FERN
FUNDY ENERGY RESEARCH NETWORK
Bi-Annual Newsletter

Issue 1 Spring 2011

Contents

Funding and Host Support:

ACADIA ESTUARINE CENTRE FOR RESEARCH

ACADIA UNIVERSITY

FORCE

Message from the Executive Co-Chairs

Welcome to the 1st issue of the FERN Newsletter. We hope you find this newsletter informative of the range of collaborative activities of FERN members and committees during the last year. Many of these activities were conducted to address the research needs associated with the early stage testing of in-stream tidal energy technology in Minas Passage and Grand Passage. The recognition of FERN, both regionally and nationally, is due to the commitment and activities of numerous (>30) enthusiastic committee members and to the FERN Coordinator, Lisa Isaacman, who has enhanced FERN's presence through the development of the FERN website and other materials, and who has provided essential research services and support to FERN and its four discipline-related subcommittees - thanks, Lisa! We look forward to a busy year ahead and to hearing and reading about the results of ongoing initiatives and plans for new tidal energy-related research activities in the Bay of Fundy.

Anna Redden and **Ken Lee**
Executive Co-Chairs
(anna.redden@acadiau.ca)
(leek@dfo-mpo.gc.ca)

Photo: Les Coleman

Message from the FERN Coordinator

This 1st bi-annual FERN newsletter is intended to provide a venue for sharing advances in Bay of Fundy tidal energy-related research within the FERN community, as well as the broader public. The publication of this newsletter marks the one year anniversary of FERN's official launch in June 2010. It has been a very busy and exciting first year - establishing subcommittees, developing opportunities and tools for facilitating effective research cooperation and information sharing, building relationships with regional, national and international organizations, and providing objective scientific research support to several organizations on tidal energy research projects, including DFO, NRCan, FORCE, OEER, and Acadia University. Our membership includes representatives

from government agencies, academia, non-profit organizations, private sector and communities – all interested in working together to further research and understanding of the environmental, engineering and socioeconomic aspects of in-stream tidal energy activities in the Bay of Fundy. Thanks to the contributions of our members -– especially our Subcommittee Chairs and members – who have put in countless hours to advance the collective goals of the network, FERN is fast becoming recognized as the source for independent, objective information on in-stream tidal energy research in the Bay of Fundy and Atlantic Canada and a model forum for furthering cooperative marine renewable energy research in Canada.

The coming year is gearing up to be even busier, with a number of research activities planned or already underway by academic, government and private institutions across the Fundy region. As well, with new demonstration projects planned for FORCE, in the Digby area and in Maine, and major provincial-, national- and international-level efforts to develop policies and standards to guide the marine renewable industry, there will be growing demand and opportunity for FERN and its members to contribute their expertise. The four subcommittees are already eagerly moving forward with various exciting initiatives (see pages 7-8). In addition to continuing our current services, FERN is proceeding with various new and improved initiatives to facilitate information sharing, collaboration, research and learning capacity on in-stream tidal energy in the Bay of Fundy, including planning various technical workshops, launching a searchable online publications catalogue, experts and projects directories, research notice boards, and collaborating on various regional and national projects, among many other things.

I would like to take this opportunity to thank our sponsors - FORCE, the Acadia Centre for Estuarine Research and Acadia University - for their ongoing support of the network. Without their generous and arms-length financial and in-kind support, an effective research network would not be possible.

Thank you to all our members for your ongoing involvement in the network and I look forward to working with you over the coming year.

Lisa Isaacman
FERN Coordinator
(lisa.isaacman@acadiau.ca)

Cape Split during flood tide. Photo: Colin Buhariwalla

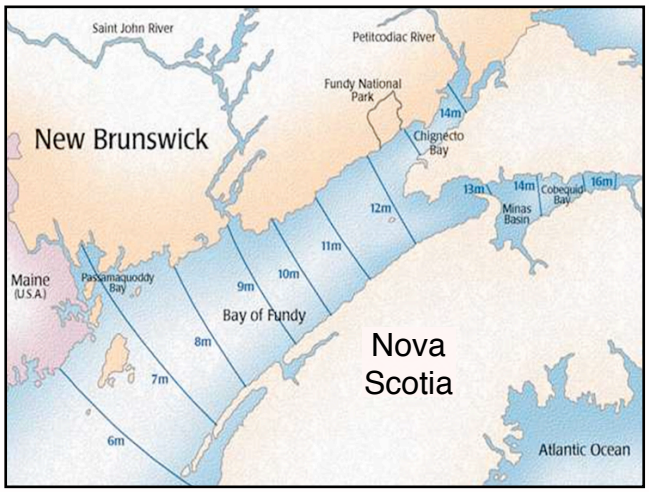
Working Together to Address the Environmental, Engineering & Socio-economic Issues Associated with Tidal Energy Developments

What is FERN?

The Fundy Energy Research Network (FERN) is an independent, impartial organization initiated by academic and government researchers as a forum for coordinating and fostering research capacity, collaborations, and information exchange on environmental, engineering and socioeconomic factors associated with tidal energy in the Bay of Fundy.

Becoming a Member

Membership is **FREE** and open to anyone involved or interested in tidal energy-related research, including academia, government agencies, environmental NGOs, consultants, and the private sector. For information about becoming a member, please visit **http://fern.acadiau.ca**



Gradations across the Bay of Fundy represent tidal amplitude, increasing from 6 m near the entrance to 16 m in Cobequid Bay. Source: EPRI Report (TP-003 NS Rev2), 2006.

FERN's Activities and Accomplishments

FERN's 2010 Annual Report is now available online. It highlights the many activities and accomplishments of the network over its first year. To view the report go to our website: **http://fern.acadiau.ca**

FERN Website

The website provides a 'one stop shop' for up-to-date information of interest to the Bay of Fundy tidal energy research community, including news and events, publications, links, research projects, turbine testing activities and FERN and subcommittee initiatives. New online services include: a searchable publications catalogue and Notice Boards that provide a venue for researchers to post research, job & collaboration opportunities and ideas, data and ship time requests and inquiries, and deployed equipment location notices. Please contact the FERN coordinator for feedback and suggestions on the website or to find out how to post information.

Aerial view of Minas Basin mud flats and suspended sediments from the Cornwallis River. Photo: Sherman Bleakney.

FERN - A Part of what is Moving the Bay of Fundy to the Centre of the Tidal World

The move to have the Nova Scotia tides declared a Wonder of the World may have its own merits with respect to postcards, tourists and "Kodak" moments, but it is the evolving story of the region's tidal demonstration that is capturing a lot of imaginations!

The commitment to a multi-technology demonstration was a critical step that exposes the region to the world-leading technologies and accelerates identification of approaches to using the region's largest renewable resource. The decision to develop FORCE's cabling infrastructure on the assumptions that the first deployments in 2012 can be successful is another critical step. It makes the progress to the initial array deployments technically feasible. The commitment of the Province of Nova Scotia to a market (the array-scale tidal FIT) for electricity from these is the added incentive that should see project development proposals come forward soon. The FIT and the cables could make Nova Scotia a critical focus for large scale tidal in the next few years.

An essential part of this "infrastructure" development is the strategic research stimulated in the SEA, built on by OEER and growing in the research teams in FERN. For a number of years we looked to the Oregon Wave Energy Trust and the PRIMARE and Supergen initiatives in the UK, but a wealth of homegrown strategic tidal energy research will emerge around FORCE and the community tidal projects of Fundy Tidal Inc. These outputs will be critical to planning for that next array stage development, but they are also a significant contribution by Canada to the world of renewable marine energy.

FERN members, thanks for your energy, commitment and experience.

Chris Campbell
Director of OREG
Ocean Renewable Energy Group
(ChrisCampbell@telus.net)

Update on FORCE, the Fundy Ocean Research Centre for Energy

FORCE continues a year focused on capital construction, research, and preparations for new technology deployment in 2012.

Construction is now complete at the FORCE visitor centre. The 3,500-square foot facility houses a visitor centre, a small theatre space, and a space for research and meetings. Interpretive exhibits are currently under construction; these exhibits will highlight both the Bay of Fundy and the FORCE project, with topics ranging from local geology to regional history to tidal technology. Research work will be highlighted through both videos and interactive displays; these are also in production right now. FORCE is pleased to report Mary McPhee has been hired as the Visitor Centre Manager in preparation for the centre's public opening this summer.

The newly built FORCE Visitor Centre near Parrsboro, NS

FORCE's 2010 Environmental Effects Monitoring Program (EEMP) report is being finalized and will be made available to the public after government review. The report covers the period from October 2009 to January 2011, including the first turbine deployment and retrieval. FORCE has also received and responded to recommendations for the 2011 EEMP from the Environmental Monitoring Advisory Committee (EMAC);

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these documents are posted here: **http://fundyforce.ca/committees**

FORCE has also recently tendered for both an Acoustic Doppler Current Profiler (ADCP) program to better understand the resource, as well as an acoustic monitoring program to characterize baseline noise levels. Both studies will be completed in the next few months.

For more information, please visit **www.fundyforce.ca**

Matt Lumley
Communications Director, FORCE
(matt.lumley@fundyforce.ca)

Tugboat and OpenHydro Installer preparing to retrieve the NSPI turbine, Minas Passage, 2010. Photo: Anna Redden

Update on the OEER Association

Located in Halifax, Nova Scotia, OEER Association (OEER) is a not-for-profit corporation dedicated to fostering offshore energy and environmental research and development including examination of renewable energy resources and their interaction with the marine environment.

OEER continues to fund marine renewable energy research as a result of the OEER and Fundy Ocean Research Center for Energy (FORCE) Tidal Energy Workshop held in Wolfville, Nova Scotia in October 2010. OEER released a new RFP in March 2010 that addresses topic areas in relation to Tidal In-Stream Energy Conversion (TISEC) devices in the following areas: Tools to study fish movements and turbine interactions, options for fish survey and sampling in high flow environments, marine mammal activity patterns, benthic habitat, potential inshore area impacts (e.g. tidal creeks, marshes, intertidal flats), potential submerged ice movements and risks and flow interactions with turbines.

These priority areas build upon the eight research projects OEER/OETR currently have underway. The RFP was divided into two stages; proposals with a spring 2011 field season and proposals without a spring 2011 field season. All proposals for these calls have now been received. Two projects with a spring 2011 field season were awarded as follows:

Acoustic Tracking of Fish Movements for the Assessment of Effects of Tidal Energy Devices in the Minas Passage. Project PIs: Dr. Michael Stokesbury and Dr. Anna Redden, Acadia University.

Passive Acoustic Monitoring of Cetacean Activity Patterns and Movements, Pre- and Post-deployment of TISEC devices in Minas Passage.
Project PIs: Dr. Dominic Tollit, SMRU Ltd and Dr. Anna Redden, Acadia University.

OEER is partnering with FORCE for the development of tidal interpretative, multimedia research and education material that will be displayed in the FORCE Bay of Fundy Visitor Center, located in Parrsboro, Nova Scotia. Planning is underway for a Phase II of the Strategic Environmental Assessment for the development of marine renewable energy off the Atlantic Coast of Nova Scotia as well as a Phase II of the Mi'kmaq Ecological Knowledge Study for potential marine renewable energy development in the Brier and Long Islands area of the Bay of Fundy.

Jennifer Matthews
OEER/OETR Associations
(j.matthews@offshoreenergyresearch.ca)

Technology Roadmap for Marine Renewable Energy, June 2011 Update

Natural Resources Canada has sponsored the development of a Technology Roadmap for Marine Renewable Energy (TRM MRE) for Canada. A team has been working through the development process since the fall of 2010. The main research is done through a series of three workshops which have been designed to be both regional and building. The last of the workshops was held in early June in Vancouver. It was successful in ratifying the "What" is to be done as well as the "When". It also provided great insights into "How" and "Who". These will be valuable to the next phase of implementation.

The development phase will be completed as planned in the late summer with the implementation team ramping up in that time frame and Canada will be well along on its path to be the dominant player in Marine Renewable Energy.

For more info, please visit the TRM MRE portion of the Ocean Renewable Energy Group website. **(www.oreg.ca)**

James Taylor, NS Power
(james.taylor@nspower.ca)

New Energy Corp (NEC) 5kw EnCurrent Generation System in the currents of Grand Passage, 2010. Photo: Greg Trowse

Returning to Parrsboro following field work in Minas Passage. Photo: Colin Buhariwalla

Upcoming Events in Canada

- Nova Scotia Tidal Symposium: Getting Power to Market, Halifax, Nova Scotia- July 7-8, 2011 more infor at **http://nstidalsymposium.ca/**
- FORCE Guided Site Visit, July 9. For more information visit **http://nstidalsymposium.ca/**
- 2011 CIGRE Canada Conference on Power Systems, Halifax, Nova Scotia- September 6-8, 2011 **http://www.cigre.ca/**
- 9th BoFEP Bay of Fundy Science Workshop, Saint John, New Brunswick, September 27-30, 2011. **http://www.bofep.org/workshop2011.htm**
- OREG 2011 Annual Conference, Montreal, Quebec. November 1 & 2, 2011. **http://www.oreg.ca/index.php?p=1_63**
- For information on the Fee-in Tariff process visit: **http://nsrenewables.ca/comfit.htm**
- See the FERN website for a list of upcoming events on tidal energy in the Bay of Fundy. **http://fern.acadiau.ca**

Updates from FERN's Subcommittees

For information on subcommittees and how to participate visit ***http://fern.acadiau.ca*** *or contact the Chairs.*

Biological & Ecological Effects

The mandate of the Biological & Ecological Effects Subcommittee (BEES), which had its first meeting in December 2010, is to:

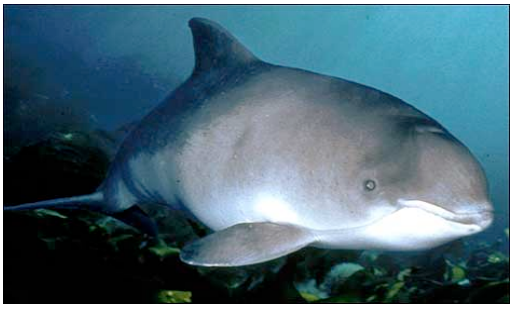
- promote information exchange and collaborative research on biological effects among institutions and stakeholders, especially through preparation of multi-institutional and multi-disciplinary research proposals; and
- advance the examination and evaluation of alternative technologies for biological monitoring and research (e.g. acoustic detection of fish behaviour).

During early 2011, members of BEES collaborated on four OEER funding proposals for tidal energy-related ecological research in the Minas Passage. Two field projects have been funded (acoustic tracking of fish movements; detection of marine mammal activity) and two others are still in review. Over the coming months, the subcommittee plans to enhance linkages with researchers in Maine working on the biological effects of harvesting tidal energy, organize mini technical workshops, including one on fish and marine mammal monitoring technologies, and brainstorm potential projects that address research gaps and needs at other tidal energy development sites in the Bay of Fundy.

Atlantic sturgeon, one of several fish species of concern. Photo: Erin Beazley

Co-Chairs:
-Graham Daborn, Acadia University (graham.daborn@acadiau.ca)
-Gerhard Pohle, Huntsman Marine Science Centre (gerhard.pohle@huntsmanmarine.ca)

Other Members:
-Anna Redden, Acadia University
-Dom Tollit, SMRU
-Gary Melvin, DFO, St. Andrews
-Jean-Marc Nicolas, NS Power



Harbour porpoise. Activity is being monitored by C-PODS. Photo: http://www.bbc.co.uk

Hydrodynamics & Geophysics

The Hydrodynamics & Geophysics Subcommittee have met twice in the past 4 months. The committee's mandate is to facilitate and communicate hydrodynamic and geophysics research related to tidal energy. At our first two meetings, the committee's focus has been the coordination of research activities. With support from the FERN Coordinator, we are in the process of setting up an online calendar of planned field work and a database of numerical simulations. Other initiatives underway include: setting up a web-based tool similar to Webtide that will allow users to get the modeled tidal currents at any location throughout the Bay of Fundy, exploring the development of guidelines or standards for hydrodynamic and geophysics data collection and analysis, specific for the tidal in-stream energy sector in the Bay of Fundy, and, finally, we are also planning to work with the other subcommittees to ensure that research activities are shared with all FERN members.

Co-Chairs:
-Richard Karsten, Acadia University (richard.karsten@acadiau.ca)
-Peter C. Smith, DFO (Peter.Smith@dfo-mpo.gc.ca)

Other Members:
-Dan Thompson, NS Power
-Danika van Proosdij, St. Mary's University
-David Greenberg, DFO, BIO
-Joel Culina, Acadia
-Tim Milligan, DFO, BIO
-John Shaw, GSC, BIO
-Alex Hay, Dalhousie
-Ryan Mulligan, East Carolina University

Socioeconomics

The Socioeconomics Subcommittee was constituted in January 2011 and met several times through the winter and spring. The committee's initial task was to learn about FERN and its various subcommittees, to understand the role it will play. Committee members then brainstormed on the key socioeconomic questions and priorities for the Fundy tidal energy sector. The committee's mandate was developed from these discussions.

The mandate is to define the scope and scale of socio-economic issues involved in in-stream tidal energy and other marine renewable energy developments. It will identify priorities, research gaps, capacity and funding opportunities and facilitate the creation of partnerships and collaborations between academia, community, government and industry stakeholders to address the priority areas. It will also catalogue resources, activities and stakeholders in the Atlantic region and serve as a network of expertise and a portal for information on socioeconomic knowledge about tidal energy in the Bay of Fundy. Finally, the committee will identify and develop links with national and international initiatives and stakeholders engaged in similar areas of expertise and interest.

The committee is now undertaking a scoping study of socio-economic issues, priorities and research gaps related to in-stream tidal energy.

Co-Chairs:
-Dana Morin, Fundy Tidal Inc. (dana@fundytidal.com)
-Kay Crinean, Maritime Tidal Energy Corporation (kay.crinean@maritimetidal.com)

Other Members:
-John Colton, Acadia- School of Recreation Management and Kinesiology
-Shelley MacDougall, Acadia-School of Business
-Terry Thibodeau, Annapolis Digby Economic Development Agency
-Jim Stanley, NS Community College
-Sandra Farwell, NS Dept. of Energy
-Erin MacNeil, NS Power
-Gay Harley, Scotian Carbon Services
-Graham Daborn, Acadia
-Eric Christmas, Mi'qmac Rights Initiative
-Peter Underwood, Deputy Minister, Special Projects, Executive Council Office

Photo Credit: NS Power

OpenHydro turbine and the gravity base built by Cherubini Metal Works, Dartmouth, NS.

Engineering

The mission of the subcommittee addressing Engineering Challenges is to facilitate research on engineering and technology issues associated with tidal energy development in the Bay of Fundy. The subcommittee membership includes researchers, practitioners and developers from across Canada and the USA and has met 5 times to date and plans monthly meetings for the near future. One of our current initiatives is to develop a rational approach to identifying and prioritizing engineering research challenges and opportunities associated with a tidal energy enterprise in the Bay of Fundy. Enhancing the economic and technical viability and competitiveness of a tidal energy project will be guided by an analysis of major cost components and potential savings in each. The team has identified some high priority areas which include cabling and mooring/platforms and will be pursuing a detailed statement of purpose and scope for the priority areas. Funding sources for the high priority areas are being identified and the subcommittee will be making presentations to interested parties in the coming months.

Co-Chairs:
-Mohammed E. El-Hawary Dalhousie University (elhawary@dal.ca)
-Sue Malloy, Glas Ocean Engineering (sue@glasocean.com)

Other Members:
-James Taylor, NS Power
-Jamie Ross, Glas Ocean Engineering
-Andrew Henry, Dalhousie
-Jim Simmons, Stantec
-Nick Strum, Strum Engineering
-Ghanashyam Ranjitka, NRCan
-Rich Grant, Grantec

Highlights of Various Bay of Fundy Research Projects

The following articles profile nine of the many dozens of collaborative research projects involving FERN members.

Submitted Project Summaries

Potential Effects of Marine Renewable Energy Developments on the Aquatic Environment

Over the past number of years, Fisheries and Oceans Canada has been working closely with Natural Resources Canada to better understand the potential effects of marine renewable energy (MRE) developments on the aquatic environment.

The two departments recently initiated a one-year project to establish a strategic approach to guide the MRE sector in advance of reviewing individual development proposals. The objective of the project is to develop a strategic science and research plan to address future regulatory information needs related to the granting of approvals for the construction, operation and decom-missioning of MRE devices (including offshore wind, offshore wave, tidal in-stream and in-river hydrokinetic) in Canadian marine and aquatic eco-systems.

Key stages will include:

•Development of pathways of effects logic models for each major form of MRE technology,

•Identification of major regulatory decision points,

•Development of environmental regulatory guidance documents,

•Completion of a gap analysis between identified regulatory decision points and what is currently known about the potential impacts of MRE projects,

•Ranking of research priorities in the form of a strategic research plan with senior management review and approval.

Tagging striped bass as they depart the Shubenacadie River.
Photo: Colin Buhariwalla

The Acadia Center for Estuarine Research recently prepared a logic model for DFO to demonstrate the various levels of interactions of MRE on the environment. The document is being translated and as next steps it will be distributed within DFO. The model(s) will be of interest to other federal departments, provincial regulatory authorities, First Nations, as well as industry and we will be seeking input over the next few months. We anticipate hosting a national workshop (central location - October or November 2011), and the pathways of effects will serve to focus the discussion, help to identify knowledge gaps, and confirm priorities.

Ted Currie, a senior environmental analyst with the Maritimes Region, is on assignment as the marine renewable energy advisor with the Oceans Directorate in Ottawa.
(Ted.Currie@dfo-mpo.gc.ca)

Resource Assessments of Tidal Currents

Our research group at Acadia - Dr. Joel Culina, MsC student Mitchell O'Flaherty-Sproul, undergraduate students Amanda Swan, Amber Corkum, and Michael Deveau - have been working on improving the resource assessment of tidal currents in passages around the Bay of Fundy. Much of our work is supported by an OEER grant and has been focused on improving the numerical simulations of tidal currents in the Minas Passage. We have been running higher resolution runs, comparing different numerical models and examining the vertical structure of the flow. The high resolution runs have shown much more eddy and wave like activity in the passage, as shown in the accompanying figure where large eddies are shown being shed off Cape Split and advected through the Minas Passage. The eddy creates pulses of high speed flow in the centre of the passage.

As well, we have been working on a project focused on the passages around Digby Neck in collaboration with Fundy Tidal Inc. and supported by the NSERC Engage program. We have developed a model with high resolution in Grand Passage, Petit Passage and the Digby Gut. The results are being compared to ADCP data gathered last fall and initial results will be made available in the next few months.

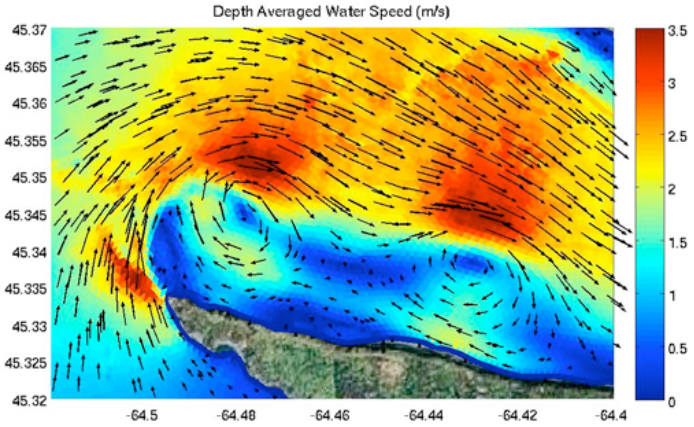


Figure 1: A snap shot of the depth averaged water speed past Cape Split during flood tide.

Finally, we have been examining the power potential associated with arrays of turbines. Our previous power assessments are based on a complete fence of turbines that is essentially a barrage. Recent results for the Minas Passage have indicated that it is possible to extract 1000 to 2000 MW of power from the flow using an array of 1000 to 2000, bottom deployed turbines. The impact of these turbines is only a 3-5% reduction in the flow through the Passage.

Richard Karsten, Acadia University
(richard.karsten@acadiau.ca**)**

New Geological Survey of Canada Project

The Geological Survey of Canada, with funding from the Clean Energy Fund, has initiated a one-year project aimed at removing some of the technical barriers to marine energy development in Canada. In 2006, the National Research Council published an Inventory of Canada's Marine Renewable Energy Resources based on numerical modeling of the potential wave and tidal energy available in Canada's offshore waters. Whereas this inventory identifies areas of "pure" or maximum potential, seabed geologic conditions will exert significant control over the feasibility

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Figure 1: Map of high tidal energy sites in Canadian waters (based on information provided by NRC and Triton Consultants Ltd.).

of installing infrastructure for energy extraction. In any development, detailed site characterization is required by proponents for placement of structures, hazard identification and assessment of environmental impacts. From a government perspective regulators will need to know the full range of potential hazards, many of which will be geological.

The principal objective of the project is to develop methodology and best practices for site characterization and the assessment of seafloor geohazards in areas of high marine energy potential across Canada. While the scope of the project is national, we are basing the study on individual case studies of potential marine energy sites from both Atlantic and Pacific coasts.

As an integral part of this work, we have been consulting stakeholders about the needs and issues surrounding site characterization and geohazards assessment. Feedback has so far been very positive and we encourage anyone interested in this to contact us. The preliminary results of the project will be presented at OREG's 2011 Annual Event, November 1-2, in Montreal, while the final products, a GIS-based map product and draft best practice guide, will be completed by March 31, 2012.

Phil Hill, Geological Survey of Canada – Pacific, Natural Resources Canada **(**phill@nrcan.gc.ca)

GSCA Sediment Dynamics Research in the Bay of Fundy

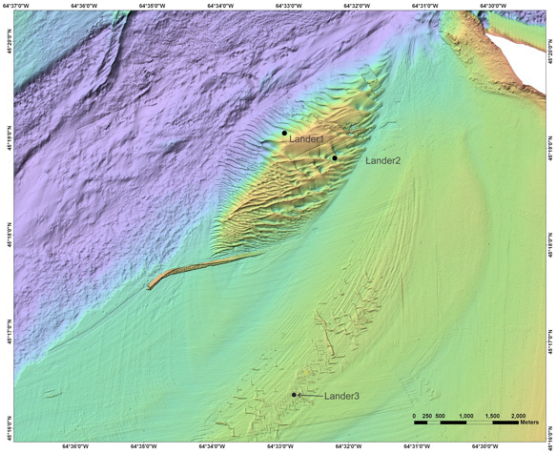

Figure 1: Seabed features over which seabed landers were deployed.

As part of the GSC Offshore Renewable Energy (ORE) Project and the CEF funded Fundy Seabed Suitability Assessment project, GSCA researchers recently successfully deployed and recovered three instrumented seabed landers from the Cape Split area, upper Bay of Fundy. These landers were deployed respectively on the sand waves of the Cape Split banner bank and the barchan dunes in Scots Bay, for the period of 26 February to 23 April 2011 (Figure 1). Initial assessment of the collected data shows that the nearbed mean currents reached up to 1.2 m/s. Camera data from Lander 1 indicate active migration of megaripples superimposed on the sand waves. Acoustic Backscatter Sensors recorded events of local sediment re-suspension. The lander data will be processed and interpreted in the coming months to provide assessment of nearbed tidal flow and sediment mobility over the banner bank and barchan dunes at the deployment sites.

GSCA will carry out another regional geological and geophysical expedition in Bay of Fundy on CCGS Hudson in September 2011. Instrumented landers will be deployed and recovered on this expedition to obtain *in situ* sediment dynamics data in the lower Bay of Fundy. Another up-coming activity will be the model prediction of the seabed shear stress, sediment mobility, and sediment transport pattern for the entire Bay of Fundy under the existing tidal current regime. This will be undertaken in collaboration with Dr. Dave Greenberg of DFO and Dr. Richard Karsten of Acadia University. The site-specific and regional knowledge on the seabed disturbance, sediment transport, and bedform mobility generated from this research should facilitate the assessment of geological constraints to tidal energy development and the potential impacts on the environment from this development in the Bay of Fundy.

Michael Li, Angus Robertson, and Robert Prescott.
Geological Survey of Canada – Atlantic, BIO
(Michael.Li@NRCan-RNCan.gc.ca)

Discovering the Seafloor of the Bay of Fundy

The Bay of Fundy has tidal power potential but a better understanding of the bay's underwater geology is needed to identify safe and suitable turbine locations. The Geological Survey of Canada (Atlantic) of Natural Resources Canada has responded to this need by mapping the Bay of Fundy seabed, and by providing topographic and geological maps and knowledge. This information will help guide development of tidal power.

GSC researchers collaborated with the Canadian Hydrographic Service (Fisheries and Oceans Canada), the Ocean Mapping Group of the University of New Brunswick, and the Centre of Geographic Sciences of the Nova Scotia Community College to map the topography and geology of the ocean bottom and the character and thickness of seabed sediments. This was achieved using a suite of sophisticated survey tools and techniques, including shipboard and aircraft-based devices. Multibeam sonar (SOund Navigation And Ranging) data collected by ships were used to construct an accurate relief map of the Bay of Fundy seabed (Figure 1). Aircraft-mounted LiDAR (Light Detection And Ranging) flown during periods of low tide collected data that enabled accurate mapping of the coastal zone.

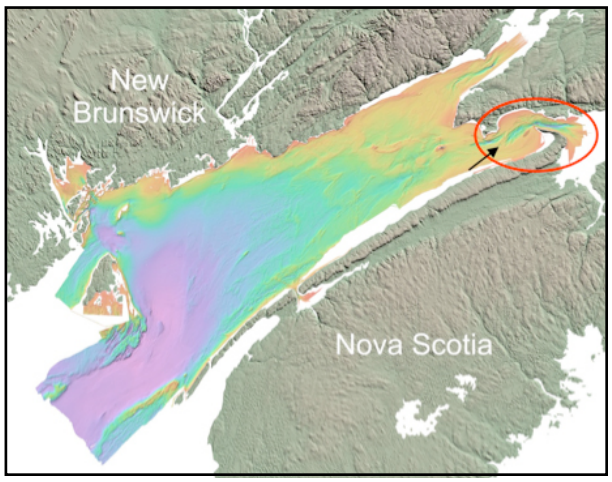

Figure 1. Bathymetric map of the Bay of Fundy. Red-to-orange colours indicate shallow water and blue-to-violet colours denote deep water. The black arrow shows the direction of the oblique view in Figure 2.

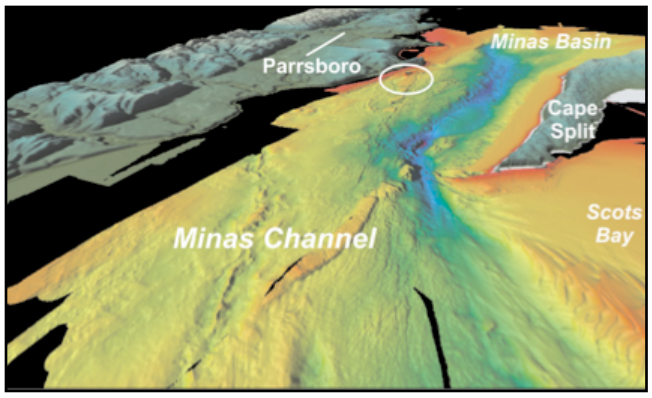

Figure 2. Oblique view of the seafloor of Minas Channel between Cape Split and Parrsboro. An in-stream tidal power device was installed in 2009–2010 on the seafloor in the area circled.

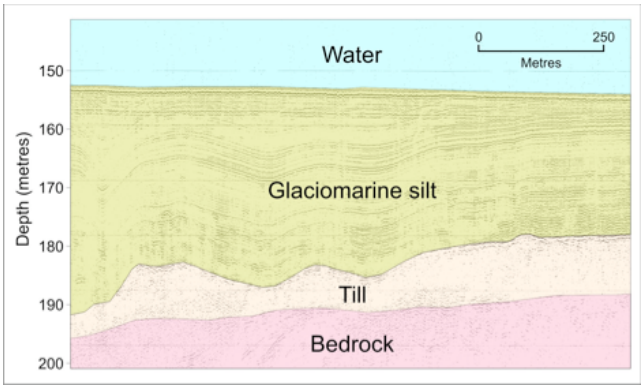

Figure 3. Interpreted seismic cross-section showing bedrock and sediment layers in the Bay of Fundy.

The combination of the multibeam sonar and LiDAR results provided the first detailed and "seamless" map from the bottom of the Bay of Fundy across the shoreline and onto land (Figure 2).

Once the ocean bottom topography was mapped, seismic profiling techniques were used to determine the types of rock and sediment that lay beneath the seafloor. Sound energy was used once more, this time to produce echoes from layers of sediment up to 50 m beneath the seabed. The result was a series of sub-surface profiles of sediment thickness produced as the survey ship completed transects of the bay (Figure 3). For more information on this project visit: **http://fern.acadiau.ca/discovering-the-seafloor.html**

Brian J. Todd and **John Shaw**
Geological Survey of Canada - Atlantic, BIO
(brian.todd@NRCan.gc.ca)

Detection of Marine Mammals in the FORCE leased area during 2010

Much needed baseline information on the activity patterns of marine mammals in the FORCE demonstration area, Minas Passage, was collected in 2010 through the collaborative research efforts of Acadia University and SMRU Ltd, and with support from the Ocean Tracking Network. The study addressed the following questions:

1. What are the activity levels of key cetaceans (porpoises and dolphins) in the Minas Passage during late summer/fall, as determined by bottom moored units fitted with continuous passive acoustic monitoring devices?
2. How does cetacean presence/activity near the NSPI (OpenHydro) turbine compare with presence/activity at a control site?

This FORCE funded project involved a continuous ~3 month long passive acoustic marine mammal monitoring field study (10 August 2010 – 23 November 2010) while the NSPI (OpenHydro) tidal turbine device was deployed in the Minas Passage. C-POD hydrophones (autonomous cetacean echolocation click detectors, Chelonia Ltd) were deployed and recovered using custom-fitted bottom moorings with acoustic releases.

Results indicate that C-PODs were effective in monitoring cetacean presence. Harbour porpoises were detected regularly through late summer and autumn but did not (with a few exceptions during neap tides in September and October) appear to spend significant time periods around either the turbine (not operational during study period) or the control site, suggesting transit through Minas Passage or local foraging in areas out of detectable range. Presence was higher at night at both sites. We found no statistical evidence of the presence of the turbine attracting or repulsing porpoise, but when porpoises were present, behavior (based on click train parameters) appeared to differ between the two sites. Further work is currently underway and includes greater temporal and spatial coverage of marine mammal activity in the Minas Passage.

For the full report,

Tollit DJ, Wood JD, Broome J, and Redden AM. 2011. Detection of Marine Mammals and Effects Monitoring at the NSPI (OpenHydro) Turbine Site in the Minas Passage during 2010. ACER Technical Report No. 101, 36 pp, Acadia University.
http://fern.acadiau.ca/biological-ecological-effects.html

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Figure 1: C-POD mounted in Sub-Buoy mooring - ready to deploy. Photo: Colin Buhariwalla.

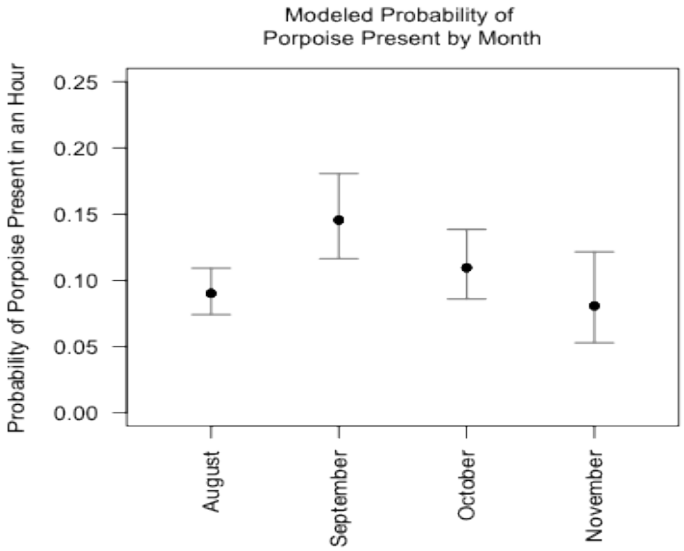

Figure 2: Probability and 95% CI of overall harbour porpoise presence in an hour, by month.

Efficiency Implications for Ducted Tidal Turbines

Several concepts have emerged for tidal turbine designs, many of which incorporate a duct which increases the mass flow through the turbine, thus enhancing its power for a given rotor size. Unlike for wind, there is a limit to the amount of energy that can be extracted from tidal flows given channel boundaries. Adding turbines to a channel will impose drag forces which reduce the flow velocity and therefore reduce its energy content. A component of the drag arises inherently due to power production, while drag due to supporting structures and ducts does not contribute to power generation and effectively reduces the total available flow energy. If an array of many turbines is to be installed, the reduction of total energy available will be significant.

In comparing ducted and open- flow turbines there are essentially two competing factors; one is the power augmentation due to increased mass flow and the other is the increased drag. Research conducted by the authors has characterized the efficiency of marine current turbines in terms of the ratio between the power produced by the rotor (neglecting any mechanical or electrical losses) and the total power lost from the flow (the sum of power production and drag losses). This allows the relative magnitude of the power augmentation and increased drag to be expressed with a single parameter providing a basis for comparing various ducted and open flow designs in terms of their overall energy extraction efficiency, alongside conventional C_P metrics.

The results show that for any ducted or open-rotor design there is an operating C_T which maximizes C_P, and a lower C_T which maximizes the overall efficiency. As the device drag (be it support structures and/or ducts) increases, the C_T for optimum efficiency tends to increase, but the peak efficiency is also reduced. This shows that any given turbine cannot operate at maximum power and maximum efficiency at the same time. As the scale of power extraction approaches limits (either physical limits to the maximum possible extraction or limits to the acceptable change in tidal regime) it becomes more important to operate at the thrust coefficient for maximum efficiency. Based on the study results, less aggressive duct designs and cleaner support structures with lower overall drag seem more appropriate as efficiency becomes more critical in larger devices and arrays of devices.

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Tidal Power - From Fundy to the World

The Bay of Fundy's unparalleled tidal energy potential and the recently revitalized research and development into harnessing this potential have made the area a world leader in tidal energy. With the continued progress towards full scale implementation a new opportunity to export the region's expertise and technology on a global scale emerges.

Being a renewable and reliable source of electricity, tidal power could play a large role in the much needed deployment of Renewable Energy Technologies (RET's) in the developing world. Of the worlds 80 lowest ranked countries in terms of the UN's Human Development Index (HDI). 56 have coastline on a tidal influenced body of water. The majority of these countries have never had their tidal energy resource assessed even though many appear to have significant potential. Governments, NGOs and academics have postulated on the possible impacts RET's could have on development with principally positive impacts identified, including; increased energy access and security, 'skipping' the fossil fuel dependent stage of economic growth and contributing to the regions' sustainability. Unique investment opportunities also exist through country specific RET policies and the Clean Development Mechanism (CDM) which finances projects in

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developing countries that help reduce green house gas emissions.

Through the Centre for Sustainable Development at the University of Cambridge this complex relationship between the global tidal energy resource, its possible contribution to human development goals and its contribution to a region's sustainable development is being examined.

The breakthroughs being made today in the Bay of Fundy could soon be applied to new emerging markets where the need and opportunity is greatest to both ease the burden of climate change and to aid in development.

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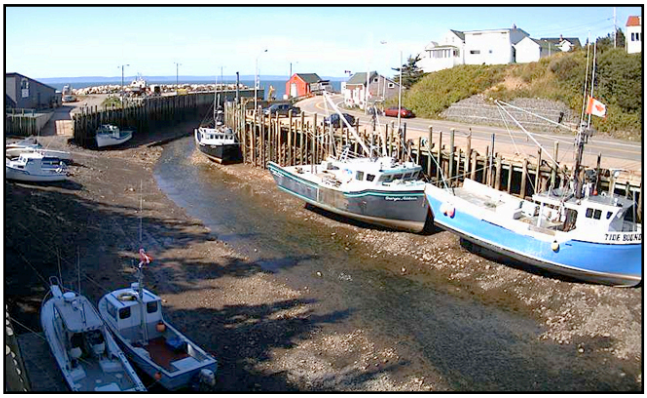

Halls Harbour, NS, at low tide, 2 Sept. 2008.
Source: www.novascotiawebcams.com/bay-of-fundy/halls-harbour-1.html

The Development of Active Sonar for Marine Mammal Detection at the SeaGen Tidal Turbine

In 2008, UK based tidal energy technology development company, Marine Current Turbines (MCT), installed the SeaGen tidal turbine in Strangford Lough, Northern Ireland. The consenting process required that an environmental monitoring programme was established. Part of this programme included measures to minimise the possible impacts of the project on marine mammals, particularly the local seal population. MCT agreed to a mitigation strategy with Northern Ireland Environment Agency (NIEA) whereby monitoring is used to instigate a precautionary shutdown of SeaGen if a marine mammal is identified in close proximity to the turbine.

Initially Marine Mammal Observers (MMO) were stationed onboard SeaGen to provide a visual monitoring capability when SeaGen was operational. SeaGen was only operational during daylight hours. In August 2009, with support from the Sea Mammal Research Unit Ltd (SMRU Ltd), MCT trialed active sonar technology with remote sonar operators initiating shutdown. The Tritech Super Seaking DST mechanical scanning sonar was found to be the most effective. The active sonar compared favourably to the MMO visual detection capability and to the satisfaction of the NIEA. Consequently active sonar has been a key part of the mitigation strategy since 2009, with the deployment of

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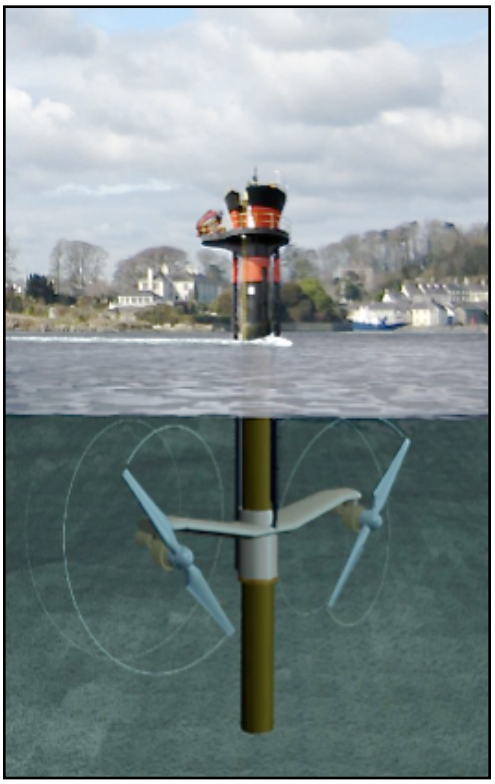

Figure 1: SeaGen showing crossbeam and rotors. Source: MCT Ltd.

two Super Seaking (375 kHz CHIRP) sonars facing upstream and downstream, on the SeaGen cross beam.

In 2010, a new sonar system, the Tritech Gemini SeaTec 720 id multibeam imaging sonar, was installed alongside the existing system for testing. Gemini SeaTec provides real time imaging with specialized software providing an early warning of the presence of marine mammals. Tritech launched the Gemini SeaTec Mammal Detection System in May 2011.

This sonar technology has been developed through collaboration between MCT, SMRU Ltd and Tritech. It is anticipated that the technology will allow for effective behavioural monitoring and mitigation of potential threats to marine mammals, supporting the continuing development of marine renewable technology at locations around the world. MCT have an agreement with Minas Basin Pulp and Power to install a tidal turbine at FORCE, the results of the active sonar studies undertaken in Strangford will be used as evidence for the impact assessment of the Minas Basin project.

Figure 2: Tritech Gemini Sea Tec 720 id multibeam imaging sonar.

Further information can be found at **www.seageneration.co.uk** and **www.smru.st-andrews.ac.uk/**

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This newsletter was designed by Erin Beazley and edited by Erin Beazley, Lisa Isaacman and Anna Redden.

We welcome your feedback on this issue and any suggestions for future issues.

FERN
FUNDY ENERGY RESEARCH NETWORK

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