explore mechanisms behind variation in yellow perch stock-recruitment relationships using population-state, individual-state distribution and individual-state configuration models with time series data between 1990 and 2010 from Lake Erie. Additionally, I will examine tradeoffs between model complexity and model efficiency under different fisheries management goals.

CAUSES AND MANAGEMENT CONSEQUENCES OF HARVEST-INDUCED PHENOTYPIC CHANGE (HIPC) IN FRESWATER FISHES

Davíð Gíslason[1], Rob McLaughlin[1], Beren Robinson[1]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road East, Guelph, ON Canada N1G 2W1

POSTER ABSTRACT

Harvesting may cause phenotypic changes in populations that may have important consequences for productivity and sustainability. If that is the case, it remains unclear whether such changes are short term and reversible (developmental) or long term and difficult to reverse (evolutionary). Harvested freshwater fish populations offer unique opportunities to better understand the causes and consequences of change in important production traits because, like their marine counterparts where effects of HIPC have been documented, many freshwater populations have been harvested for decades using size-selective methods. Relative to marine fishes, freshwater fishes span a limited range of body sizes, and spatial extent and connectivity of stocks, while exhibiting considerable size and life history variation across a range of food web structures, further complicating whether effects of HIPC translate to harvested freshwater species. To investigate the causes and consequences of HIPC in freshwater fish populations, I will evaluate whether and how harvesting promotes change in freshwater populations similar to those reported for marine fish populations. I will quantify variation in phenotypic change among populations and evaluate potential predictors of phenotypic responses to harvesting. I will also evaluate how much information is required to determine, with a specified level of confidence, whether phenotypic change has occurred in a harvested population. I will then evaluate the capacity of various theoretical models that aim to disentangle environmentally mediated from evolutionary responses in populations with changing phenotypes. Finally, I will use models to evaluate the consequences of phenotypic change on catch production and sustainability of fished populations. My work will provide insights relevant to the management, and fundamental biological aspects, of harvested fish populations.

BIOECONOMIC EVALUATION OF HARVEST CONTROL RULES FOR A COMMERCIAL FISHERY

Kate Tsiplova[1], Kevin Reid[1], Yan Jiao[2] and Tom Nudds[1]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road East, Guelph, ON Canada, N1G 2W1
2. Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA USA 24061-0321

POSTER ABSTRACT

A simple stochastic bioeconomic simulation model that incorporated uncertainty about recruitment and stock status was used to examine the effects of alternative harvest control rules (HCRs) on ecological and economic performance indicators for the commercial walleye (*Sander vitreus*) fishery on Lake Erie, Ontario, Canada. A suite of constant and state-dependent HCRs, including the HCR currently used to set annual total allowable catches of Lake Erie walleye, was evaluated. The performance of these alternative harvest control rules in terms of expected stock abundance, catch, commercial yield, gross and net revenues, and present value of net revenues was assessed. Potential tradeoffs between risk to the stock and risk to the fishery were evaluated using probabilities that selected indicators would fall below undesirable thresholds. State-dependent HCRs provided a better trade-off between economic performance and biological performance than did HCRs based on constant fishing mortality rates (F). At fishing mortalities less than F=0.3, small increases in walleye abundance were achieved at the cost of disproportionate declines in both gross and net revenues. High exploitation rates such as constant F=0.5, were associated with high probabilities of poor biological and economic outcomes. These results provide a rationale for conducting a management strategy evaluation (MSE), with an active adaptive management focus, for the Lake Erie walleye.

SPATIAL PATTERNS OF TROPHIC STRUCTURE AND ENVIRONMENTAL CORRELATES: INSIGHTS FOR THE GREAT LAKES FROM THE NORTHUMBERLAND STRAIT

Allan Debertin[1,3], J. Mark Hanson[2], Simon Courtenay[2,3]

1. Department of Integrative Biology, University of Guelph, 50 Stone Road E., Guelph, Ontario, N1G 2W1
2. Department of Fisheries and Oceans, Gulf Fisheries Centre, Oceans and Science Branch, P.O. Box 5030, Moncton, New Brunswick, E1C 9B6
3. Fisheries and Oceans Canada at the Canadian Rivers Institute, Biology Department, University of New Brunswick, P.O. Box 4400, 10 Bailey Drive, Fredericton, New Brunswick, E3B 5A3

POSTER ABSTRACT

The Decision Analysis and Adaptive Management Project for Lake Erie Commercial Fisheries identified spatial and temporal variation in the nature of trophic control, as well as abiotic drivers, on the dynamics of harvested fish stocks as key uncertainties among managers, policy decision-makers and the fishing industry on Lake Erie. In an effort to better understand similar questions in the Northumberland Strait, we concurrently sampled fish, zooplankton and key oceanographic characteristics. There was significant spatial variation in species composition and abundance of zooplankton assemblages. We distinguished recurrent assemblages in the west end and central areas of the Strait in 2008-2009, and, when sampling extended eastward in 2009, a third assemblage located at the eastern end of Strait was detected. Similarly, fish assemblages varied spatio-temporally; we distinguished five, three of which co-occurred in space each year with zooplankton assemblages. Although requiring testing by further analysis of gut contents from planktivorous fish collected concurrently, the evidence to date suggests that the nature of trophic control may vary less with time locally, than with space regionally, perhaps due to the influence of regional environmental drivers. Environmental variables, however, accounted for only 29 and 49% of variation in spatial structure of zooplankton assemblages in 2008 and 2009, respectively, and 40% of variation among fish assemblages in each year, leaving a large portion of regional variation in both trophic levels as yet unexplained. Techniques presented herein may provide the means to determine the nature of spatio-temporal variation in species composition and abundance among consumers and producers in Lake Erie and other Great Lakes and aid to further parse how variation in top-down and bottom-up trophic control, and environmental conditions, influence the dynamics of harvested fish stocks.

Evaluating Management Strategies for the British Columbia Small Boat Groundfish Fleet Using Influence Diagram Modeling

CCFRN AGM Poster Session,
St. John's, Newfoundland, December 6, 2011
Danielle Edwards and Murdoch McAllister

British Columbia's groundfish fisheries have undergone major transformations in recent years. A new integrated groundfish management regime was introduced in 2006 in response to concerns about unreported discard and stock depletion. This new management system included 100 percent monitoring coverage across all groundfish fleets, expanded use of individual transferable quotas, new requirements to account for bycatch, increased transferability of quota between fleets (e.g., between trawl and hook and line), and allowances for vessels to retain and land their bycatch. In addition to groundfish integration, other management actions have been taken to address the depletion of rockfish populations that could have wide-reaching impacts on the groundfish fisheries. Rockfish conservation areas (RCAs), where no groundfish fishing is permitted, have been established to protect inshore rockfish. As well, a number of rockfish and other groundfish species have been and are continuing to be considered for *Species at Risk Act* (SARA) listing. The integration of the groundfish fisheries has created new opportunities for the BC small boat groundfish fleet. It has also led to a number of emerging challenges which, when considered along with other ongoing management changes such as RCAs and SARA listing, lead to heightened concerns about the long-term financial viability of the fishing fleet.

The management strategy evaluation (MSE) approach enables candid evaluations of the performance of current and alternative fisheries management plans against agreed-upon management objectives using simulation modeling. The MSE approach is being used to evaluate the performance of current and alternative management plans for the BC small boat groundfish fishing fleet to meet dual objectives of recovering and preventing further depletion of species of concern and securing and maintaining the future viability of the small boat groundfish fleet. To facilitate examination of the complex outputs from the simulation modeling and to act as a communication tool with stakeholders, an influence diagram model has been developed. An influence diagram model (IDM) is a graphical representation of the key elements of the system including the different states of nature (e.g., stock size), decision nodes (e.g., listing under SARA, TAC), utility (e.g., net profit) and the probabilistic relationships between these. An IDM of the BC groundfish fishery was developed, focusing on the financial performance of the small boat fleet and a select set of species of interest. Over the course of the project, stakeholders will be consulted and extensive simulation modeling will be undertaken to refine and extend the IDM as one component of the BC small boat groundfish fleet project.

The use of decision analysis and influence diagram modeling to communicate in-season management options for the West Coast Vancouver Island salmon troll fishery, British Columbia, Canada

Sarah Hawkshaw and Murdoch McAllister
University of British Columbia, Vancouver, Canada
CCFRN AGM Poster

Abstract

Variability in fish dynamics, stock size estimates, social and economic factors, and impacts of inaccurate implementation of harvest control rules are some of the factors that complicate fisheries management. In the face of them decisions about management actions need to be made. The West Coast of Vancouver Island (WCVI) commercial salmon troll fishery is an example of a spatially complex mixed-stock, multi-stakeholder fishery that has undergone a number of management changes under the influence of a variety of different policies. Given the large amount of uncertainty over the impacts of this fishery on various salmon stocks, management decisions have largely been guided by increased precaution. As a result, management changes have lead to a significant reduction in salmon harvest rates for the commercial fishermen, threatening the economic viability of this fishery. Decision analysis of management options for this fishery has not been conducted and the trade-offs between stakeholder objectives have not been clearly communicated. We are in the process of developing a formalized, quantitative decision analysis of the WCVI commercial salmon troll fishery in-season management options. Results are to be communicated to managers and stakeholders throughout the process using decision analysis tables and Bayesian influence diagram modeling. In this poster we illustrate the concept of an influence diagram and its application to modeling policy options and the linkages between key factors affecting the future viability of the WCVI salmon troll fishery.