

**Canadian Fisheries
Research Network**

**Réseau canadien de
recherche sur la pêche**

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Meeting**

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Abstracts

Résumés

Canadian Fisheries
Research Network



Réseau canadien de
recherche sur la pêche

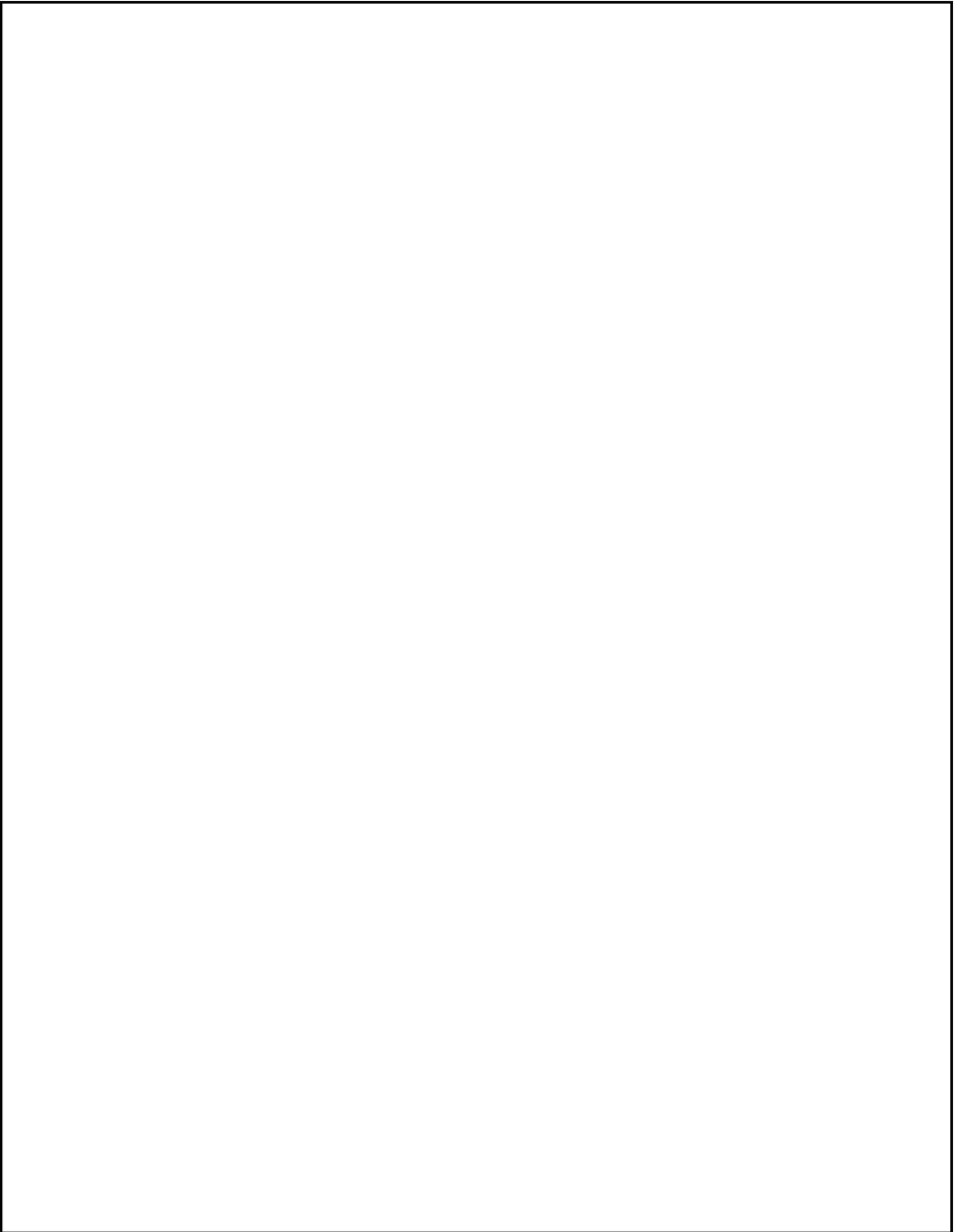


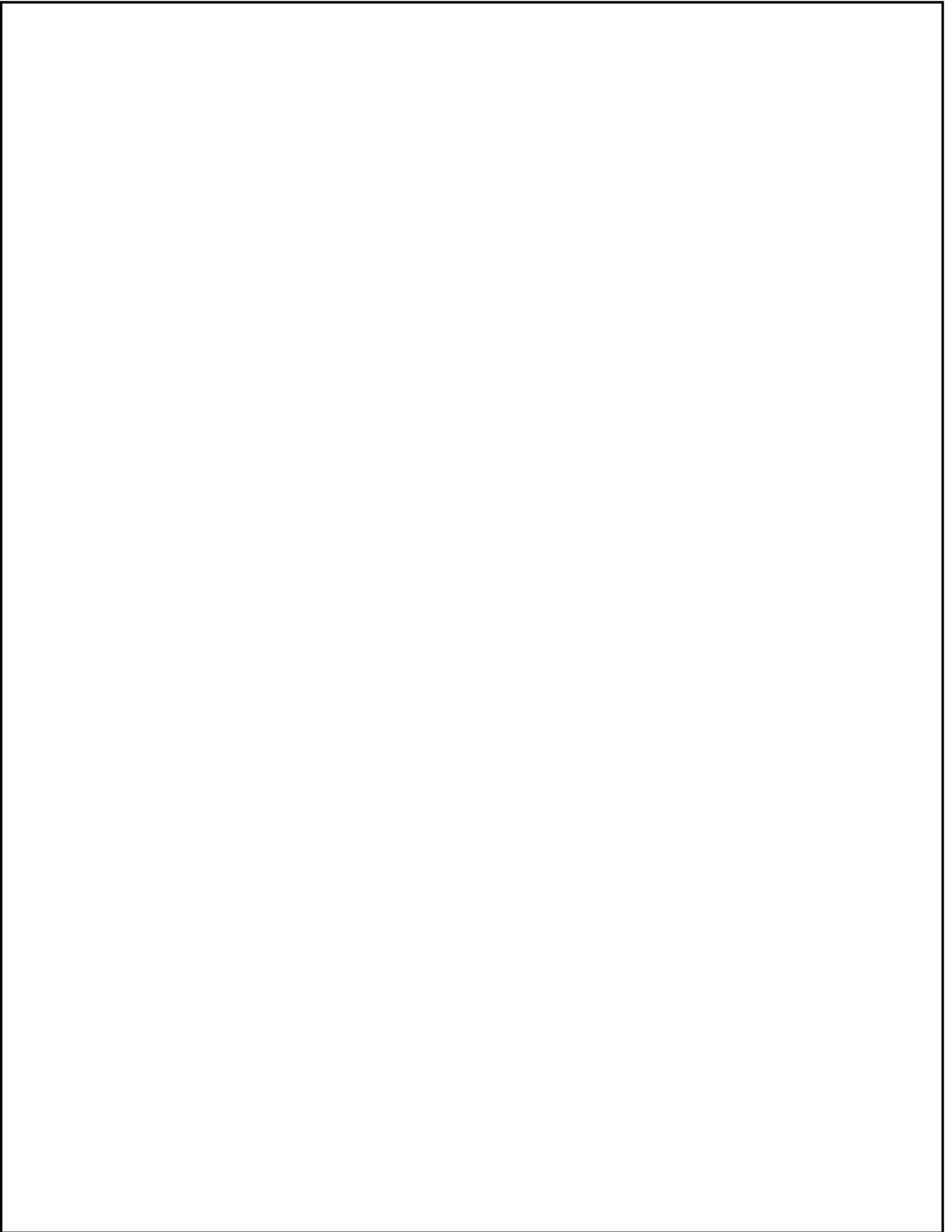
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A holistic framework for consideration of ecological, economic, social and institutional aspects for sustainable fisheries

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Poster and oral presentation

This study is identifying the scope of knowledge required for the emerging 'ecosystem-based' and 'integrated' management approaches that place more emphasis on a broader view of sustainability. We have discussed the diverse aspects of sustainability and agreed on a comprehensive working definition. We have anticipated from Canadian Sustainable Fisheries Framework and other policy documents, and from what is happening elsewhere in the world, a candidate set of objectives that span ecological, economic, social and institutional aspects. We have developed, from relevant literature and from experience of our diverse team, the types of performance indicators and metrics that may be used to operationalize these objectives. We have developed a framework ('report card') for this suite of objectives and are testing that report card on various fishery case studies. The framework remains in draft form (a 'living document') so that it can be modified and updated on the basis of our ongoing work.

Big Fish, Little Fish: Examining Corporate Concentration in BC's Salmon and Herring Fisheries

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Poster and oral presentation (5 minutes)

Licensing policy of BC's fisheries, particularly in the absence of owner-operator provisions, has had some unintended outcomes for the ownership structure of fisheries access rights, raising concerns over the amount of corporate control being exerted in BC's fisheries. This project aims to investigate the amount of corporate control in BC's salmon and herring fisheries, by using DFO license lists from 1990 to 2010, cross-referencing them with corporate registry search tools. As many fishing operations are incorporated for insurance purposes, a definition of "corporate control" will be co-derived with members of the fishing industry, and then these definitions will be applied to the historical license lists. Then, the amount of corporate control of fisheries access over this 20-year period will be reviewed and analyzed using SQL database tools. This project is anticipated to have far-reaching implications for the licensing policy and management of BC's fisheries going forward into the future.

Scientific Approaches for Holistic Fishery Evaluation

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Oral presentation (5 minutes)

Our research is aimed at understanding the spectrum of scientific approaches that may allow fisheries science and management to move toward a more holistic and participatory process. We focus on the generation of information for the purpose of supporting fishery management decisions, and the methods in which it is combined. In this brief talk we will provide an overview of the suite of methods we have evaluated, which include two research themes in the CFRN: management strategy evaluation and adaptive management. We will present the criteria we are using for our evaluation, and highlight methods that we believe have the highest potential for application in a fisheries management context.

Resolving Conflict over Risk Management in the Marine Environment— Strengthening Governance Institutions

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Oral presentation (5 minutes)

Since the 1980's, salmon aquaculture has rapidly expanded throughout the inshore waters of Southwest New Brunswick where traditional fisheries such as lobster, groundfish, scalloping and herring continue to operate. In this region, the Marine Advisory Committee was established to address conflict associated with these interactions and other coastal issues such as cumulative impacts. This governance initiative is intended to be a proactive approach to risk assessment and management. Through large scale consultations with communities, the Marine Advisory Committee has developed a performance based audit framework in the form of Community Values Criteria which expresses local knowledge about risk. This set of Community Values Criteria is proposed to facilitate resilience by informing, directing and measuring planning processes and management plans. At the national level, the Canadian Fisheries Research Network also hopes to use an audit approach in the form of a 'report card' to improve both ecological and social outcomes of the Canadian Fishery. While my research is still the data collection phase, this presentation will explore the application of my research on the Bay of Fundy Marine Advisory Committee to project 1.1, and more specifically to the National Report Card framework.

Development and Testing of a Fisheries Indicator Framework with Application to Analyzing the Distribution of Benefits within an Atlantic Canadian Fishing Community

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Poster and oral presentation (5 minutes)

It has been described (by representatives from government, academia and the fishing industry) that there have been changes to the way that benefits (such as profits, employment opportunities, income, etc.) - from the fishing industry - have been distributed to members of fishing communities, and to fishing communities as a whole. The representatives have stated that the benefits gained from fishing have not been equitably distributed between members of fishing communities (and the communities in general) across Canada. Therefore, the purpose of this study will be to enter into the aggregate fishing community of Grand Manan (which was chosen based on its relevance to this research) and collect data regarding the changes that have occurred with the distribution of fishing benefits (stated above) of this Atlantic Canadian community.

Human dimensions of the Skeena River salmon fisheries

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Author Affiliation(s): Simon Fraser University

CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Oral presentation (5 minutes)

Indicators such as landed value or employment are a common tool for capturing changes in the human dimensions of a fishery over time. These are useful numbers, provided there is a clear understanding of what they represent and, just as importantly, what they do not tell us. As a rule of thumb, the deeper you want to go in understanding the human side of fisheries, the harder it is to find an appropriate indicator. The Skeena River salmon fisheries on British Columbia's north coast will serve to illustrate some of the benefits and the challenges of using indicators in a fisheries management context.

Economic and cultural perspectives on value in a fishery

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Author Affiliation(s): Simon Fraser University

CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Poster

Two dimensions of salmon fisheries in northern British Columbia are profiled here: economic and cultural. Skeena River salmon stocks supported the most important commercial fishery in the region until very recently. Explanations for the decline in economic value of the fishery differ widely depending on who you talk to. A retrospective analysis is used here to evaluate the most common explanations for the poor economic performance of the fishery over the past 20 years. The cultural significance of salmon fisheries in the region is explored using testimony from the recent environmental review of the proposed Enbridge Northern Gateway pipeline. Qualitative data analysis techniques are used to develop a thick description of the benefits that people associate with salmon, who they identify as the beneficiaries of the resource, and what links the two.

Fisheries Policy and Regional Development: Successes from the Newfoundland and Labrador Shrimp Fishery

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Oral presentation (15 minutes)

The sustainability of many coastal communities and regions in Canada has long been tied to changes in fisheries policies. Yet little research has examined how specific fisheries policies impact regional development opportunities and outcomes. This project examines the impacts of the northern shrimp fishery on regional development in three areas: Southeast Labrador, the Northern Peninsula of Newfoundland, and Fogo Island. Drawing on a literature review and 54 interviews, we found that shrimp allocation policy guided by the principles of adjacency and regional economic development goals resulted in the establishment of two innovative regionally based fishing organizations in Southeast Labrador and the Northern Peninsula, and the strengthening of a third existing fishing organization on Fogo Island. Each organization used relatively small quotas productively for regional development purposes. Outcomes in these cases measure up relatively well against objectives of social sustainability contained in various fisheries management frameworks in Canada and elsewhere.

Current data availability and future information requirements of a holistic fisheries evaluation

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CFRN Project 1.1: Enhanced fisheries knowledge for an evolving management regime

Presented as: Poster and oral presentation (5 minutes)

The information requirements of fisheries management are changing. Emerging 'ecosystem-based' and 'integrated' management approaches place more emphasis on a broader, more holistic view of sustainability, and as such require more and different kinds of information. In this study, we have conducted a scan of Canada's Integrated Fisheries Management Plans (IFMP), the primary management tool through which the Sustainable Fisheries Framework policy is applied, to define the kind and amount of information that is currently being provided to manage Canada's fisheries. In addition, the type of information used by DFO's economists to populate the socio-economic component of the IFMPs is documented. This information has been compared to the CFRN's Project 1.1 holistic fisheries framework to determine the gaps in information that currently exist. Results to date suggest that there is an information gradient with emphasis on ecological information, less on economic material and considerably less in the social category. It is also becoming evident that we are dealing with a subset of the information required of our policies and of a model IFMP. We are now challenged to determine what information, if we had it, would make the most impact. Next steps in this evaluation include investigating where this new information would come from, and our capacity to acquire it.

Validating and Improving Estimates of Fisheries Connectivity from a Large-Scale Model of Lobster Larval Drift

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CFRN Project 1.2: Metapopulation dynamics, management areas and biological units of lobster in eastern Canada

Presented as: Poster and oral presentation (5 minutes)

Drift of larvae with ocean currents has the potential to influence recruitment to lobster populations, and to form source-sink linkages between geographically separate fisheries. We used a new oceanographic model to estimate larval drift and potential patterns of large-scale connectivity among lobster fisheries across eastern North America. We found that larvae could drift between fisheries separated by considerable distances, and identified fisheries that may have relatively high larval retention, as well as those that may export much of their larvae to other areas. Next steps with this work will involve attempting to validate settlement and connectivity patterns predicted by the model against real observations in nature, and then based on this determine whether and how to improve the model with better data (e.g., geographic differences in larval production). In the future, predictions of this model will be used in efforts to define biological units of lobster to inform management decisions.

Seasonal Migrations and Thermal Histories of Large Egg Bearing Lobsters (*Homarus Americanus*)

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Author Affiliation(s): University of New Brunswick, Saint John

CFRN Project 1.2: Metapopulation dynamics, management areas and biological units of lobster in eastern Canada

Presented as: Poster and oral presentation (5 minutes)

Adult American lobsters in different parts of the species' range have been documented to undergo seasonal movements or long-range migrations. It has also been hypothesized that female egg bearing lobsters undertake seasonal shallow/deep migrations to maximize the development of their embryos by always keeping them in the warmest water available. I have begun to test this hypothesis on egg bearing American lobsters from Grand Manan, New Brunswick by equipping them with Pop-up Satellite Archival Tags (PSATs). These tags, deployed on 2 animals in 2013 and planned for 8 in 2014, will measure daily depth, temperature and location as the lobsters travel between their shallow summer area and their deep overwintering area (>150m). Once they return again to their summer area the tags will pop off the animals and transmit all the data back by satellite. Tagging procedures, predicted results and fun pictures of large satellite tagged lobsters will be presented.

Light traps as a tool to sample pelagic larvae of American lobster (*Homarus americanus*)

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CFRN Project 1.2: Metapopulation dynamics, management areas and biological units of lobster in eastern Canada

Presented as: Poster

We built a simple and relatively inexpensive light trap and tested its efficacy at catching pelagic larvae of the American lobster. In laboratory experiments, 55% of postlarvae were caught by the traps, and 24% of postlarvae placed inside the traps escaped, over a 24-hour period. In the field, the traps caught larval stages I and IV, but no stage II or III larvae. Catches of postlarvae were lower than in previously published larval tow studies when standardizing for the amount of time the sampling devices spent in the water, but were similar to these when standardized for the number of work hours. Abundance of stage IV postlarvae was significantly related to spatial variability in settlement. Our results suggest that the traps may eventually provide an additional tool to sample larvae and postlarvae. However, we believe further experiments should be conducted to improve this new tool.

Patterns and processes of American lobster settlement in the Bay of Fundy

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CFRN Project 1.2: Metapopulation dynamics, management areas and biological units of lobster in eastern Canada

Presented as: Oral presentation (5 minutes)

The overarching goal of my project is to elucidate patterns and processes of lobster settlement. My objectives are to: (1) quantify the abundance, spatial patterns and patchiness of lobster settlement, (2) elucidate the processes responsible for the patterns observed, and (3) test new tools to sample lobster postlarvae. This project has so far discovered important nursery areas for lobster, identified high variability in settlement at the scale of 1-10 km² and much lower variability at larger and smaller spatial scales and tested light traps as a tool to sample pelagic larvae. Future analyses will aim to identify the processes that are most important in explaining the spatial settlement patterns observed, and to design future studies aimed at validating the postlarval dispersal-settlement model of the CFRN's Lobster Node.

Effect of Substrate on Settlement Behaviour, Development, Growth, and Survival of American Lobster Postlarvae, and Evidence that Mud Bottom can serve as Secondary Nursery Habitat

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CFRN Project 1.2: Metapopulation dynamics, management areas and biological units of lobster in eastern Canada

Presented as: Poster and oral presentation (15 minutes)

Postlarval American lobsters, *Homarus americanus*, prefer settling onto a cobble substrate and delay settling onto other substrates. Using tanks lined with cobble, mud, or sand, I found that postlarvae settled first onto cobble, second onto mud, and last onto sand. Furthermore, postlarvae molted sooner on cobble than on mud, and sooner on mud than on sand. The longest delay of settlement, over sand, resulted in reduced carapace length and mass at the next moult in comparison to postlarvae which settled earlier onto mud or cobble. The costs of delaying settlement could encourage settlement onto less-preferred substrates when cobble is unavailable. Accordingly, I deployed passive collectors onto mud habitat in Maces Bay, NB, Bay of Fundy. These collectors were colonized by juvenile lobsters ranging in size from young of the year up to adolescents. Consequently, I identify mud habitat as secondary nursery habitat for American lobster settlement and early life history.

The effect of sedimentation on the settlement behavior of the American lobster (*Homarus americanus*)

Author(s) : Benoît Bruneau¹ (benoit.bruneau1@gmail.com), Gilles Miron¹, Dounia Daoud² and Martin Mallet²

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CFRN Project 1.3: Factors influencing recruitment and early life survival of lobsters

Presented as: Poster and oral presentation (5 minutes)

Low recruitment of lobsters in the Northumberland Strait combined with an important commercial fishery contributed to the decline of existing populations. Questions were raised by stakeholders in eastern Canada on the effect of habitat modifications on recruitment processes. Most benthic invertebrates have a life cycle involving a pelagic dispersal phase followed by a benthic settlement phase. The transition between these phases is critical to the American lobster (*Homarus americanus*). Of the various factors that may affect larval deposition the effect of substratum modifications, due to sedimentation, on larval behavior is investigated. Sedimentary regimes can be severely affected and ultimately impede lobster recruitment. The main objective of this study is to quantify how different thickness of fine sediments over preferred substrate will affect the larval behaviors involved during settlement. Experiments carried out included behavioral observations over various types of substrates (single- vs. multiple-choice experiments) and lipid measurements to standardize behavioral responses.

Effet de la prédation sur le budget d'activités des larves du Homard américain (*Homarus americanus*)

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Organisme(s) d'appartenance : ¹Université de Moncton, ²Homarus Inc.

Projet n° 1.3 du RCRP : Facteur influençant le recrutement et la survie des larves de homard

Type de présentation : Présentation orale (5 minutes) et affiche

Le Homard américain (*Homarus americanus*) est un décapode qui a une grande valeur écologique et économique sur la côte est du Canada. Le présent projet doctoral fait partie d'un programme de recherche sur l'étude du comportement des larves de homard de stade IV au moment de la descente de la colonne d'eau vers le fond et de la sélection de l'habitat. Plusieurs facteurs environnementaux susceptibles d'affecter les larves de homard à ce moment précis ont été proposés par l'industrie du homard et le MPO (température de l'eau, sédimentation et prédation). Ce travail débutera en 2014 et portera sur l'étude en laboratoire du comportement larvaire face à des prédateur benthique (Crabe de vase *Dyspanopeus sayi*) et pélagique (Chaboisseau à épines courtes *Myoxocephalus scorpius*). Les résultats devraient nous permettre de fournir des informations fondamentales sur l'écologie du homard et quelques recommandations à l'industrie du homard concernant les pratiques d'ensemencement et améliorer la survie des homards.

Settlement behavior of American lobster (*Homarus americanus*) postlarvae: effect of stock origin and incubation temperature – preliminary results

Author(s): Léo Barret (leo.barret@uqar.ca)¹, Gilles Miron², Patrick Ouellet³ and Réjean Tremblay¹

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CFRN Project 1.3: Factors influencing recruitment and early life survival of lobsters

Presented as: Poster and oral presentation (5 minutes)

The settlement success of the American lobster postlarvae is a key factor in the study of population dynamics and stock management. Water temperature is a factor that could limit the establishment of postlarvae on the seafloor mainly with the presence of an important vertical stratification. The spatial distribution of this species allows its pelagic larvae to encounter heterogeneous thermal zones. However, very few information is available on the occurrence of a local adaptation for stocks and their ability to cope with temperature acclimation during larval development. The main objectives of the experiments are to characterize: 1) The settlement behavior of the larvae in relation to the incubation temperature and the origin of the stock; 2) The behavioral responses of larvae in the absence/presence of a thermocline. The resulting behavioral modifications will have ecological implications for larval dispersion and population connectivity. This will also provide relevant data for the lobster industry in relation to enhancement procedures.

Why does a non-quota commercial fishery persist in Lake Erie?

Author(s): Allan Debertin (adeberti@uoguelph.ca) and Tom Nudds (tnudds@uoguelph)

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CFRN Project 1.4: Effects of socio-ecological complexity on dynamics of harvested fish stock

Presented as: Poster and oral presentation (5 minutes)

Typically, commercial fisheries do not persist without extensive management methods such as quota systems. Quota systems restrict the total allowable catch for a species, and were established for the Lake Erie gillnet fishery for Yellow Perch (*Perca flavescens*) whereas white perch (*Morone americana*) are harvested without quota. Despite a 10-fold increase in commercial white perch harvest since the 1980s, this fishery continues to persist. Preliminary surplus-production stock assessment models indicate that the current status of white perch is not considered to be overfished nor is overfishing occurring. However, overfishing of the stock likely occurred during the 1990s. Harvesters may have increased harvest of white perch during this period to compensate for lost wages due to a reduction in yellow perch quota. We suggest strong-weak interactions between a monetary-driven fishery and quota/non-quota fish species can provide a possible explanation to the persistence of this commercial fishery.

The Effect of Harvesting on Size at Maturation in Lake Erie Yellow Perch

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CFRN Project 1.4: Effects of socio-ecological complexity on dynamics of harvested fish stocks.

Presented as: Poster

Harvesting may cause age and size at maturation to decline in intensively harvested marine fish stocks. Such changes in maturation timing and size are of concern if they represent a genetic change in the fish stock caused by the selectivity and insensitivity of the harvesting. However, reduced age and size at maturation may also result from compensatory responses of individual fish to harvesting whereby reduced fish abundance increases resource availability to the remaining fish, which subsequently grow and mature more quickly at a smaller body size and younger age. We applied cross correlation analyses to test for time-lagged relationships between harvesting, juvenile density, growth and size at maturation in Lake Erie Yellow Perch. Time lag was predicted by a simple harvest and maturation schedule model that reflects current understanding of perch life history. Harvesting was not related to juvenile density, individual growth and size at maturation over the time lags predicted by our model, although harvesting was related to maturation changes at longer temporal scales.

Effects of walleye predation on recruitment dynamics of Lake Erie yellow perch (*Perca flavescens*)

Author(s): Fan Zhang¹ (fzhang02@uoguelph.ca), Kevin Reid^{1,2} and Thomas Nudds¹

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CFRN Project 1.4: Effects of socio-ecological complexity on dynamics of harvested fish stocks

Presented as: Poster and oral presentation (15 minutes)

To investigate whether predation during early life stages has strong effects on recruitment, the impact of predator populations on recruitment dynamics was studied using time series data (1981-2010) of yellow perch and walleye in the west and central basins of Lake Erie. There was significant negative correlation between yellow perch recruitment and age-2 walleye abundance in the previous year, consistent with predation of YOY yellow perch by age-1 walleye. The modified Ricker model incorporating the variable of age-2 walleye abundance in the previous year had significantly lower AIC than an unmodified Ricker model, which indicated strong predation effect from age-1 walleye on YOY yellow perch. In addition, this predation effect tended to be stronger in the 2000s and 1980s than in the 1990s.

Keywords: recruitment dynamic, inter-specific predation, stock-recruitment relationship, Lake Erie, yellow perch

Bridges and Barriers to Collaboration in Canadian Fisheries Science

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CFRN Project 1.4: Effects of socio-ecological complexity on dynamics of harvested fish stocks

Presented as: Oral presentation (10 minutes)

At the last General Assembly of the Canadian Fisheries Research Network, the Guelph node organized a workshop to identify bridges and barriers to collaboration in Canadian Fisheries Sciences from the perspective of the Industry, the Government and Academic. We created 6 large matrices (13 x 13, total of 169 cells), where half of the matrix were barriers and the other half were bridges to collaboration among the participants. We then asked the participants to identify bridges and barriers to collaboration and write them on colored “post-its” in order to fill the matrix. We collected an impressive number of 336 comments. Comments from the industry composed 32% of the comments, 15% from the Government and 52% from Academics. Comments were well distributed among bridges (148 comments) and barriers (188 barriers). Broad similarities and differences among Academic, Industry and Government with respect to perceived bridges and barriers to collaboration will be presented.

Fishermen that fish to live or live to fish: Response of commercial and recreational fishermen to change in resource abundance and quotas

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CFRN Project 1.4: Effects of socio-ecological complexity on dynamics of harvested fish stocks

Presented as: Oral presentation (15 minutes)

Catch can be regulated by quotas coupled dynamically to resource abundance. Weak compensatory quota adjustment by managers may introduce lags between changes in abundance and catch that generate population instability and risk of fishery collapse. We show from time series of Lake Erie walleye and yellow perch that commercial fisheries are less responsive to changes in abundance than are recreational fisheries, consistent with the idea that delayed changes in quotas, effort and catch directly determined commercial fishery dynamics, whereas resource and fishing quality determined dynamics of recreational fisheries. Further, a change in management policy in early 2000s led to quicker changes in quota, effort and catch in response to perceived changes in abundance by commercial fisheries, strongly reducing lags between catch and abundance. We conclude that weak incremental changes in quotas contribute to destabilizing lags between abundance and catch that can jeopardize long-term economic and biological objectives for sustainable management.

Can Bayes and hermeneutics overcome barriers to broad interdisciplinarity?

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CFRN Project 1.4: Effects of socio-ecological complexity on the dynamics of harvested fish stocks.

Presented as: Poster and Oral presentation (5 minutes)

Incorporating the human dimensions of fisheries into the management process will require management to evolve toward a truly interdisciplinary approach. The broadest forms of interdisciplinarity range across the full spectrum of disciplines from the natural sciences to the humanities. Barriers to broad interdisciplinarity in fisheries management have proven difficult to overcome, but new tools and techniques are contributing to bridge these barriers and move fisheries management toward broad interdisciplinarity. There is emerging evidence that Bayesian philosophy and methods are well suited to this purpose. The utility of Bayesian philosophy and methods for the integration of knowledge, from a wide range of humanities, social and natural science disciplines, into fisheries management is discussed.

Keywords: interdisciplinarity, humanities, natural science, Bayesian philosophy and methods

Weak effects of shrimp fishing on benthic invertebrate community composition in the Estuary and Northern Gulf of St. Lawrence (EGSL)

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CFRN Project 2.2: Reducing seabed impacts of mobile fishing gears

Presented as: Oral presentation (15 minutes)

Trawling has become an environmental issue worldwide since it is assumed to be one of the most destructive fishing activities, severely altering seafloor structure and benthic communities due to the passage of fishing gears and frequent by-catch. We investigated whether shrimp trawling had long-, mid-, and short-term (20, 10, 4-year) impact on benthic macro-invertebrates of the EGSL by combining scientific survey and fishery data. We found no significant effect of trawling on species richness during considered time-periods. Significant but weak effects on biomass and benthic community structure were detected at fishing ground scale (10-50 km). We hypothesize that, since trawling was conducted for decades in the EGSL, critical level of disturbance was met after the first trawl passages, removing from the seafloor vulnerable species and blocks providing 3-dimensional habitats, constraining benthic communities to reach a disturbed state, now at equilibrium and on which current trawling disturbance has limited impact.

Assessing trade-offs between fisheries landings and protection of corals and sponges to inform spatial management of bottom trawling

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CFRN Project 2.2: Reducing seabed impacts of mobile fishing gears

Presented as: Oral presentation (15 minutes)

Spatial closures are a widespread management tool for protecting corals and sponges from potential damage by bottom trawling. However, spatial closures may also overlap with important fishing areas, reducing fishing opportunities and possibly landings. A better understanding of the potential fishery economic costs associated with spatial closures could help to balance habitat protection and fishery value. We assessed these costs using a spatial optimization procedure to select closures that protect predicted coral and sponge habitat while minimizing losses in landings for the bottom trawl fishery within Hecate Strait, British Columbia. We predicted negligible losses in landings value for 0 to 70% protection of predicted coral and sponge habitat, but losses increase rapidly above 90% protection. Losses from spatial closures were highest for rockfish catch (*Sebastes* spp.). The overall low predicted costs of spatial closures suggests that win-win management options are possible in which the majority of coral and sponge habitat is protected without reducing trawl fishery landings.

Behavioural reactions of Snow Crab (*Chionoecetes opilio*) encountering a bottom trawl used in the Newfoundland and Labrador shrimp fishery

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CFRN Project 2.2: Reducing seabed impacts of mobile fishing gears

Presented as: Poster

Trawl-mounted video camera observations were conducted to understand how individual snow crabs (*Chionoecetes opilio*) interact with the rockhopper footgear components of a traditional inshore shrimp trawl used in Newfoundland and Labrador, Canada. Observations of individual snow crab interactions with different footgear components were recorded and evaluated including their orientation, reaction behaviour (i.e., direction of movement), and nature of encounter (i.e., different types of encounters; duration of encounter, and fate of encounter). The analysis demonstrated that snow crabs were quickly overtaken by the approaching trawl and about 54% of the crabs observed experienced an encounter with the footgear (either disc or spacer/chain). The study also revealed that the majority of the crabs observed appeared to be aware of the trawl and were actively responding and/or reacting to the approaching threat. We discuss the impacts of shrimp trawling on the snow crab resource, further research required to better understand the interactions between snow crab and bottom trawls, as well as potential gear modifications to reduce impacts.

Keywords: snow crab, shrimp trawl, footgear, underwater video

**Computer simulation and flume tank testing of scale engineering models:
How well do these techniques predict full-scale at-sea performance
of bottom trawls?**

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CFRN Project 2.2: Reducing seabed impacts of mobile fishing gears

Presented as: Poster

A Canadian demersal survey trawl (Campelen 1800) was used to investigate the differences in trawl geometry and resistance using dynamic simulation, flume tank testing, and full-scale at-sea observations. A dynamic simulation of the trawl was evaluated using DynamiT software. A 1:10 scale model was built and tested in a flume tank at the Fisheries and Marine Institute of Memorial University of Newfoundland (Canada). Full-scale observations of the Campelen 1800 in action were collected during the 2011 fall multi-species survey aboard the research vessel *CCGS Teleost*. The numerical and physical modeling data were assessed to determine their ability to predict full-scale at sea performance of the Campelen 1800 trawl. The numerical simulation data were also compared against scale model engineering performance under identical conditions. The study demonstrates that the ideal method with which to accurately predict full-scale at-sea performance of bottom trawls or used for designing a trawling system probably does not exist. Therefore, the importance of using two or three complementary tools should be encouraged as an ideal process for designing a trawling system and/or assisting the gear development circle.

Keywords: bottom trawl, dynamic simulation, physical modeling, flume tank

Dropper Chain Footgear: A new approach to environmentally friendly inshore Northern shrimp fishery in Newfoundland and Labrador, Canada

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CFRN Project 2.2: Reducing seabed impacts of mobile fishing gears

Presented as: Oral presentation (15 minutes)

The experimental trawl used in this study was designed to be low seabed impact through the reduction of contact area of the footgear by replacing traditional heavy rockhopper footgear with only a few drop chains lightly in contact with the seabed (i.e., dropper chain footgear). Results from flume tank testing demonstrated that the trawls were similar in net geometry but the experimental trawl had a 62% reduction in contact area with the seabed compared to the control trawl. Comparative at-sea fishing trials revealed that the dropper chain footgear trawl has the potential to catch a similar amount of shrimp with appropriate dropper chain rigging and modifications. Major bycatch species (i.e., turbot, American plaice, and redfish) in terms of percentage of total catch in weight, quantities (i.e., counts), and size (i.e., length distribution) were not significantly different between trawl types. The experimental trawl had significantly lower resistance (i.e., warp tension) than the control trawl, however this did not translate into a detectable reduction in fuel consumption. Although the results are preliminary, this study demonstrated the potential and possibility of using dropper chain footgear trawl for the Newfoundland and Labrador (inshore) Northern shrimp fishery. We recommended further studies that would lead to improve/optimize and eventually commercialize the dropper chain footgear trawl as a low impact shrimp trawl choice in the province of Newfoundland and Labrador.

Closed Areas for Fish, Fisheries and Fishers

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CFRN Project 3.1: Closed Areas in Ecosystem Based Fisheries Management

Presented as: Poster and oral presentation (5 minutes)

This work covers a broad perspective towards the use of closed areas in an ecosystem based management approach, working on the balance between sustainable fisheries and conservation. A large focus is on local fisher involvement, and the use and usefulness of closures (of all types) as a tool. This work covers a global to local approach, and includes: (1) A review on the use of all types of closures with fisher involvement; (2) fishers perceptions and knowledge of closures from multiple use MPAs (Tanzania); (3) fishers perceptions of a fishery closure that was established by local fishers (Labrador, Canada); (4) in depth biological study on the before vs. after effects of a boreal offshore fishery closure (Labrador, Canada). Section 1 is in draft form, 2 and 3 have been published (2), or accepted (3) to scientific journals. Section 4 is in progress. This work should be completed by late 2014.

Visual observations of predation events in estuaries can be used to estimate predation rates by harbor seals on Strait of Georgia chinook and coho salmon stocks

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CFRN Project 3.2: Pinniped and salmon interactions in the Strait of Georgia

Presented as: Oral presentation (5 minutes)

Uncertainty exists over why marine survival rates for chinook and coho stocks have plummeted over the last few decades. We propose conducting visual surveys of pinniped predation on adult salmon in estuarine and riverine habitats to improve understanding of harbor seal predation of salmon in river estuaries. Surveys will occur during the fall and spring months, in order to capture predation events on adult salmon returning to spawn and juveniles out-migrating to marine environments, respectively. There will be focus on counts of seals present in spring, summer and autumn, and harbor seal attack rates and handling times for both smolts and adult salmon. Accurate estimates of these components are crucial in establishing plausible rates of predation from pinnipeds on Strait of Georgia salmon during various life stages. Functional response models established with these datasets will eventually be incorporated into stock assessment models and management strategy evaluations for salmon and harbor seals.

Enhancement options for Atlantic cod in the southern Gulf of St. Lawrence

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CFRN Project 3.2: Assessing the impact of marine mammals on the recovery of salmon, rockfish, herring, and cod

Presented as: Oral presentation (5 minutes)

Two decades of a commercial fishing moratorium on Atlantic cod in the southern Gulf of St. Lawrence has not stopped the population decline. Some hypothesize that high predation rates by grey seals have hampered recovery by increasing natural mortality to unprecedented levels. However, there is uncertainty about when, where and how much cod are being consumed. There has been much discussion of the role of grey seal predation on target fisheries species in the Gulf of St. Lawrence. We developed a catch-at-age model with residual mortality to address consumption of cod. The biological modeling was complimented with an in-depth fishery questionnaire through a consultation process with fishermen and social scientists. This methodology allowed us to explicitly address direct and indirect effects of the impacts of grey seals on target fishery species. We received 300 responses from Gulf fishermen, 200 of which were analyzed in terms of attitudes toward employment opportunity, fishery involvement, gear damage by fishing area and parasite infection rates. We found that attitudes toward future employment opportunities in the Gulf of St. Lawrence were generally negative, regardless of seal presence or fished area. We conclude that it is possible to quantify specific interactions with respect to time allocated to minimizing or redressing negative interactions with grey seals. However, specific monetary accounting of negative interactions requires further investigation. The results of this study will be incorporated into a risk assessment framework to analyze a portfolio of grey seal management scenarios as they impact important fisheries species. Results will be placed within a decision network for the southern Gulf ecosystem.

Comparing the predicted food requirements of seals and sea lions

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CFRN Project 3.2: Assessing the impact of marine mammals on the recovery of salmon, rockfish, herring and cod

Presented as: Poster and oral presentation (15 minutes)

Marine mammal predation has been a leading hypothesis for declines of commercially valuable fish stocks in Canada, but it remains poorly quantified. We predicted the energetic requirements of Steller and California sea lions, harbour and grey seals using a bioenergetics model. The energetics model predicted daily energy requirements by accounting for the costs of growth, metabolism, activity, digestive efficiency and reproduction. Overall, sea lions had higher predicted energy needs per unit body mass than seals (e.g., adult male Steller sea lions required ~23% more energy than harbour seals). When translated into total daily fish requirements, an adult male Steller sea lion would require ~22 kg/day of Pacific salmon compared to a harbour seal that would only need 2.3 kg/day. Similarly, a grey seal would require 7 kg/day of Atlantic cod. These results will be incorporated into consumption models to determine the impact of marine mammals on fish stocks.

Evaluating Impacts of Policy on the Financial Viability of the BC Small Boat Groundfish Fleet: Use of Cash Flow Modelling to Assess Enterprise Level Financial Viability

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CFRN Project 3.3a: Applying management strategy evaluation to identify economically viable harvesting options for the B.C. small boats groundfish fleet

Presented as: Oral presentation (5 minutes)

British Columbia's groundfish fisheries have undergone major change in recent years. An integrated groundfish management regime was introduced in 2006 which included 100 percent monitoring and expansion of the individual transferable quota system. 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. Despite the opportunities presented by integration for the small boat fleet, rising costs and limited access to quota have been identified as major challenges. A cash-flow modelling approach is one component of broader research being undertaken to evaluate the long-term implications of different policy options on the BC small boat groundfish fleet. Cash flow analysis is a common method used in finance to value an enterprise and assess financial metrics such as rate of return. Typically used where full access to company financials is available, for the purposes of this research, a fully functioning cash flow analysis tool will be developed specific to the BC groundfish fishery and populated using simulation modelling techniques. The cash flow tool will be an important output of the research and the estimated financial metrics will contribute to the latter stage of the research, namely the development of a fleet dynamics model and integration within a Management Strategy Evaluation framework.

Evaluating Impacts of Policy on the Financial Viability of the BC Small Boat Groundfish Fleet

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CFRN Project 3.3a: Applying management strategy evaluation to identify economically viable harvesting options for the B.C. small boats groundfish fleet

Presented as: Poster

An integrated management regime was introduced in the BC groundfish fisheries in 2006 which included 100% monitoring and expansion of the individual transferable quota system. The integration of the groundfish fisheries opened new opportunities for the BC small boat groundfish fleet, but has also led to a number of challenges. Two areas in particular have presented difficulties in recent years: 1) quota availability for non-directed catch, notably rockfish stocks being managed under rebuilding strategies; and, 2) the functioning of the quota market. This research will address questions about the long-term viability of the small boat fleet, contribute to an improved understanding of the BC groundfish fisheries, and demonstrate new approaches for fisheries management and evaluation. Specific actions being undertaken as part of this project include a review of the current state and historical trends in the ownership dynamics of the BC groundfish fishery, the development of a fishing vessel profit model using a cash flow modelling approach, development of a fleet dynamics model for the small boat fleet, and communicating and evaluating model results through techniques such as Bayesian Decision Networks and Management Strategy Evaluation.

Evaluating the impacts of current and alternative harvesting strategies on Skeena River salmon populations and fishing fleets

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CFRN Project 3.3b: Skeena River salmon fisheries

Presented as: Oral presentation (5 minutes)

Computer simulation tools have been developed that can be used by commercial fishers and government managers to create better policies for regulating the complex Skeena River fisheries. These tools consider a variety of conflicting objectives (production, biodiversity, allocation among users) defined through meetings and discussions with industry (United Fishermen and Allied Workers Union) and government (biologists and managers) collaborators. Some preliminary analyses of current and possible future management strategies are discussed.

Linear programming for constrained optimization of the Skeena River fisheries

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CFRN Project 3.3b: Skeena River salmon fisheries

Presented as: Poster

Linear programming is used to optimize harvest of the mixed stock pacific salmon fishery on the Skeena River. An in-season management model is built to track salmon stocks migrating through the fisheries that they may face during their adult migration from the ocean to the Skeena River and then to upstream spawning areas. This model is used with linear programming algorithms to optimize the value of the fishery within any given fishing season (measured in landed value of fishes) while respecting social, economic, and conservation constraints on harvest rates.

Bayesian estimates of Sockeye Salmon run size and timing on the Skeena River

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CFRN Project 3.3b: Skeena River salmon fisheries

Presented as: Poster

Bayesian analysis is used to improve models of in-season estimates of pacific salmon run size and timing on the Skeena River, this analysis takes advantage of advances in Bayesian software to perform full Bayesian inference and evaluate the posterior probability of the run size and run timing as the fishing season develops. Simulation evaluation shows marked improvement over the methods currently in use on the Skeena and a retrospective analysis is conducted to evaluate the performance of this new method to the old method currently in use.

Simulation Evaluation of a Depletion Estimation Survey Design

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CFRN Project 3.3c: Closed Loop Simulation of Input Controls for the Hecate Strait Dungeness Crab Fishery

Presented as: Poster

Depletion estimation has been used in Fisheries for over 70 years. If you caught all the fish you would know how many fish were in the water prior to fishing. You cannot catch all of the fish, but by carefully keeping track of how much more difficult catching fish becomes as the stock depletes you can estimate how large the stock had to be at the beginning. In the Dungeness crab fishery the legal sized male crabs are heavily exploited, so a depletion estimate may perform well. There are challenges in designing survey protocols for tracking how difficult catching fish becomes; fishermen might maintain a high catch per trap pull on a small spatial area even when the stock is at low abundance, or there may be spatial areas of high crab abundance that are unfished. Computer simulations can screen protocols for estimating how hard it is to catch fish.

Pacific Hake management strategy evaluation

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CFRN Project 3.3d: Developing management procedures robust to variability in stock productivity arising through trophic interactions and persistent environmental changes - Pacific hake case study

Presented as: Poster and oral presentation (5 minutes)

Pacific hake is a transboundary stock managed under an international treaty between the U.S. and Canada. The species is characterized by its migratory behavior. Spawning occurs off Southern California during the winter and fish migrate North during summer and fall to feed, with larger fish reaching further North. In recent years, a decreasing trend in the proportion of the stock that migrates into Canadian waters has been observed. Potential causes are: the truncation of age and size distribution, density dependent effects (fish do not migrate as far as if abundance is low) and environmental effects (fish will migrate further north in warmer years). This project aims at developing a management strategy evaluation for Pacific hake to evaluate the current management procedure and to identify alternatives that would promote an equitable access to the resource for both U.S. and Canada.

Using simulation to address critical fishery management problems

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CFRN Project 3.3d: Developing management procedures robust to variability in stock productivity arising through trophic interactions and persistent environmental changes

CFRN Project 3.3e: Developing in-season management methods for spatially complex mixed-stock fisheries with a focus on the West Coast Vancouver Island salmon troll fishery

Presented as: Oral presentation (15 minutes)

There is increasing use of complex stock assessment methods in the management of North American fisheries. While technically advanced, these assessments often fail to account for critical population processes or address established data problems. Common failures relating to spatial stock structure, regime shifts and unreliable historical fishery data are often apparent to stakeholders. These limitations combined with the technical detail of complex stock assessment can lead to a gap in understanding between analysts and stakeholders. The problem may be further exacerbated by providing results of limited relevance to decision making of stakeholders. In tandem with an increasing body of research into data-limited assessment methods, simpler and transparent management procedures are being developed and tested that can outperform those using complex assessments which may be expensive and opaque. While imperfect, simulation evaluation can address many of the issues above and provide outputs that are of greater relevance to stakeholders.

Spatial management strategy evaluation for the BC Herring fishery

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CFRN Project 3.3d: Developing management procedures robust to variability in stock productivity arising through trophic interactions and persistent environmental changes

Presented as: Poster

The BC herring fishery is currently managed as a number of discrete stocks each with its own area. However tagging data and genetic analyses provide evidence of movement among these areas. We propose a management strategy evaluation framework to quantify the performance of various management procedures that may be robust to spatial stock structure. The framework is designed to generate results relevant to the diverse interests of the various industry stakeholders. Central outputs of this research include identification of suitable assessment methods, revealing trade-offs in utility among stakeholders and identifying suitable protocols for data gathering.

A population dynamics model of Chinook salmon stocks intercepted by the West Coast of Vancouver Island salmon troll fishery

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CFRN Project 3.3e: Developing in-season management methods for spatially complex mixed-stock fisheries with focus on the West Coast Vancouver Island salmon troll fishery

Presented as: Poster and oral presentation (5 minutes)

The West Coast of Vancouver Island (WCVI) salmon troll fishery is a spatially complex mixed-stock, multi-stakeholder fishery that has undergone many management changes under the influence of a variety of policies. Due to the large amount of uncertainty surrounding the impacts of this fishery on intercepted salmon stocks, management decisions have largely been guided by increased precaution for salmon conservation. As a result, management changes in the past have led to a significant reduction in harvest rates, threatening the fishery's viability. Under such conditions, the most efficient investigative tool to begin with is a stochastic model of the population dynamics of the Chinook salmon stocks. Use of this model has the potential to improve our ability to investigate the consequences of various uncertainties in and harvest influences on salmon stocks and aid development of improved management strategies to more effectively sustain the WCVI salmon troll fishery into the future.