



Sustaining the Bay of Fundy: Linking Science, Communication, Policy, and Community Action

Proceedings of the 10th BoFEP Bay of Fundy Science Workshop, Coastal Zone
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Editors

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Preface

The Proceedings describe the program, papers, posters and discussions that occurred at the 10th BoFEP Bay of Fundy Science Workshop, held in Halifax, Nova Scotia, June 2014, in conjunction with the Coastal Zone Canada Conference. The BoFEP workshops have been a continuing series, started in 1996 in Wolfville, NS. The objective has been to have a biennial forum on scientific studies and general community based information on environmental and resource issues in the Bay of Fundy and its watersheds. The Halifax workshop sessions were well attended. Special sessions were held on sediment dynamics, the role of information in coastal and ocean management, and indigenous communities and their enduring contribution to the future of coastal ecosystems and resources. Contributed papers covered topics such as intertidal ecology, tidal energy, aquatic ecosystem health, and emerging issues. An interactive poster session was held, intermingled with the posters of the larger conference. The success of the workshop reflected its inclusion in the Coastal Zone Canada 2014 Conference, whose organizers contributed greatly to its logistics and coordination.

Acknowledgements

The Management and Steering Committees of BoFEP thank the organizers of the Coastal Zone Canada 2014 Conference for including the workshop as part of the main CZC program, and for their considerable assistance and financial support to make the workshop a success.

Workshop Organizers

Marianne Janowicz and Peter Wells were members of the CZC 2014 Program Committee. Susan Rolston handled logistics for CZC 2014. Jon Percy advertised the workshop through BoFEP channels.

Partners and Sponsors

The CZC 2014 Conference, which included the BoFEP Workshop, was sponsored by the following organizations. They are greatly thanked for their financial and /or in-kind support which was crucial to the success of the entire conference. The partners and sponsors are:

- 1) **Advocate Partner:** Coastal Zone Canada Association.
- 2) **Oceans Gala Partners:** Dalhousie University; Ocean Technology Council of Nova Scotia; Nova Scotia Community College; Waterfront Development (Halifax).
- 3) **Opening and Poster Receptions Partners:** Saint Mary's University; Gulf of Maine Council on the Marine Environment.
- 4) **Student Partner:** World Wildlife Fund.
- 5) **Breaks and Lunches Partners:** Newfoundland and Labrador, Fisheries and Aquaculture; Marine Institute, St. John's, NL; CBCL Consulting Engineers; Canadian Wildlife Federation; Ecology Action Centre; Stantec.
- 6) **Friends of the Coast:** Dalhousie University (Environmental Information: Use and Influence Program); Situating Science – Science in Human Contexts; Tangier Lobster Company Limited; Clearwater; Glenora Distillery; Prince Edward Island, Canada; Nova Scotian Institute of Science.

- 7) **Collaborating Organizations:** COIN Atlantic; Atlantic Coastal Zone Information Steering Committee; Ocean Tracking Network; Halifax Regional Municipality; International Ocean Institute – Canada; Institute for Ocean Research Enterprise; Fisheries and Oceans Canada; Environmental Services Association of Nova Scotia; MEOPAR (Marine Environmental Observation Prediction and Response Network); Bay of Fundy Ecosystem Partnership; Museum of Natural History, Halifax, Nova Scotia; Maritime Museum of the Atlantic.

Core Sponsors of BoFEP

BoFEPs' core sponsors over many years have been the following: Environment and Climate Change Canada; Fisheries and Oceans Canada; Gulf of Maine Council on the Marine Environment; Acadia University (Acadia Center for Estuarine Research); and Dalhousie University (Environmental Information-Use and Influence Program; International Ocean Institute-Canada); and SeaPen Communications, Granville Ferry, NS. They are greatly thanked for this long-term financial and/or in-kind support. Thank you also to the members of BoFEP who have given generously of their time, skills, and in-kind support to BoFEP activities, projects and administration.



1. Overview of the Workshop

The theme of the workshop was “Sustaining the Bay of Fundy: Linking science, communication, policy and community action.” This was chosen to emphasize the importance of translating what we know and obtaining action more rapidly and effectively on current problems facing the Bay and its watersheds. The workshop benefited greatly by being part of the greater conference, whose theme was “Our Coast – Legacies and Futures.”

Three keynote talks addressed challenges that society confronts – that of managing the data and information for efficient access and use, the need to mitigate the effects of climate change, and the need to put our challenges into the context of the global oceans where many coastal communities are seeking common solutions.

Some of the main points from special sessions at the workshop were as follows. It is crucial to understand the origin, fate and effects of sediments along the coasts, that is, the field of sediment dynamics. Particles transport wastes and toxic substances, and are influenced by coastal industrial activity, such as aquaculture and tidal power development. The sediment dynamics session presented cutting edge research in this field. The session on information explored the importance of understanding the science-information-communication-policy interface in coastal management; an interdisciplinary group of speakers addressed current understanding of how information flows across the various interfaces between production and use, and why this was important to conducting research relevant to policy formation, the underpinning of solutions. The EIUI team sponsoring this session have produced a book on the topic, to be published in May 2016 by CRC Press (see p. 31 below). A third session was held on indigenous communities and their role in the future of Canada’s coasts; the session highlighted the unique issues and challenges faced by coastal First Nations peoples.

In the contributed papers sessions, there was a very strong session on intertidal ecology (salt marshes and mudflats), core research to the BoFEP mission of protecting sensitive Fundy habitats and species. Much new work on methods of marsh restoration has been accomplished. Mudflat studies continue with an emphasis on monitoring the presence and impacts of invasive species, e.g. green crabs, and understanding the food requirements of shore birds and the ecology of their prey, especially the amphipod *Corophium*. New work reported on tidal energy focused on animal tracking technology and the approaches to environmental risk assessment that can be used to aid decision making for tidal development projects. The session on aquatic ecosystem health had papers on indicators, as well as a description of BoFEP’s current work to develop an ocean health index for the southwest part of the Bay. The final contributed paper session was on current issues for coastal peoples, covering emerging contaminant issues, coastal development, whale protection and new emerging issues. The range of topics speaks to the diversity of challenges faced by the Bay of Fundy in this era of climate change and advancing coastal development, both along the shorelines and in the watersheds.

The BoFEP poster session was integrated in the larger CZC 2014 session and greatly contributed to the whole Conference.

Several of the CZC 2014 outcomes (CZCA, 2014, unpubl. doc.) are relevant to the Bay of Fundy and greater Gulf of Maine, and deserve mention. For effective coastal management, one must recognize the roles of big data, the science-policy interface, the importance of involving non-government organizations and youth, and social media. Recommendations of CZC 2014 were made under the headings of governance, research and data, management, and public outreach, all relevant topics to the

long-term management of the Bay of Fundy. The reader/participant is encouraged to read the full document, available on the CZCA website. Of special importance to the theme of the BoFEP workshop is the recommendation to continue to raise public awareness of the issues, and to invest in education about the coasts and oceans in schools and with the interested public.

This workshop series continues with the eleventh planned for Fredericton in June 2016, on the theme of “Fundy in Flux.” This workshop comes at a time of the twentieth anniversary of BoFEP, a time to reflect on accomplishments of the past and the future challenges for the group and the Bay.

2. Keynote Addresses (with Coastal Zone Canada)

Timothy Kearns – *The Pandemic of Databesity*
Vice-President of Consulting Services, ClipCard

We have more data at our disposal than ever before yet our utilization of it remains cumbersome and ineffective. The rise of mobile and cloud computing is enabling us to take advantage of extracting the valuable information out of all this big data we are generating.

Dr. Francis Zwiers – *Evidence of a Changing Climate*
Director and CEO, Pacific Climate Impacts Consortium

Despite some recent slowdown in the rate of global warming, there is overwhelming evidence that the climate system has warmed over the past century and that human induced emissions of greenhouse gases are a major contributor to that warming. This talk will review the evidence, describe projections for the future, and consider the prospects for limiting the amount of additional warming.

Right Honorable Paul Martin – *It’s Time to Think About the Global Oceans*
Commissioner, Global Ocean Commission

Mr. Martin is one of 17 Commissioners on the Global Ocean Commission, who have spent the last year reviewing the present state of the World’s oceans to provide politically and technically feasible recommendations to address key issues facing the high seas. In his address Mr. Martin will consider the state of the Commission’s work and his experience with it in reviewing the state of the World’s oceans and the potential to address the pressing issues they face. He will also reflect on his experience in the Commission in terms of the potential for Canadian ocean leadership, its role as a coastal nation and a path forward that includes government, private sector and coastal communities to meet the challenges ahead and the need for common solutions.



3. Special Session Abstracts

3.1 Sediment Dynamics in an Evolving Coastal Zone

Convenors:

Brent Law, Fisheries and Oceans Canada, Brent.Law@dfo-mpo.gc.ca

Danika van Proosdij, Department of Geography, Saint Mary's University, dvanproo@smu.ca

The transport and deposition of fine grained particulate material in aquatic environments are fundamental processes that affect the development and sustainability of habitat. Mud makes up the largest and most abundant type of bottom habitat but in the wrong location it can become problematic. Studies of benthic ecology require knowledge of both the substrate and the supply of food to it making flocculation and its effect on particle transport an essential research component of ocean resource management. The study of sediment dynamics in the coastal zone has application to almost all components of ecosystem.

The issues are wide spread and can include:

- 1) Aquaculture – the deposition and accumulation and erosion and transport of aquaculture waste, changes in sedimentation due to aquaculture activities
- 2) Oil and Gas – the fate and effects of drilling muds, the transport and accumulation of drill muds, the transport and accumulation of produced water constituents and oil spill dynamics
- 3) Tidal Power – the effects of in-stream tidal power and possible changes to sediment dynamics including basin scale, tidal flat, tidal channel and tidal marsh systems
- 4) Tidal Barriers – the changes in sediment dynamics related to restrictions of flow
- 5) Optics – the effect of particle composition and packaging on optical properties including remote sensing of plankton blooms and sediment transport in coastal waters
- 6) Contaminant transport – Historic Mine Tailings, dredging and other MEQ issues.

This session looks to draw from a wide audience to get a full understanding of sediment dynamics research in the coastal zone including observations and modelling, its implications and possible future research required in the field. Student research will compose a large component of this session as well as talks directly related to the Bay of Fundy

Papers presented in this session:

Variability of Particle Distribution Using Optical Measurements Within the Columbia River Plume

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The Columbia River plume is affected strongly by river, tidal and wind-driven flows. These flows influence the suspended sediment and associated optical properties. To explore the linkages among physical forcing, particle properties and optics, we measured profiles of in situ optical properties concurrently with measurements of suspended particle concentration and size distributions in the

plume in June, 2013. At a series of stations distributed throughout the mouth and into the nearshore during ebbing and flooding tides, a Machine Vision Floc Camera and a LISST-100x were deployed to measure particle sizes for diameters ranging from approximately 2 μm to 4 cm. Beam attenuation was also measured by the LISST. Water samples were collected, and particles were filtered and weighed for analysis of suspended particulate mass concentration, which was compared with beam attenuation measurements at 0, 5 and 10 m depth. Preliminary analysis indicates rapid loss of flocculated sediment from the river plume once the plume loses contact with the seabed. The largest concentrations and particle sizes occur in the toe of the salt wedge. Biological particles dominate in nearshore waters.

Flocculation and Sediment Deposition in a Hypertidal Creek

O'LAUGHLIN, Casey¹, VAN PROOSDIJ, Danika¹, MILLIGAN, Timothy G.²

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In the hypertidal Bay of Fundy, environmental impacts in response to commercial-scale tidal power development remain to be fully understood. The extraction of tidal energy may impact sediment dynamics in far-field environments, such as the intertidal zone, through potential alterations to tidal amplitude in the Minas Basin. Tidal conditions (e.g. current velocity, turbulence, suspended sediment concentration) were monitored in a sheltered salt marsh creek over 18 tidal cycles in various stages of the spring-neap cycle. Samples of suspended and deposited sediments were collected and analyzed for grain size using a Beckman Coulter Multisizer III. Results suggest that the flocculated component of both suspended and deposited sediment is consistently high over a wide range of tidal conditions. A routinely high incoming concentration of highly-flocculated material results in large amounts of sediment deposition in tidal creeks in response to individual tidal cycles. Much of this newly deposited material is re-suspended with tides that fully inundate marshes. Disruption of the current sediment balance and tidal regime due to a reduction in Minas Basin tidal amplitude may lessen the cumulative export capacity of tidal channels over time, potentially leading to gradual infilling of tidal creeks.

Seasonal Variability in Sediment Dynamics in a Bay of Fundy Tidal Channel and Salt Marsh

POIRIER, Emma¹, VAN PROOSDIJ, Danika¹, MILLIGAN, Timothy G.²

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The purpose of this research was to determine the seasonal variability in hydrodynamics, sediment characteristics and sediment behaviour in a Bay of Fundy tidal creek and salt marsh system. With anthropogenic and climatic changes being imposed on intertidal communities, it is necessary to understand the fundamental sediment processes occurring. Sediment deposition, suspended sediment concentrations, current velocities and surface sediment samples were collected at Kingsport marsh approximately every six weeks from May 2012 to June 2013. Data were collected along a cross section including four zones: the creek thalweg, marsh bank, marsh edge and marsh surface. To measure seasonal changes in elevation in a broader perspective, five high resolution topographic surveys of the channel were conducted. Deposition was highest in the creek thalweg, intermediate on the marsh bank and lowest at both the marsh edge and surface. Grain size and concentration both decreased with

increasing distance from creek. Periods with rainfall were followed by high suspended sediment concentrations as rain mobilized sediment during low water. Incoming suspended sediment concentrations were generally higher in the three colder deployments. This increase in sediment supply in the winter was enough to influence deposition in the creek and on the marsh bank but not enough to influence the deposition on the marsh edge and marsh surface. Therefore, the high marsh was not as seasonally variable as the bank and the creek. Understanding the mechanism of sediment transport and behaviour in these intertidal ecosystems is crucial to anticipating changes in sedimentation patterns from anthropogenic influences.

Temporal and Spatial Change in Grain Size and Erodibility on a Macro-tidal Channel-flat Complex in Kingsport, N.S., Canada, Versus a Meso-tidal Channel Flat Complex in Willapa Bay, Washington, USA

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Understanding of sediment texture and erodibility on muddy tidal flats and channels on temporal and spatial scales is required to resolve formative processes and the subsequent transport of sediment in these areas. Recognition of the importance of flocculation to the formation and maintenance of cohesive intertidal deposits has spurred investigations on textural studies of bed sediments, field studies of suspended flocs, and modelling studies. Regional grain size surveys were carried out in September 2008, July 2009, and February 2010, on the muddy meso-tidal flats and channels in the southern end of Willapa Bay, Washington State. Results indicated that floc fraction, the amount of bed sediment deposited as flocs, showed a strong inverse correlation with seabed elevation. No correlation between sediment grain size and distance to the nearest channel could be delineated. Erodibility studies, using a Gust chamber, showed that bottom sediments became more erodible in the tidal channel during winter when suspended sediment concentrations were high in comparison to summer values.

In April 2012, a study was initiated to examine the seasonal change in grain size and erodibility on a muddy macro-tidal flat and channel complex in Kingsport, N.S. Sixty samples were collected for bottom sediment grain size analysis every month with 37 from the tidal flat and 23 from a tidal channel and its banks. Erodibility measurements were made monthly with a Gust erosion chamber on duplicate samples from the tidal flat, left and right tidal channel bank, and the channel thalweg. The monthly sampling was completed in March 2013. Results to date suggest that bottom sediment size does correlate with distance to the nearest channel. Erodibility measurements show an annual order of magnitude difference in cumulative mass eroded and may be responsible for the order of magnitude change in suspended sediment concentration in the Upper Bay of Fundy between winter and summer.

Tidal and Seasonal Variation of Sediment Concentration in Minas Basin

HORNE, Edward¹, DROZDOWSKI, Adam¹, LAW, Brent¹, BUGDEN, Gary¹, CRAIG, Susanne²

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Sediment concentrations from anchor stations in Minas Basin over a tidal cycle in June 2013 and March 2014 are analyzed to show how the concentration varies over a tidal cycle and with the season. The results are compared with current meter data taken in the area to show a possible driving mechanism for the variability. Remote sensing is used to help show the seasonal variability. Optical measurements of reflectance are used to help ground truth the remote sensing.

Spatial Variability in Sediment Transport Processes in the Minas Basin: Implications for Modelling the Potential Effects of Tidal Energy Extraction

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Accurate modelling of the potential effects of tidal energy extraction requires sound empirical field data for validation. The challenge however is to differentiate between the various scales of natural variability. This variability is expressed both spatially and temporally, within and between sites. This presentation will examine the spatial variability in sediment transport processes and resultant deposition at a range of spatial and temporal scales within the Cornwallis Estuary in the Minas Basin. Data were collected at three intertidal ecosystems with varying geomorphologies, exposure, position within the tidal frame and vegetation communities. Sediment transport processes, deposition, vegetative, sediment and meteorological conditions were recorded during approximately 120 tides over a 4 year period. Sediment deposition varied between intertidal environments with significant differences in creek versus marsh surface and tidal amplitude. The grain size spectra between tides were very similar, and the highly flocculated nature of the material leads to more rapid settling with higher suspended sediment concentrations and more resultant deposition with a greater volume of water. However sediment deposition is not linked to changes in floc fraction. Suspended sediment is consistently highly flocculated, and high incoming SSC encourages rapid settling with calm conditions. Increases in flow velocity and bed shear stress increase the proportion of coarse particles in deposited material, however is spatially variable. Overall, these findings provide important baseline information regarding natural variability in biophysical processes and the resilience of intertidal ecosystems to respond to changes in the environment that can be applied to computer models currently being developed to investigate the potential far-field effects of tidal energy extraction.



3.2 Does Information Matter? A Critical Question for the Future of Coastal Zone Management

Convenor:

Bertrum MacDonald, Dalhousie University, bertrum.macdonald@dal.ca

This session presents interdisciplinary perspectives on the challenges of communicating scientific information to users, e.g., policy makers, decision makers, and resource managers, for integrated coastal and ocean management (ICOM). For several decades, coastal and ocean managers have developed the theory and practice of ICOM. But while ICOM is regarded as highly complex, the vital role of information in solving environmental and societal problems receives much less recognition. Furthermore, in spite of the increasing quantity of available scientific information published as primary and grey literature, in print and digital formats, the ability to solve coastal and marine environmental problems appears to be decreasing. Why? Will this situation worsen or can it be turned around? What characterizes the information activities occurring at the science-information-policy interface? What factors influence awareness and use of information and knowledge in policy-making contexts? Drawing on their expertise, presenters will address these and other questions aimed at resolving the disconnect between the availability and potential use of information, and problem resolution. The session will cover historical perspectives of the contribution of science to policy, the changing information landscape, methods for measuring information use, global environmental governance related to information use, evidence-based policy making, and characteristics of the science-policy interface.

Papers presented in this session:

Bridging the Science-Policy Gap in Marine Environmental Management

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This paper will introduce the special session “Does Information Matter” for coastal zone management organized by the Environmental Information: Use and Influence (EIUI) interdisciplinary research initiative at Dalhousie University. The role of information in solving environmental and societal problems has received little recognition, particularly in the highly complex subject of coastal zone management. Moreover, in spite of the growing quantity of available scientific information, the ability to solve coastal and marine environmental problems does not appear to be increasing. How management advice is used in policy-making is not clear. How do policy-makers determine what is the “right” information, how do they interpret scientific advice, what is the role of various actors in information use in the policy process, what are the indicators of information use or influence in this process? Such questions are guiding studies on knowledge mobilization at the science-policy interface, including data accessibility and use, and information management in policy contexts. The work of leading experts and research initiatives, such as EIUI, can increase understanding and provide insights to bridge the science-policy gap. The paper will present an overview of historical and contemporary thought on the science-policy interface including the characteristics and interpretations of the interface, information use related to global environmental governance, evidence-based policy making, the main challenges to information use, methods to identify the challenges and opportunities for information use in policy contexts, and existing and emerging tools to connect science and policy.

Inducing More Effective Stakeholder Searches for Sound Environmental Information

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Over the past several decades there has been remarkable progress in generating useful information relevant to environmental decision making. While there are still challenges in the generation of sound environmental information, it is clear that the “uptake” of sound environmental information has not kept up with its supply. Citizens, resource-users and policymakers too often rely on inadequate or inappropriate environmental information. There is no shortage of possible reasons for this: proliferation and spread of unsound information, confusion over reliability of sources, information glut in general, overly technical information, issue fatigue, etc. The problem has been addressed largely by asking how sound information can be packaged and delivered more effectively. Yet the problem also has to be addressed from the other side: how to induce more effective stakeholder searches. Numerous potential approaches include the content and format of the information, but go beyond that to strategies of social interaction.

Therefore this paper will explore the following question: what approaches can governments, NGOs, researchers, or others use to induce people to extend their information searches, both temporally and in scope, to secure an adequate understanding of the consequences of their actions and of policy alternatives that affect the environment?

In the Eye of the Beholder: Scientific Uncertainty and Information Flow in Fisheries and Land-Use Governance Networks

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Scientific uncertainty in fisheries science has negatively impacted management deliberations, and considerable effort has been put to reducing uncertainties in scientific models and developing new mechanisms to discuss uncertainty. While some fisheries scientists have argued that an over-emphasis on uncertainty can lead to management paralysis, others have found that a lack of openness and transparency about uncertainty can undermine credibility of the science. The salience, credibility, and legitimacy of scientific information have been shown to be critical factors driving the use of science in fisheries management. At the same time, communication research reveals that the public can interpret scientific uncertainty as a poor understanding of the topic and those who communicate about uncertainty are untrustworthy, while scientists view estimation of uncertainty as reflecting a deeper understanding, and more credible science. In sum, the social science paints a confounding picture; uncertainty is not an insurmountable barrier to effective communication and use of science, but different stakeholder audiences respond differently to the same message. We examine fisheries and land-use communication and influence networks to illustrate the nature of scientific information flow and impact in decision-making, the impact of multi-stakeholder network structure and function on information flow and influence, and the challenges and opportunities for building salience, credibility and legitimacy. Subgroups of experts, boundary spanners, and other connectivity roles among network members drive the flow of information and contribute to the influence of the scientific information they

supply. Ramifications for integrated coastal and ocean management and fisheries management are discussed.

Designing Outcome-oriented Research to Improve the Relevance of Environmental Science for Policy

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Research in science policy has demonstrated consistent challenges in effectively linking environmental science with decision making. Some of these challenges are due to different cultures, epistemologies and priorities that separate science from policy. But one underlying challenge relates to the fact that most environmental science research is undertaken in a mode consistent with a linear model of science policy, one that elevates the purpose and value of knowledge inquiry over the relevance of knowledge to inform decision-making. Moreover, scientists often believe that if decision-makers had more knowledge they would make better decisions, when in fact more research, that lacks relevance to the policy problem, fails to adequately inform decisions. This presentation will identify some of the challenges inherent in undertaking policy-relevant research and then explore ways that scientists and their organizations can re-shape their research agendas and organizational processes in ways that can increase the relevance and social value of the knowledge they produced. The design and function of boundary organizations and necessary human capital to facilitate engagement between science and policy will also be discussed.

Communicating Complex Environmental Information in Political Contexts: Lessons Learned from the IPCC for IPBES and Marine Biodiversity Conservation

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Global biodiversity is declining at an unprecedented rate, requiring political action on multiple fronts, from the local to national and international levels. Established in 2012, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) will provide a scientific advisory role for the UN Convention on Biological Diversity analogous to that provided by the Intergovernmental Panel on Climate Change (IPCC) to the UN Framework Convention on Climate Change. The IPCC has encountered significant controversy in its fifteen-year history, including attacks on its credibility and on the quality of the information it has produced. This paper will examine the legacy of the IPCC's experience with communicating science to political and general audiences, and resulting opportunities and challenges for the developing IPBES process. According to its mandate, IPBES will aim to strengthen capacity for the effective use of science in decision-making at all levels. While communicating science on climate change has significant political challenges as evidenced by the controversies weathered by the IPCC, the IPBES's approach, pooling biodiversity and ecosystem services, may open the door to debates on issues including, (1) valuing nature and (2) biodiversity offsets, both of which take an anthropocentric view of biodiversity conservation and are mired in controversy. Drawing on examples of science communication in spatial approaches to marine biodiversity conservation, such as Marine Protected Areas, this paper

will provide an opportunity to think strategically about possible pitfalls while the IPBES's approach and mechanism is still in an early stage of development.

Measuring Use of Fisheries Information in Policy-Making for Fisheries Management

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Evidence-based policy-making is a complex process in which scientific knowledge interacts with other types of knowledge, e.g., local knowledge, in addition to a range of factors including personal and institutional interests and values of multiple stakeholders. Studies on the use of marine fisheries information in policy-making are limited and these studies indicate a limited use of fisheries scientific information in the policy process to effect fisheries management.

This paper describes doctoral research which seeks to address the gap in the knowledge of the role of available fisheries scientific information in policy-making for marine fisheries management. The research aims to develop an understanding of the role(s) of fisheries scientific information, produced by governmental and intergovernmental organizations in influencing policy decisions by identifying instances where information is or can be used in fisheries policy development and management decisions and by identifying the main actors involved.

Research includes case studies of three inter-related organizations – the UN Food and Agriculture Organization, Northwest Atlantic Fisheries Organization, and the Canada Department of Fisheries and Oceans. The research utilizes mixed-methods, including mainly qualitative methods, to understand the production and use of fisheries scientific information within each organization. Methods include surveys of key actors, direct observations at relevant science and advisory meetings, and content analysis of key scientific publications. The findings will develop models of information flows and a tested methodology for assessing information use. The research will be one of the first comprehensive studies within governmental organizations on the role of fisheries scientific information in policy-making.

Just Evidence: Governing Knowledge by Opening Data

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Evidence-based policy weakened to evidence-informed policy has reached a critical turn, exposed as conflicted by science that lacks transparency and accountability. Growing public attacks by scientists across disciplines, concerned about industry and ideological doctoring and the blocking of data from independent expert critical review, has showcased politics in the process of research design and analysis. Public trust in corporatized science, in the making and uses of medicines, in research and health service “enterprises”, is in decline worldwide. Social media have opened the window to both witness and respond to the techno-political interventions that disrupt and poke holes into ecosystems. Context counts in these systems; epigenetics is unlocking new human and non-human kinds co-evolving from the matrices of biologies, environments and socio-biopolitics. Particular assemblages of architects

and institutions construct and authorize the scientific instruments used to define certainty and kinds of truth. They determine the allowable margins for uncertainty, for whom and what is measured in health, therapeutics and environments, for what counts as evidence. A morally engaged anthropology can lend critical ethnographic interrogation to these assemblages of science and technologies. It maps the local-global interstices connecting bio-political cultures to human and non-human becomings, and roots out the values attached to life; values that are not always economic. Structural adjustments that have produced unsustainable and inequitable economic gains and capital accumulation have promoted the interested authorization of evidence. Let us consider how we might engage in the development of moral policies that govern and defeat unjust perversions to expert knowledge.

Awareness and Use of State of the Marine Environment Reports: A Case Study of the State of the Scotian Shelf Report

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Over the past 40 years, various governments, non-governmental organizations, and inter-governmental partnerships have produced State of the Marine Environment (SOME) reports. These reports provide comprehensive accounts of available scientific information for particular marine ecosystems, for the purpose of supporting policymakers in the decision-making process. However, in recent years, concern has arisen about the extent to which these reports are actually used.

The Environmental Information: Use and Influence research initiative, in collaboration with the Canadian Department of Fisheries and Oceans (DFO), has conducted a case study investigating the awareness and use of the State of the Scotian Shelf Report, a regional SOME report co-published by DFO and the Atlantic Coastal Zone Information Steering Committee (ACZISC). Subscribers of ACZISC's Coastal Update Newsletter, the primary audience for promotion of the report, were surveyed, as were other target groups. The surveys, along with the results of other analytics, were used to assess the degree to which the document is being used to support decision-making by the target audience.

Results of the study will be presented, and recommendations provided for the development, formatting, and promotion of State of the Marine Environment Reports generally.

Does Information Matter? Identifying Critical Issues Related to Information Use in ICOM (Integrated Coastal and Ocean Management) - Panel Discussion

WELLS, Peter G.¹, SOOMAI, Suzuette S.¹, DE SANTO, Elizabeth M.², MACDONALD, Bertrum H.¹

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This paper has two objectives: (1) to present highlights of papers from the special session “Does Information Matter” for CZM (coastal zone management) and ICOM (integrated coastal and ocean management); and (2) to initiate discussion of critical issues related to future evidence-based policy and decision making for the oceans. Topics covered during the preceding talks will include: the rationale

behind the EIUI (Environmental Information: Use and Influence) project with its focus on marine environmental and fisheries information (MacDonald and EIUI team); why people should extend information searches in order to understand the consequences of their actions and the policy alternatives (Ascher); international attention being given to understanding and resolving problems at the science-policy interface through an analysis of activities within the IPCC (Intergovernmental Panel on Climate Change) and their application for the nascent IPBES (Intergovernmental Platform on Biodiversity and Ecosystem Services) (De Santo); ensuring public trust in policy and decision making in the health professions by governing knowledge with open data (Graham); recognizing that salience, credibility and legitimacy of scientific information are critical to the use of science in fisheries management (Hartley); and defining the future for the role of information in all aspects of managing the oceans and ICOM, recognizing its human (social), ecological and economic dimensions (Soomai, McNie, Ross and Breeze). The paper initiates the panel discussion with the session's invited speakers, to provide a working roadmap for elevating the vital role of information to the front lines of ICOM.

3.3 Enduring Legacies: Indigenous Communities and the Future of Canada's Coasts

Convenors:

Anthony Charles, Saint Mary's University, tony.charles@smu.ca

Marianne Janowicz, BoFEP, mjanowicz@hotmail.com

This session aims to provide a forum to highlight the unique issues and challenges concerning coastal management and policy faced by aboriginal communities. The session consists of three speakers from across Canada, followed by an open discussion among session participants.

On the West coast of Canada, Nuuchalch communities face increasing restrictions on maintaining traditional livelihoods. **Dawn Foxcroft**, Nuuchalch community representative and Community Conservation Research Network (CCRN) researcher, will discuss the ongoing court case against the Government of Canada through which the community is seeking to assert its legal right to access and manage traditional fisheries.

In Labrador, the Innu Nation faces increasing challenges from climate change and caribou conservation policies, even as they transition into self-government. **Helen Andrew**, community representative and Community Conservation Research Network (CCRN) researcher will provide insights on the process of creating an environmental plan balancing traditional knowledge, scientific research and policy negotiation.

Indigenous communities have traditionally approached conservation in distinct ways that could add great value to the way our coastal communities think of conservation. Two speakers will discuss how indigenous perspectives look at maintaining communities for thousands of years: the true meaning of 'sustainability'.

After short presentations from each of the three speakers, the session will transition into a discussion of common challenges and future directions. Attendees will be encouraged to discuss perspectives from their own experience.

Session Participants

Angeline Gillis, Confederacy of Mainland Mi'kmaq, agillis@mikmawconservation.ca

Hugh Akagi, Chief, Passamaquoddy Peoples of Canada, akagih@nb.aibn.com

Dawn Foxcroft, Uu-a-thluk (Nuu-chah-Nulth Tribal Council), dawn@whiteravenconsulting.ca

Helen Andrew, Innu Nation, handrew@innu.ca



4. Contributed Paper Session Abstracts

4.1 Intertidal Ecology (Salt Marshes)

Chair: Gail Chmura, McGill University

Ecological Re-engineering of a Fallow Agricultural Dykeland for Tidal Wetland Restoration in a Macro-tidal System

BOWRON, Tony¹, LEMIEUX, Ben¹, GRAHAM, Jennifer¹, NEATT, Nancy¹, VAN PROOSDIJ, Danika², LUNDHOLM, Jeremy²

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This paper examines the natural recovery of vegetative, sedimentary, and hydrologic response to ecological re-engineering of a fallow agricultural dykeland site in the macro-tidal Upper Bay of Fundy. Restoration of tidal flow to a 13 hectare section of agricultural dykeland along the St. Croix River (Nova Scotia) was undertaken in 2009. A series of breaches in the dyke and channels re-connected the site to the river, which triggered significant self-organization within the restoration site. A six year monitoring program was developed. Previous works examining natural salt marsh vegetation (self design) recovery have shown that projects are most successful when: (1) there is no restriction on the dispersal ability of target species near the site, and, (2) there is a disturbance to remove non-target species within the site. The high rate of sediment deposition over the first year following restoration (>23 cm) resulted in the creation of mudflat conditions over much of the site. High resolution, low-altitude geo-referenced aerial photography was used to better understand factors influencing vegetation recovery and surface changes. Hydrogeomorphic analysis showed the reactivation of old agricultural ditches into a new hybrid drainage network. The vegetation survey showed a rapid change of vegetation dominance from pasture grasses to wetland species following restoration. Preliminary image classification showed that exposed mud exceeded vegetated patches during the first growing season and that colonization of wetland species primarily occurred near secondary drainage channels. The results of the first four years of post-restoration monitoring are presented.

Development of a Superimposed Hydraulic Network at a Macro-tidal Restoration Site

GRAHAM, Jennifer¹, BOWRON, Tony¹, LEMIEUX, Ben¹, NEATT, Nancy¹, VAN PROOSDIJ, Danika², LUNDHOLM, Jeremy²

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Tidal wetlands provide many beneficial ecosystems services including valuable fish habitat, protection against storm surge and sea-level rise, and carbon sequestration. Human activities have led to degradation and loss of these habitats, particularly in macro-tidal estuaries where the practice of land reclamation through dyking is prevalent. In the Bay of Fundy, where tidal ranges can exceed 16 m, the loss of salt marsh has been estimated at 80-85% since European settlement, making the restoration of these habitats a priority in the region. The research presented here focuses on the development of a hydraulic network at a tidal wetland restoration site, which was found to be occurring at a rate comparable to other studies. The incorporation of drainage ditches, relict creeks, and surficial rills throughout the site into a hybrid/superimposed network allowed rapid dewatering and efficient movement of water through the site in the initial year of restoration. By the second year many of these channels were no longer detectable through aerial photography or site visits. The creation of a single dyke breach at the restoration site, as opposed to multiple breaches, had significant impact on how the system functions with regards to tidal inundation and circulation, creek erosion, and species diversity. A lack of sedimentation in some areas, a delay in the removal of detrital matter, and the high probability of prolonged velocity pulses in the primary channel leading to erosion and slumping indicate that more breaches are preferable.

Classification and Environmental Correlates of Tidal Wetland Vegetation: Implications for Ecological Restoration and Monitoring

PORTER, Caitlin¹, LUNDHOLM, Jeremy², VAN PROOSDIJ, Danika², BOWRON, Tony³, NEATT, Nancy³, GRAHAM, Jennifer³, LEMIEUX, Ben³

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Tidal wetland vegetation of eastern North America shows conspicuous zonation attributable to biotic interactions between plant species and differential tolerance of salinity and flooding. Tidal marshes are a conspicuous feature of the coastline in Nova Scotia, and previous descriptions suggest that many of the plant communities are similar to those found in New England, which have been extensively studied. The goal of this study was to perform a numerical classification of tidal marsh vegetation in Nova Scotia, and to determine the relationships between variation in plant species composition and environmental factors. Sampling was conducted from vegetation communities of six tidal wetland sites along a range of tidal ranges (micro- to macro-)[fix-emphasize range of tidal conditions] designated as reference (intact) sites for paired tidal wetland restoration projects. Cluster analysis revealed seven distinct plant communities related to gradients of inundation duration and salinity. Plant community types were usually dominated by a single graminoid species. Communities detected were similar to those found farther south in Maine and New England, but three brackish communities were also identified within this study, of which the *Juncus balticus*/*Festuca rubra* and *Spartina pectinata* communities have not been previously described. Redundancy analysis shows continuous variation among these community

types and highlights key environmental variables related to plant community patterns. These analyses provide a baseline for further restoration work and identify environmental correlates of plant communities, allowing for better predictions of ecological restoration trajectories in tidal marshes.

Carbon Loss from Agricultural Transformation of Bay of Fundy Salt Marshes

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Extensive areas of salt marsh on the Bay of Fundy have been diked and drained for agricultural use, beginning with early Acadian settlement in the 17th century. We assume that this land use change resulted in considerable release of carbon dioxide to the atmosphere, but there are few direct measurements of carbon dioxide release with marsh drainage. We took a modelling approach to estimate how much carbon dioxide could have been lost from the top meter of soil due to historical marsh reclamation on the Bay of Fundy. We simulate carbon dioxide loss, starting with the carbon content measured in Bay of Fundy marshes today, apply a decay rate determined from agricultural soils, and assume that as the marsh soil decomposed that agricultural activities would simultaneously have added carbon. The loss from drainage and gain from agriculture nears equilibrium within 120 years, but minor losses of carbon dioxide could continue for another 100 years. Assuming that 85% of the original marsh area on the Bay of Fundy was transformed to agricultural land, then approximately 9×10^8 kg carbon dioxide could have been released due to this land transformation. Even with agricultural management only ~5% carbon of the original carbon stored (41000 g carbon) in the marsh soil was retained in the model upon reaching equilibrium. The land use transformation has had a greater impact on carbon dioxide emissions than many other anthropogenic sources from the Maritime Provinces.

4.2 Intertidal Ecology (Mudflats)

Chair: Ashley Sprague, Nova Scotia Department of Fisheries and Aquaculture

Striped Bass Eggs and Larval Retention in the Macrotidal Shubenacadie River

DUSTON, Jim¹

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Retention in the estuary nursery habitat is important for survival of striped bass early life stages and subsequent recruitment. Eggs and early stage larvae behave as passive particles in the highly turbulent macrotidal estuary, and are transported back and forth by the ebb and flood tide in the brackish water. Net up-estuary transportation is due to the asymmetric tidal cycle. The tidal bore and high velocity flood tide carries eggs and larvae as far as the salt front at high tide, but not into tidal freshwater. The distance transported up-estuary is greatest and retention highest when freshwater discharge is low. By contrast, during high freshwater discharge, both the salt front and striped bass eggs and larvae are forced 20 km or so down-estuary. Moreover, during the ebb tide eggs and larvae are advected from the estuary mouth into Cobequid Bay, which we believe is unsuitable as nursery habitat. This passive

mechanism for retention of striped bass is possible in the tidal saltwater section of the Shubenacadie River because it is relatively long, >30 km. By contrast, the shorter estuary in the inner Bay of Fundy cannot serve as reliable nursery habitat because the risk of advection during the ebb tide is too high.

Population Dynamics of Invasive Green Crabs on Mudflats in the Upper Bay of Fundy

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The European green crab (*Carcinus maenas*) is an invasive species that has altered the ecological balance of many ecosystems in which it has established populations. While green crabs have been present in the Bay of Fundy for over fifty years, they have only recently been observed on intertidal mudflats in the upper Bay, and their effects on soft-sediment habitats elsewhere indicate that they have the potential to cause significant ecological changes in this area. We investigated the extent of the invasion of green crabs in the upper Bay, and examined the breeding status of the population. From May 2013 to January 2014, we trapped green crabs at distances corresponding to low, intermediate, and high tide levels at three mudflats and three adjacent rocky intertidal sites. Green crabs were present at all sites. Abundance at two rocky sites and one mudflat showed a dramatic increase in autumn, while numbers remained consistent at the third rocky site and few crabs were caught at the other mudflats. Ovigerous females were observed at one rocky site and newly settled juveniles were found at one mudflat and two rocky sites. Data also suggest a pattern of spatial segregation between green crabs and native rock crabs, where green crab distribution tends to be more concentrated in the intermediate to high intertidal zone. Observed abundance and past invasion history indicate that green crab populations in the upper Bay of Fundy warrant comprehensive study to inform and assist future management and conservation strategies, should they become necessary.

Behavioural Response of *Corophium volutator* to Shorebird Predation in the Upper Bay of Fundy

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Predator avoidance is an important component of predator-prey relationships, and can affect prey availability for foraging animals. Each summer, the burrow-dwelling amphipod *Corophium volutator* is heavily preyed upon by Semipalmated Sandpipers (*Calidris pusilla*) on mudflats in the upper Bay of Fundy. We conducted three complementary studies to determine if adult *C. volutator* exhibit predator avoidance behaviour in the presence of sandpipers. In a field experiment, we monitored vertical distribution of *C. volutator* in bird exclosures and adjacent control plots before sandpipers arrived and during their stopover. We also made polymer resin casts of *C. volutator* burrows in the field throughout the summer. Finally, we simulated shorebird pecking in a lab experiment and observed *C. volutator* behaviours in the burrows. Adult *C. volutator* were generally distributed deeper in the sediment later in the summer (after sandpipers arrived), with a significantly stronger response in areas exposed to

predation than in bird exclosures. During peak predator abundance, many *C. volutator* adults were beyond the reach of feeding sandpipers (>1.5 cm deep). However, burrow depth did not change significantly throughout the summer. Detailed behavioural observations indicated that *C. volutator* adults spent more time at the bottom of their burrow when exposed to a simulated predator compared to controls. This observed redistribution suggests that *C. volutator* adults move deeper into their burrows as an anti-predator response to the presence of sandpipers. This work has implications for studies of sandpiper foraging behaviour, as *C. volutator* density may not provide an accurate estimate of prey availability.

Movement and Diet Patterns of Semipalmated Sandpipers During Migratory Stopover in the Bay of Fundy

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Up to 75% of the global population of Semipalmated Sandpipers (*Calidris pusilla*) stops in the Bay of Fundy annually to feed on mudflats and build up reserves for their southern migration. Recently, diet shifts and a possible segregation of staging populations between the arms of the Bay (Chignecto Bay and Minas Basin) have been observed. During summer 2013, we radio-tagged 40 birds in James Bay (a stopover between the arctic breeding grounds and the Bay of Fundy) and 90 birds at four locations within the Bay of Fundy. We tracked their movements using a combination of stationary towers with receivers and aerial surveys. We also sampled mudflats around the Bay to determine prey availability and obtain samples allowing us to estimate bird diets. Preliminary results suggest at least four separate staging populations within the Bay. At all sites, sandpipers appear to stay longer than previously thought, which means we may be overestimating the regional population. Our data also suggest that sandpipers frequently cross land when leaving the region, instead of exiting through the Bay of Fundy. Further, birds staging in James Bay do not make extensive use of the Bay of Fundy. Ongoing analyses will allow us to examine sex-specific variation in movement and duration of stay, as well as diet differences among regions. The global population of Semipalmated Sandpipers is in decline, and accurate information on movement and diet within the Bay will allow stakeholders to make informed decisions concerning the conservation of this species and this important habitat.

4.3 Tidal Energy

Chair: Scott Kidd, BoFEP

Tidal Current Energy Technology

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Various types of renewable energy are used now and will continue to be in the near future. Marine renewable energy is one of the most important topics for generating electrical energy these days.

Canada is one of the world leaders in the use of marine renewable energy due to its unique geography, abundant resources, and expertise in ocean engineering and offshore operations. Billions of tonnes of seawater ebb and flow every day along Canadian shorelines. Tidal current technologies started growing in the last ten years in Canada. This paper presents a general overview of tidal current energy generation technology as well as a brief discussion on its origins and background and the development of associated technologies and components. The primary aim of this paper is to explore current research and the different technologies proposed for improving the tidal current integration. A review of various types of generators and their dynamic are also conducted.

Fish and Tidal Races: Use of Animal Tracking Technology to Assess Potential Risk of Tidal Turbine Interactions

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The Fundy Ocean Research Centre for Energy (FORCE), Canada's leading tidal energy test facility, is one of the most physically challenging marine renewable energy demonstration sites. It features a 13 m tidal range, extreme currents (up to 6 m/sec), short slack water periods (5-15 min), large masses of sediment-laden ice in winter, and diverse and abundant fish species, some of which are nationally designated as "at risk". At this extreme high flow site, conventional methods of assessing the temporal and spatial patterns in the presence and abundance of fish (e.g., via midwater trawls) are not an option. Consequently, little is known about the degree to which migratory species use the Minas Passage and FORCE site. This presentation will highlight tidal energy developments and associated research in the Bay of Fundy, including the design of a cabled environmental sensor platform at FORCE, and research results from a recent multi-year tracking study in which the movements of tagged American lobster and selected migratory fishes were acoustically detected in and near the FORCE test facility. The 2010–2013 dataset includes receiver line detections (using Vemco animal tracking technology) of species designated as endangered (striped bass), of high conservation significance (Atlantic sturgeon), and of special concern (American eel). Results provide evidence that the FORCE test area represents an important part of the migratory corridor for lobster and fish, with striped bass also showing frequent non-migratory use of the Minas Passage.

A Framework for Environmental Risk Assessment and Decision-Making for Tidal Energy Development in Canada

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In-stream tidal energy initiatives are rapidly developing in Nova Scotia, Canada, but there remains a high degree of uncertainty regarding the nature and extent (in space and time) of environmental implications of energy harvesting activities. To ensure the tidal energy industry in Nova Scotia (and elsewhere in Canada) develops in an environmentally safe and sustainable manner, regulators and industry are in need of a consistent, objective and efficient approach to assess and mitigate the risk of adverse

environmental impacts of a proposed project. This paper presents a science-based environmental risk assessment and decision-making framework developed on behalf of the Nova Scotia Department of Energy and Federal Department of Fisheries and Oceans. The framework offers key steps and considerations for identifying, assessing, and addressing the environmental risk of in-stream tidal energy projects based on the best available scientific knowledge, expert advice, and best practices for environmental risk and impact assessment. The guiding principles of the framework include: appropriate consideration of ecosystem-scale and cumulative effects; acknowledging natural changes; use of precautionary and adaptive management approaches; early initiation of baseline studies; consideration of site-specific and project-specific characteristics; and consideration of other human uses and values. The risk assessment approach is based on a set of practical criteria and related risk indicators that are relevant, flexible and can be consistently applied to projects of any type, size or location. By following this approach, project planners and reviewers can also gain insights as to: site-appropriate project design and size consideration; the level and type of baseline studies and monitoring that may be required; methods of mitigating or reducing the level of risk of a project; and evaluation measures or trigger points for adaptive management actions. The guidance framework has been peer reviewed by scientists, industry and provincial and federal government agencies and will inform the creation of a joint Federal/Nova Scotia Statement of Best Practice for the management of in-stream tidal energy development.



4.4 Aquatic Ecosystem Health

Chair: Peter G. Wells, Dalhousie University

Evaluation of Benthic Far-field and Site Recovery Effects from Aquaculture Within the Letang Inlet, New Brunswick

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Beginning in the 1980s the Letang Inlet within the lower Bay of Fundy was one of the first areas where aquaculture of marine fish, specifically Atlantic salmon, was developed in eastern Canada. This marine

tidal inlet became an intensive fish grow-out area, with one of the highest density of fish farms, where net-pen operations continue today.

A multi-year project (2012–2015) is being undertaken in cooperation with industry, government and NGOs to evaluate far-field effects of salmon aquaculture in view of a baseline study undertaken in the 1990s within the same area. The objective is to document, compare and evaluate current conditions with those of two decades earlier in light of various mitigating measures undertaken since, including the reduction of operational sites, establishment of treatment sites and protocols, and bay management following procedures.

The study is based on benthic macrofaunal assemblages and environmental parameters sampled annually in the fish farming areas of Lime Kiln Bay and Bliss Harbour, and an un-farmed reference area. The work encompasses a full following cycle in order to evaluate the potential effects of operating years 2013 and 2014 on Bay-wide cessation of operations within the Letang Inlet in 2012 and 2015. In addition, an assessment of long term recovery at a single site not in operation since 1998, but within an area of intense fish farming, will be undertaken using base line data from 1995-2000.

Using Sand Shrimp as a Sentinel Species in Nearshore Areas in the Saint John Harbour, Bay of Fundy

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The Saint John Harbour (SJH) estuary is one of six regional nodes in a Canadian Water Network-sponsored national project looking at developing monitoring programs in support of cumulative effects assessment. My study examines whether there are responses in sentinel species exposed to effluent from a new municipal wastewater treatment facility. Nearshore sampling was carried out at low tide, during the day, with a 9 X 1.5 metre beach seine with 9mm stretch mesh. The most abundant epibenthic animal caught was *Crangon septemspinosa* (sand shrimp). The potential of sand shrimp as a sentinel species for contamination will be investigated. Sand shrimp from the sewage discharge site and four reference sites will be followed throughout an annual cycle to detect spatial and temporal changes in abundance, size, condition factor (a metric of energy storage), sex ratios, and fecundity. Results show differences among sites in condition factor, weight, and length. Females are more abundant than males (>70% of total catches), have a higher condition factor and a smaller size-at-maturity at all sites. Stable isotope and contaminant body burden analyses are in progress to help establish residency. If sand shrimp prove to be a good indicator of contamination we will be able to develop baseline biological data for the watershed providing a tool for watershed end-users to carry out cyclical monitoring in a dynamic marine environment that will see major developments in the years to come.

Implementing the CCME Environmental Risk Assessment process for the Upgraded Greater Moncton Sewerage Commission Wastewater Treatment Plant

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The Greater Moncton Sewerage Commission (GMSC) is planning to install secondary treatment capabilities at its 80,000 m³/day municipal waste-water treatment plant. In line with the Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CCME, 2009) an Environmental Risk Assessment (ERA) was carried out to determine Effluent Discharge Objectives (EDOs). The determination of the EDOs is based on the Environmental Quality Objectives (EQOs), which are derived for the particular receiving water and the effluent mixing performance. The presentation illustrates the main components of the CCME Risk Assessment process, using the GMSC expansion as an example. The presentation shows the methodology followed to carry out the ERA, and the results obtained. The process included monitoring of the effluent and river quality (Petitcodiac River Estuary), bathymetric surveys, measurement of the mixing zone in the field using dye tracers, modeling of effluent dilution under various scenarios, determination of EQOs, and ultimately back-calculation of the EDOs.

Applying the Ocean Health Index to the Southwest New Brunswick Bay of Fundy Marine Resources Planning Area

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The Ocean Health Index (OHI) is a peer reviewed environmental health index (EHI) used to assess and assign a score to the state of the world's oceans globally and regionally. EHIs represent the aggregated scores of sets of environmental indicators. Along with providing assessments of the state of ecosystems, EHIs are also used to quantify human impacts on ecosystems and verify the results of management and conservation efforts. By transforming complex data into scores more easily understood by the public and decision-makers, EHIs are also effective communication tools. To date, an EHI has not been used for the Bay of Fundy. This project's objective is to apply a smaller version of the OHI to the Southwest New Brunswick Bay of Fundy Marine Resources Planning Area (MRPA). The MRPA is being used because there is more data presently available for it compared to the rest of the Bay of Fundy and an earlier planning initiative has detailed the ecological, social, cultural, and economic community values of the MRPA. While the OHI score is the average score of ten broad OHI goals (indicators), due to several constraints we are working with a subset of four OHI goals that best captures the MRPA's community values. The results of the project will be used to establish an OHI baseline for future work and determine whether it is practical to use the full OHI for the Bay of Fundy. Lessons from this project will be useful to other Canadian coastal and marine EHI efforts.

4.5 Emerging Issues for Coastal Peoples

Chair: Marianne Janowicz, BoFEP

Mitigation of Emerging Contaminants Disposal in the Bay of Fundy Ecosystem

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Over the years, Bay of Fundy Environmental Partnership (BoFEP) has strived for concerted efforts to monitor and protect the health and environmental sustainability of Bay of Fundy's (BoF's) ecosystem. Recently, there is a considerable evolving emphasis on combating the disposal of emerging pollutants into the bay's watershed as well as in its coastal shores. Among others, the target contaminants as identified by Health Canada, Canadian Water Network as well as USEPA include; pesticides, bisphenol A (BPA), estrogen, pharmaceuticals, and nonylphenols. Typical other source materials attributed to release of these compounds at higher concentrations vary from biosolids, synthetic fertilizers, electronic wastes, industrial and agricultural wastewater. Most of these chemicals are released into the natural environment during their life cycles of production, transportation, storage, consumption, as by-products and waste streams. The rising rates of cancer, obesity and infertility in human as well as in aquatic species suggest that there are compounds recently introduced into the environment are responsible for these deleterious effects. Although the environmental guidelines, public awareness outreach and applied research exploration are gaining momentum, it is important to enact effective framework for public policy and pursue further research collaborative work in this area. This presentation explores the overview of the challenges and opportunities to mitigate the disposal of the emerging pollutants in the BoF's coastal zones.

Erosion Styles and Implications for Development at Blue Beach, Nova Scotia

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In response to a request from the Municipality of the County of Kings planning department, a detailed assessment of geohazards along a 600 m section of coastline at the Blue Beach fossil cliffs was undertaken by the Nova Scotia Department of Natural Resources. Varying styles of coastal erosion along the cliff face were assessed with respect to infrastructure development and associated requirements for set-backs from the eroding cliff face. Evidence of both large-scale periodic mass wasting and slow, long-term cliff erosion were observed. Four forms of mass wasting were identified, including: rock fall, rotational slumps, rock slides, and earth flows. Geological factors that controlled the frequency and size of individual events were evaluated and the hazard to infrastructure associated with the different forms of mass wasting was assessed. The study identified a high or significant potential for small-scale rotational slumps and slides, the potential for large-scale translational slides, and a small hazard potential due to long- or short-term shoreface erosion. It was determined that a minimum setback of 23 m was required for development along this section of shoreline.

On the Right Way to Right Whale Protections in the Gulf of Maine – Case Study

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For centuries, the right whale was abundant to harvesters. Almost five hundred years of heavy exploitation brought the North Atlantic right whale to the verge of extinction. In 1937, whaling nations agreed to stop harvesting of the species. Although the North Atlantic right whale hunt is non-existent now, the recovery rate is still very low and faces several challenges. Ironically, despite a very successful

enforced ban on right whale hunting, the characteristics which made it so attractive to whalers are those that still threaten it today. The North Atlantic right whale migration range is along the continental shelf waters of the eastern United States and Canada where there are high concentrations during the summer in the Gulf of Maine, the Bay of Fundy, and the Scotian Shelf and off Florida where the winter calving grounds are located. This migration route runs adjacent to the most populated and industrialized areas of North America. Major anthropogenic activities affecting the marine environment include marine traffic, land-based industrial and agricultural pollution, degradation and loss of habitat, noise, and fishing gear entanglements. In this presentation we examine the threats to right whales, the legal status of the right whale in the United States and Canada, evolving technology used to locate the right whale, and how these two may be integrated in a right whale management and conservation plan. We conclude with the challenges and risks which may arise from such plans.

Emerging Environmental Issues in the Gulf of Maine and Bay of Fundy: A Sequel for the Gulf of Maine Council on the Marine Environment

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This paper presents an overview of some of the newly recognized emerging issues in the Gulf of Maine and Bay of Fundy, and represents a sequel to the theme paper on Emerging Issues prepared in 2010 for the Gulf of Maine Council on the Marine Environment (see www.gulfofmaine.org/2/resources/state-of-the-gulf-of-maine-report/). In order that work of the Council stays timely and relevant, a consideration of issues requiring revisiting or completely new issues requiring urgent review and investigation seems judicious. A file of such issues is being maintained to facilitate discussion, especially in this era of heightened awareness of climate change and its effects on the ocean. The issues recognized to date are organized as per the DPSIR (driver-pressure-state-impact-response) framework, simplified as pressures, impacts and societal response. They include: ocean acidification, underwater noise, micro-plastics, expansion of open water coastal aquaculture, region wide effects of tidal power development, future adaption and mitigation to climate change, and the public need for a coastal or ocean health index. These issues and others are presented in this paper.



5. Poster Abstracts

The SOS Story: Local Citizens Work to Preserve Ocean Science

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Canadian communities are increasingly aware of how they are affected by changes in federal science programs and are seeking more involvement in the policies that shape Canada's marine environment and economic future. Save Ocean Science (SOS) is one example. This broadly-based citizens group in southwestern NB was formed in 2012 in response to federal plans to eliminate select research programs and close a new \$4 million library at the federal St. Andrews Biological Station in St. Andrews, NB. While minor concessions resulted in the retention of rare books at the Biological Station, SOS was unable to convince the government of the negative impact that the library's closure would have on scientists, researchers and students from government, industry, academia and the NGO sector. SOS was unable to engage the government in exploring alternatives. The Station's library and contaminants and toxicology programs were eliminated in 2013.

SOS has now re-focused on a wider agenda that 1) draws public attention to the importance of government-led science in maintaining the region's healthy marine environment, the sustainable development and conservation of the coastal zone, and a longterm resource-based economy, 2) encourages federal fulfillment of promises for digital science library services, 3) provides web-based access to regional ocean science related stories, 4) encourages and supports science initiatives by organizations within the region's 'marine science hub' and 5) stresses public awareness that good federal policy development and regulatory decision-making must be based on sound science. Its work can be followed at www.saveoceanscience.ca.

A Proposed Model of Neuro-Wavelet Using Fourier Based on Least Square Method for Tidal Current Forecasting

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The increasing penetration of a renewable energy in the power system grid makes it one of the most important topics for generating electricity for the near future. Tidal current energy is one of the most technologies growing rapidly for generating electric energy. It is so hard to store the electrical energy for later use. It is very important to have advance knowledge of the tidal current energy to manage the production of the electrical power so that it may ensure that this power will be controlled in an efficient way to allow scheduling different electrical energy resources to minimize the interruptions. Forecasting is the first step for dealing with the future generation of the tidal current power. In this paper different tidal current models based on ANN, Fourier based on least square method (FLSM) and wavelet constituent components were developed and evaluated for a monthly forecasting. A hybrid model of neuro-wavelet using FLSM is also proposed. These models are compared with the proposed hybrid model

of neuro-wavelet based on FLSM. These proposed models are ranked in order depending on their performance and validated by using another set of data (tidal current direction). The proposed hybrid model of neuro-wavelet based on FLSM is highly accurate and outperforms. This study was done using data collected from the Bay of Fundy in 2008.

Accessing Indicator Information Through The Gulf of Maine Council's EcoSystem Indicator Partnership

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In 2009, the Gulf of Maine Council's EcoSystem Indicator Partnership (ESIP) concluded a thorough investigative and discussion process that resulted in the selection of twenty-two priority indicators for the Gulf of Maine. The indicators were selected to assist in assessing the state of the Gulf of Maine with respect to aquaculture, aquatic habitats, coastal development, climate change, contaminants, eutrophication, and fisheries. A concentrated effort on the part of ESIP's volunteer members and data providing organizations has resulted in the completion of initial analysis for the following indicators: aquaculture economic value, production and area for aquaculture sites, distribution of eelgrass, employment density, impervious surface, ocean jobs, dominant fisheries species, population density, location of point sources, sea level change, precipitation trends, air temperature trends, nitrogen loading, and dissolved oxygen.

Data for the indicators is available through ESIP's Indicator Reporting Tool (www2.gulfofmaine.org/esip/reporting). This innovative tool allows users to easily locate and graph datasets from multiple organizations enabling the user to compare indicators across the Gulf of Maine. In addition, fact sheets have been released for five of the seven theme areas: aquaculture, aquatic habitats, climate change, contaminants and eutrophication. By providing multiple avenues for obtaining status and trend information for the region, ESIP has gone a long way towards assisting individuals and organizations to evaluate the health of this large and productive ecosystem that stretches from Cape Cod, Massachusetts to Yarmouth, Nova Scotia.

Student-built, Fishermen-deployed, Satellite-tracked Drifters

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Nearly a thousand student-built drifters have been deployed in the last decade off the New England coast in attempt to resolve transport pathways and provide surface current information to numerical modelers. Over a million kilometers of tracks have been logged, archived, and now served through the Northeastern Regional Association of Coastal Ocean Observing System's website (neracoos.org). This program provides students a hands-on introduction to physical oceanographic principles by engaging them in the entire process of building the instruments, connecting with local fishermen and other mariners (who deploy the units offshore), and following their tracks through time in the classroom.

Recent enhancement to the program includes open source software packages and lesson plans for both teachers and students. These utilities expose students to basic Python programming, allows them to process/plot a variety of remotely- served oceanographic data products, and overlay that information on track of their own drifters. In addition to being a hands-on educational tool, these drifters have provided oceanographers at approximately 50 federal, state, and academic labs a source of low-cost instrumentation for a variety of applications. In particular, they provide circulation modellers data they need for validation, impacting regional, national, and international systems. While both surface and drogued drifters are built with easy-to-find, eco-friendly materials, they are configured according to oceanographic standards.

Spatio-temporal Phenology of Macroinvertebrates and Bird Use of a Coastal Wetland Landscape Near Aulac, NB

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The isthmus that connects Nova Scotia and New Brunswick is a topographic low which supports an expansive marsh landscape. Migrating birds frequent the area as a stopover site which lies along the Atlantic flyway. Like many coastal areas of the Maritimes, the salt marshes were diked and drained, leaving behind vast stretches of rich agricultural land. This has led to a drastic ecological gradient in a small geographic area, beginning as salt marsh, abruptly met by dikes then agricultural fields, leading to a lacustrine environment further inland. Conservation and restoration efforts have resulted in several artificial wetlands in this area—an effort to restore natural characteristics reminiscent of precolonial times. Better knowledge of the use and function of artificial wetlands will help maximize their utility for mitigation and conservation purposes. A simultaneous examination of waterfowl, their invertebrate food prey, and the physico-chemical parameters of the wetlands was completed in 2012 and 2013. A selection of 11 sites were studied: two brackish (natural), five proximate ponds dug into reclaimed agricultural fields (artificial), and four in the lacustrine environment (mixed). 2012 consisted of weekly invertebrate sampling between 14 May – 31 July, while 2013 involved bi-weekly sampling to expand the study period (16 April – 19 September). Preliminary data reveal that tidally influenced sites are significantly higher producers of invertebrate biomass, yet freshwater sites show a greater taxonomic diversity. Annual variation of biomass within sites was shown to be insignificant. Generalized additive models will be employed to reveal temporal and spatial trends.

Macro- and Meso-tidal Wetland Restoration in Canada's Maritime Provinces

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Tidal wetland restoration is in its infancy in Canada's Maritime Provinces. Tidal wetland restoration projects have mostly been opportunistic in nature, or required by legislation. Restoration projects have been undertaken in all three Provinces, with the majority of projects in the Bay of Fundy, the area of greatest historical loss (80%). The unique hydrological and sediment conditions experienced in the Bay, combined with the historical significance of these marshes, importance for migratory and endangered

species, and as a significant component of the Gulf of Maine ecosystem have served to focus restoration efforts on these marshes. Projects with the primary goal of restoring tidal wetlands have only been undertaken since 2005, and of those projects, few have involved long-term comprehensive monitoring programs. For most of these projects, restoration efforts have focused on the reduction or elimination of the primary restriction to hydrology (dyke or causeway) and have relied on natural processes to restore the natural flora and fauna. This poster highlights the research activities, partnerships, and legislative measures leading to the success of these projects. The focus is on the 8 tidal wetland restoration projects in Nova Scotia that are using the GPAC Regional Monitoring Program in order to illustrate some of the lessons learned regarding the ecological condition of Nova Scotia tidal wetlands and their response to restoration efforts.

Working Towards Objectivity and Accuracy: The Process of Producing an Environmental Assessment of the Whites Point Quarry and Marine Terminal Project, Digby, Nova Scotia

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Information deficits, federalism, and neo-liberalism have all reduced the role of North American governments and regulatory bodies in their ability to deal with the growing volume of complex environmental (scientific and technological) information. As a result, these governmental bodies often contract with third-party groups associated with private industry to conduct exhaustive and extensive environmental impact assessments. Such partnerships between private industry and governmental bodies have raised questions by numerous interested parties that environmental documents produced from the assessments lack the accuracy and objectivity that scientific research necessitates. Information surrounding the Keystone XL pipeline project shows that these arguments are less concerned with environmental assessment reports themselves and more with the process by which the reports are produced. This poster investigates the process in which environmental assessments are produced through a study of the work of the Joint Review Panel for the Whites Point Quarry and Marine Terminal project, Digby Neck, Nova Scotia. It analyzes the role of and interactions between governmental bodies, private industry, environmental groups, and other organizations involved in this environmental issue. The poster will outline the relationship between the perception of the objectivity and accuracy of environmental assessment documents with the process that produced the assessment. Through investigating this recent coastal zone issue as a case study, this poster emphasises the evolving role of Canadian governments in environmental management issues and the processes that produce objective and accurate environmental impact assessments.

The Northeast Coastal Ocean Data Partnership – Building a Region-wide Information System from the Bottom Up

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How do you find, access and integrate data related to the ocean waters from northeast United States and Canadian Maritime provinces? The Northeast Coastal Ocean Data Partnership (NeCODP) is making progress on simplifying the answer to that question.

The NeCODP promotes and coordinates the sharing, linking, electronic dissemination, and use of data in this region with a focus on facilitating information sharing and training for the regional data managers, providers and integrators. The Partnership was formed through a Memorandum of Agreement in 2004 as a region-wide effort to assist individual institutions in sharing valuable data and information on the physical, biological, chemical and geologic conditions in the region. The Partnership has grown to include twenty-two member organizations from government agencies, intergovernmental organizations, academic, research, and other nongovernmental and nonprofit entities and is hosted by the Northeast Regional Association of Ocean Observing Systems (NERACOOS).

Four main focus areas have been designated as priorities: Data Assurance, Data Discovery, Data Accessibility, and Data Interoperability. Recommendations and protocols are in development for each focus area. These are based on either accepted protocols, or best practices if no protocols exist. The partnership intends to use standards and protocols already in use by the various disciplines represented wherever possible.



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Science, Information, and Policy Interface for Effective Coastal and Ocean Management

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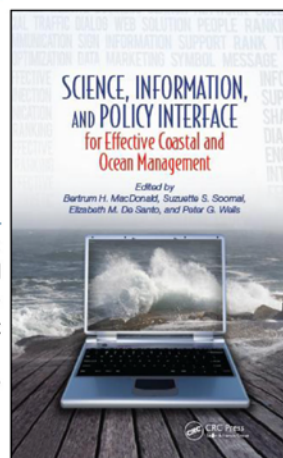
The purpose of the book is to provide a timely and original look at the role that information, and particularly scientific information, plays in the policy-making and decision-making processes for coastal and ocean management. The knowledge gained from the principles and case studies described in the book will enhance best practices for more effective communication and use of marine environmental information, particularly at the science-policy interface. The book will also contribute to the current understanding of information, particularly by arguing that the term "science-policy interface" is a misnomer, as there may be many interfaces between science and policy.

Key Features

- Explicitly examines the role of information in coastal and ocean management
- Provides an overview of key concepts and theory
- Take a case-study based approach
- Concepts and case studies are grounded in a global context, as reflected by the international authorship
- Chapters are authored by established experts in their fields

Selected Contents

Introduction; Understanding the Science-Policy Interface in Coastal and Ocean Environmental Management; Fundamentals, Concepts, and Principles; Scientific Information and Global Ocean Governance; The Key Role of Scientific Information in Integrated Coastal and Ocean Management; Scientific Information and Global Environmental Politics; Risk and Governance; Scientific Information and Governance—Participatory Approaches.



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