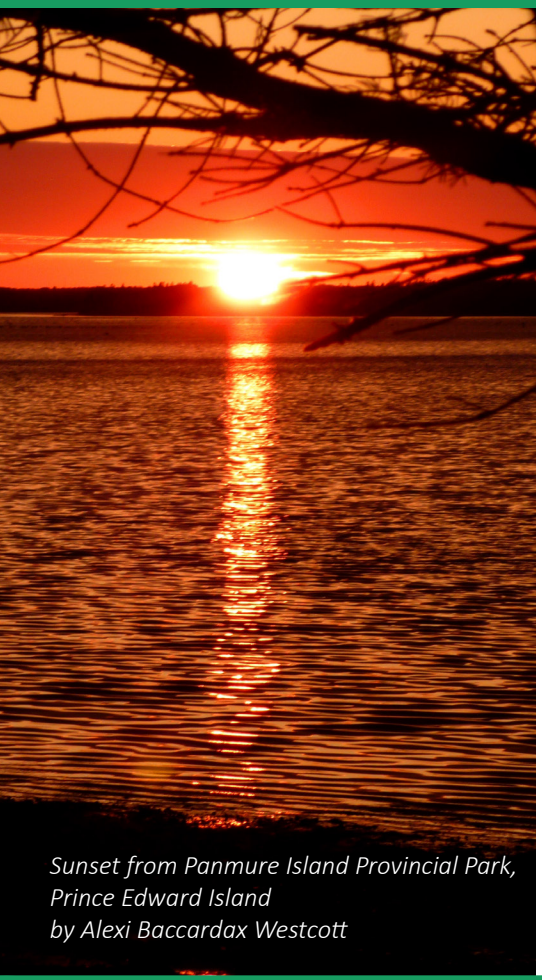
In this issue

THE ZONE



Sunset from Panmure Island Provincial Park, Prince Edward Island by Alexi Baccardax Westcott

Welcome to this second issue of the new and improved newsletter of the Coastal Zone Canada Association, **THE ZONE**.

Letter from the President

This issue comes at the time when we are in full preparation for the next biennial Coastal Zone Canada conference, to be held in Toronto on June 12-16, 2016. The program for the conference will be a very exciting set of sessions, papers, and guest speakers that will address coastal and ocean management issues from all of Canada's coastal zones and beyond to include international and global ocean and coastal zone management (OCZM). It is a wonderful opportunity for the ocean and coastal management community in Canada to come together and share our issues and concerns, and discuss and plan for new, innovative solutions. It will also be a time to assess the new political environment that we face in Canada with the election of the federal Liberal government back in October.

In a separate article in this issue of the The Zone, I have identified many policy areas where the new federal government presents hope for a brighter and more progressive future for OCZM in Canada. One of the aims of the CZCA has always been to work with governments to support better policy and practice in OCZM, and in particular to assist the federal government in carrying out its significant responsibilities under the Canada Oceans Act and other legislation. This part of our mandate became increasingly difficult as the last federal government disengaged with the oceans and environment files. CZC2016 is an opportunity for us to discuss how we re-engage with the federal government on such critical issues as climate change, coastal resource management, marine protected areas, and community-based management, to name but a few.

The CZC conferences are the primary activity and purposes of our Association, and I urge all members, and non-members who are concerned and engaged in our oceans and coasts, to take the opportunity to attend CZC2016. Please read the information provided in this issue of the Zone and explore the CZC2016 website (http://www.czcatoronto2016.com) for more information on the conference. Not only is it the opportunity to participate in a great coastal conference, but it is also a chance to discover the state of coastal management in Canada's Great Lakes coastal zone and experience Canada's largest coastal city, Toronto.

At last year's Annual General Meeting, Pete Zuzek was elected as President Elect and Alexi Baccardax Westcott was elected as Vice-President (Communications). I want to take this opportunity to thank Pete for stepping forward to take on the responsibility of leading our Association into the future, and Alexi for her great work on the communications file and the creation and design of The Zone. Thanks also to Pete for his tremendous efforts in organizing CZC2016. Let's show our full support for sustaining the biennial CZC conferences by going to the website right now and registering to attend CZC2016.

Thank you for your continuing support for the CZCA and I look forward to seeing you all in Toronto in June.

Peter Ricketts, President, CZCA

Coastal Zone Canada 2016 Conference

"Resilience through Collaboration"

http://www.czcatoronto2016.com

Don't miss out on the upcoming CZC 2016 conference where coastal zone scientists and practitioners get together to share their knowledge from their research and projects conducted all over the world. The conference will be full out plenary sessions, workshops, networking events, and career development opportunities. The draft agenda is now available online: *http://www.czcatoronto2016.com/?page_id=204*

Coastal zones across Canada and globally are facing unprecedented use as well as feeling impacts from climate change. As a result, collaboration among communities, government agencies and the private sector is becoming increasingly important. The complexity of coastal ecosystems also necessitates an integrated policy and management structure that will rely on much closer cooperation among stakeholders than previously.

Over the past 20 years the biennial CZC conferences have brought together experts and interested individuals from across Canada and worldwide, to share ideas and lessons learned. Through such meetings CZC helps to promote better understanding and response to the challenges facing our coastal resources and communities.

We are excited about hosting the 2016 CZC conference in Toronto, adjacent to the largest freshwater resource complex in the world. While progress has been made in managing our coastal zones, there remains much work to do.

The abstract submission deadline has passed. However, authors can request to have their papers included in an upcoming issue of The Zone. Contact The Zone Editors at czcanews@gmail.com with your abstract by 30 June 2016. See more details on the call on page 3.

The conference registration is now open via the website. Every effort has been made to organize a high quality technical conference at an affordable price. We are grateful to our conference partners who provide critical assistance with keeping the registration fees low.

Keynote Speakers

Two keynote speakers have been announced for the opening plenary: Dr. Julie Dean Rosati, US Army Corps of Engineers and Dr. Biliana Cicin-Sain, University of Delaware. Refer to the website for additional details.

Day two will start with a second plenary focused on project examples to increase coastal resilience. Adam Hosking of CH2M will share global examples of projects focused on planning, designing and enhancing coastal resilience. Dr. Rob Nairn from Baird & Associates will present on the outcomes from the recent Changing Coarse Design Competition, which focused on options to re-align the Mississippi Delta to increase coastal resilience, enhance ecosystem function, and strengthen the local economy. The final presentation will highlight the ongoing work to re-design the mouth of the Don River, which drains into Toronto Harbour, to address flood conveyance, enhance habitat and support regeneration of the local waterfront.

Youth – Employer Forum and Opening Social

The conference will kick-off on Sunday afternoon with our Youth – Employer Forum at the Steam Whistle Brewery in downtown Toronto. The forum will include a keynote presentation by Ryan Coelho on the Millennial Engagement Movement and small breakout groups to further relevant issues in today's coast workplaces.

The Opening Social for CZC 2016 will commence at 7 pm at the Steam Whistle Brewery and feature light hors d'oeuvres and a cash bar. Don't miss this chance to catch up with old friends, meet new professionals from across the world, and get a free tour of the beer making facility! The revitalized Toronto waterfront is only steps away from the brewery, as is the CN Tower and new Ripley's Aquarium.

Natural and Nature Based Features Workshop

The Natural and Nature Based Features (NNBF) Workshop will run within the conference on Wednesday June 15, 2016. NNBF are of heightened interest to coastal practitioners, engineers and scientists for their aesthetic capabilities, storm damage reduction, and habitat creation potential. They can naturally increase the resiliency of our coastal zones and represent a valuable adaptation approach to address the threats associated with climate change. However, the engineering and economic benefits of NNBF have only recently been studied, and guidance for design, ecological function, performance capabilities, maintenance requirements, costs, and adaptive potential is lacking.

The workshop will explore recent successes and lessons learned concerning design and performance of naturally-occurring and constructed NNBF features within the Great Lakes, ocean coastlines, embayments and estuarine zones. The potential for joint Canadian and USA demonstration sites will also be explored. The needs for future research and monitoring, plus the development of a community of practice (NNBF COP) to communicate and disseminate information will be discussed.

Closing Plenary

We are also pleased to announce that Natural Resources Canada (NRCAN) will help close-out our conference on Wednesday June 15th with a presentation on their recently released assessment of climate change sensitivity, risks and adaptation for Canada's coastlines. This interactive session will also include opportunities for the conference attendees to comment on the report entitled "Canada's Marine Coasts in a Changing Climate" and provide recommendations for future studies. Refer to the NRCAN site for more details on the study and to download a copy of the report:

www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2016/18388

Field Trip

On Thursday, June 16, the workshop participants will join Gord MacPherson, Associate Director of Restoration for the Toronto Region Conservation Authority, to observe local examples of NNBF along the coast of Lake Ontario. Transportation will be provided from the conference hotels. A wide variety of sites will be visited that integrate NNBF, including habitat restoration sites in Toronto Harbour, the proposed Don River Mouth re-alignment, habitat creation projects in Tommy Thompson Park, large-scale erosion mitigation along the Scarborough Bluffs, and dune and marsh restoration in the Frenchman's Bay area.

I look forward to seeing you in Toronto in June!

Pete Zuzek, Conference Chair
czc2016@baird.com

GET IN THE ZONE

Submit your news items for the next issue of The Zone (Fall 2016). We wish to continue the dialogue of coastal zone work on Canada between the biennial conferences, considering sharing your updates with us to be included in the next issue.

News Items

To submit a news item (maximum 500 words) please send to

czcanews@gmail.com
by July 29, 2016.

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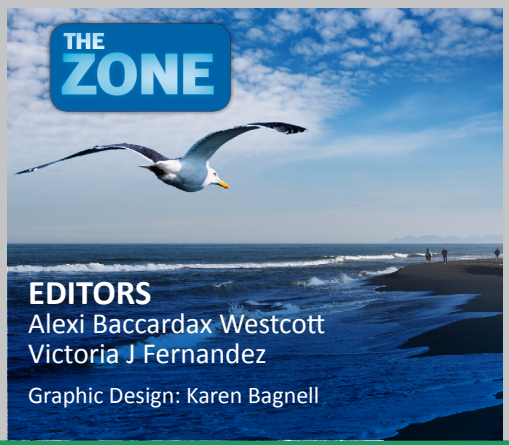
http://eepurl.com/byGoF5

We would like to sincerely thank all of the contributors to this edition of the Zone, the authors of the papers and articles herein, as well as the reviewers.



CALL FOR PAPERS

Please consider submitting a paper to the next issue of the CZCA Newsletter. We are looking for paper submissions of 1000-2000 words on a wide range of topics covering Canada's coastal zone: governance and policy, engineering, ocean science, and social science.

If you wish to submit a paper please submit your abstracts (maximum of 250 words) to CZCAnews@gmail.com by June 30, 2016. Papers will be due July 29, 2016.

Call for French Editors

The Zone is looking for French speaking or bilingual (French and English) volunteer editor(s). For further information please contact us at

CZCAnews@gmail.com

CZCA Membership

Registration at the biennial CZC conferences automatically includes CZCA membership dues for two years. If you miss the 2016 conference and would like to either update your membership or become a new member, please contact the CZCA Secretariat (email czcadmin@dal.ca). Biennial membership is $40/ year. More information on membership is available on the CZCA website:
www.czca-azcc.org/html/membership.html
www.czca-azcc.org/html/adhesion.html

After The Election: A New Beginning For OCZM In Canada?

Dr. Peter Ricketts[1]

It is fair to say that there is a strong consensus amongst members of the CZCA that the Harper years have not been good for ocean and coastal management in Canada. As I reflect upon the outcome of the October 19 general election, I cannot help feel a sense of renewed optimism that things can only improve under the new Liberal government of Justin Trudeau. However, we cannot take for granted that ocean and coastal zone management (OCZM) will suddenly become important again in the federal political agenda. The fact is that all areas of environmental and resource management, and scientific research in general, have suffered in recent years under federal policies that have prioritized resource extraction and reduced reliance upon evidence-based policy. There is much for the new government to do as it begins to repair the damage done to the federal research infrastructure and capacity to support policy development and implementation. We know that the new government does not have infinite resources to spend, and it has significant policy commitments that were made before and during the election.

The Liberals made a number of important commitments regarding oceans, and so this is a good place for the CZCA to start in its efforts to influence and assist the new government. Before looking at that, let us consider one last time the impact of the last government just on our Coastal Zone Conferences.

The last ten years of CZC conferences provide an interesting reflection of the impacts of the Conservative government on OCZM and Canada's responsibilities under the Oceans Act. In 2006, the first CZC conference of the Harper era was in Tuktoyuktuk and was virtually entirely underwritten by DFO. They chartered the plane, leased the conference facility, and generally subsidized the whole conference to make it affordable for participants to attend. For CZC 2008 in BC, I worked closely with our key DFO contacts in Ottawa and Pacific Region to ensure that the conference would make a positive contribution to the Health of the Oceans Initiative, which was the Conservative government's successor to the previous Liberal government's Oceans Action Plan. DFO made a substantial financial contribution through a Contribution Agreement (and Environment Canada also contributed a smaller but significant amount) and the conference statement was a lengthy document that made a whole set of recommendations to DFO and Environment Canada for implementation of the Oceans agenda.

After the conference, attempts to reach out to the federal government went unanswered and before long the individuals who had been working with us were no longer with DFO and Environment Canada. In 2010, the PEI conference was largely supported through the regional and provincial offices of DFO and Environment Canada, but we began to see the first real signs of federal disengagement. Despite representing a local PEI riding and being in the area at the time of the conference, the DFO Minister couldn't find the time in her schedule to attend. The Charlottetown Declaration calling on Canadians to heal our oceans and coasts was ignored by DFO, despite efforts to promote its message to the Minister and the government in general. However, it was in 2012 in Rimouski where we felt the impact of the change in circumstances that DFO and other federal government scientists were experiencing. DFO provided financial and significant logistical and personnel support through the Maurice Lamontagne Institute near Mont-Joli, but at the last minute numerous DFO and Environment Canada participants had to pull out for lack of funding approval to attend the conference.

Also, for the first time the federal scientists who did attend told us that they could have no part of any conference statement that might be in any way critical of the federal government. They were hugely apologetic and embarrassed by this situation, but they had no choice and so this became the first conference that did not develop a conference statement and call to action. We were now in majority government time, and the full force of the government's crackdown on scientists was coming into play. Which brings us to 2014 in Halifax, which became the first CZC conference not to receive any DFO or other federal funding. While we continued to get support from dedicated individuals within the DFO Maritimes Region, as an organization the Ministry of Fisheries and Oceans was no longer prepared to financially support Canada's major ocean and coastal management conference. Again restrictions on conference travel and permissions to present papers resulted in the smallest ever participation by federal government scientists and public servants in a CZC conference.

So today, we now have a new federal government. While it would be foolish to think that the Trudeau government will suddenly turn the financial taps back on, at least we should be able to go back to having an informed discussion about the role that the Association can play in assisting the government reach its goals. During the election campaign, the Liberals made a number of pledges regarding Canada's oceans and coast. These are as follows:

Excerpts from Real Change: Protecting Our Oceans

"We will improve Canadians' quality of life: the air we breathe, the water we drink, the parks and beaches where our children play. That means investing in the protection of our oceans – the health of which is critical to safeguarding our environment and growing our economy. Our plan will help fish stocks recover, support eco-tourism, protect coastlines from erosion, ensure ecological integrity and protect species at risk. We will restore Canada's reputation as a leader in ocean science, strengthen our laws and regulations, and give communities more say in how we manage our oceans."

Specifically, the Liberals committed to:

1. Meet Canada's international commitment to protect marine and coastal areas under the 2010 International Convention on Biodiversity and the Aichi Biodiversity Targets to protect freshwater, marine, and coastal habitat. One of those commitments was: "By 2020, at least 17 percent of terrestrial and inland water, and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes." [Strategic Plan for Biodiversity 2011-2020, Target 11] While other countries such as Australia (33.2%), the United States (16.6%), and even Russia (11.6%) have made great strides to meet their commitments, Canada has protected only 1.3 percent of our marine and coastal areas. The Liberals promised to increase the amount of Canada's marine and coastal areas that are protected from 1.3 percent to 5 percent by 2017, and 10 percent by 2020.
2. Invest in ocean science by reinstating $40 million that was cut from the federal government's ocean science and monitoring programs. The aim is to restore much-needed scientific capability in the Department of Fisheries and Oceans, and return Canada to being a well-respected world leader in oceans and marine research. This funding will be used to ensure the health of our fish stocks, such as the iconic British Columbia salmon, monitor contaminants and pollution in our oceans, and to support an environmentally sustainable, responsible, and economically successful aquaculture industry on both coasts. The Liberals committed to using scientific evidence and the precautionary principle and take into account climate change when making decisions effecting fish stocks and ecosystem management.
3. Strengthen Canada's laws by restoring robust oversight and thorough environmental assessments of projects that could impact areas under federal jurisdiction – including oceans and freshwater – and conduct a wholesale review of the Conservative amendments to the Fisheries Act and other legislative changes, incorporating modern safeguards to protect our oceans and freshwater fish habitat.
4. Encourage community engagement through effective co-management of our oceans, by working with the provinces, Indigenous Peoples, and other stakeholders. The Liberals promised to develop plans that will make best use of our marine resources, and also give coastal communities more say in managing the resources around them.
5. Protect the marine environment from oil spills by formalizing the moratorium on crude oil tanker traffic on British Columbia's North Coast, including the Dixon Entrance, Hecate Strait, and Queen Charlotte Sound, to ensure that ecologically sensitive areas and local economies are protected from the potentially devastating impacts of a spill.

In addition to these specific policy proposals there is also the strong commitment to addressing both the causes and impacts of climate change. The new Minister of DFO, Hunter Tootoo is from the Nunavut, Catherine McKenna, MP for Ottawa Centre, is the new Minister of Environment and Climate Change, and the new Minister of Natural Resources is Jim Carr from Winnipeg. As President of the CZCA I will be in touch with our new key Ministers to see if we can restart a dialogue with the federal government on renewing Canada's commitment to ocean and coastal management and helping the new government fulfill its commitments. Hopefully we can use CZC 2016 in Toronto, 12-16 June 2016, as a platform to launch a new era of ocean and coastal management in Canada.

As ever before, the CZCA stands ready and willing to assist the federal government in fulfilling its commitments and responsibilities under the Oceans Act and other federal legislation, as well as its commitments globally under international laws and conventions.

Ottawa, November 11, 2015

[1]President, Coastal Zone Canada Association, Carleton University, Ottawa

Juvenile Banded Rudderfish at Mill Cove, St. Margaret's Bay, Nova Scotia, by Alexi Baccardax Westcott

IOI-Canada 2015 Training Program

Madeleine Coffen-Smout[1]

The International Ocean Institute (IOI) held its 35th annual training program at Dalhousie University, Halifax, Nova Scotia from 20th May to 17th July 2015. This interdisciplinary course on Ocean Governance: Policy, Law and Management was attended by marine professionals from Africa, Asia, the Caribbean, Europe and South America. The participants were drawn from a range of ocean-related backgrounds, with equal representation of women and men in the group.

The program consisted of more than 200 hours of intensive learning, organised thematically across 10 modules. The detailed syllabus is available online at: internationaloceaninstitute.dal.ca/2015Syllabus.pdf. While it was primarily lecture-based, the classroom component also included interactive discussions, presentations by each participant, skills sessions, video footage, exercises, and a course-long simulation involving both individual and group work, culminating in an International Round Table. Lectures and presentations were delivered by over 100 speakers and included local and international experts and practitioners (see: internationaloceaninstitute.dal.ca/lecturers.htm).

Multiple field trips complemented the lectures, exposing the participants to a range of ocean-related activities in coastal communities and enabling them to compare theory with reality at the grassroots level. A three-day trip to the Bay of Fundy – home of the world's highest tides – was one of the course highlights and included tours of an aquaculture facility, tidal power station, coastal marsh, beaches, first nation's cultural centre, marine plant research facility and a fisheries museum. More locally, the group toured the Bedford Institute of Oceanography and one of its research vessels, attended a presentation at the Northwest Atlantic Fisheries Organisation, visited the Eastern Canada Response Corporation to learn about oil spill responses, witnessed a dramatic underwater session at Survival Systems Training Ltd, and explored the Port of Halifax by boat.

By the end of these two months of intensive studies, the 2015 participants had been challenged to:

- deepen their understanding of the complexity and role of ocean-related issues in sustainable development;
- strengthen and update their academic knowledge, while also being exposed to practical lessons drawn from actual experience in integrated coastal and ocean management;
- develop valuable skills in areas such as information management, project cycle management, performance management, and communication including presentations and media interviews to help them apply their new knowledge; and, ultimately,
- assist their countries towards maximising benefits to be derived from the UN Convention on the Law of the Sea, through the proper integration of coastal and ocean management into national and international development strategies.

As part of a unique network of nearly 670 alumni from over 100 countries, they are well placed to make a real difference in the world. For full details, see the 2015 Course Report (http://internationaloceaninstitute.dal.ca/2015CourseReport.pdf).

For more information on IOI Canada, past and upcoming training sessions, and contact information, see the website: http://internationaloceaninstitute.dal.ca

Please contact the Program Officer (ioi@dal.ca) for more information.

[1]*International Ocean Institute Dalhousie University*

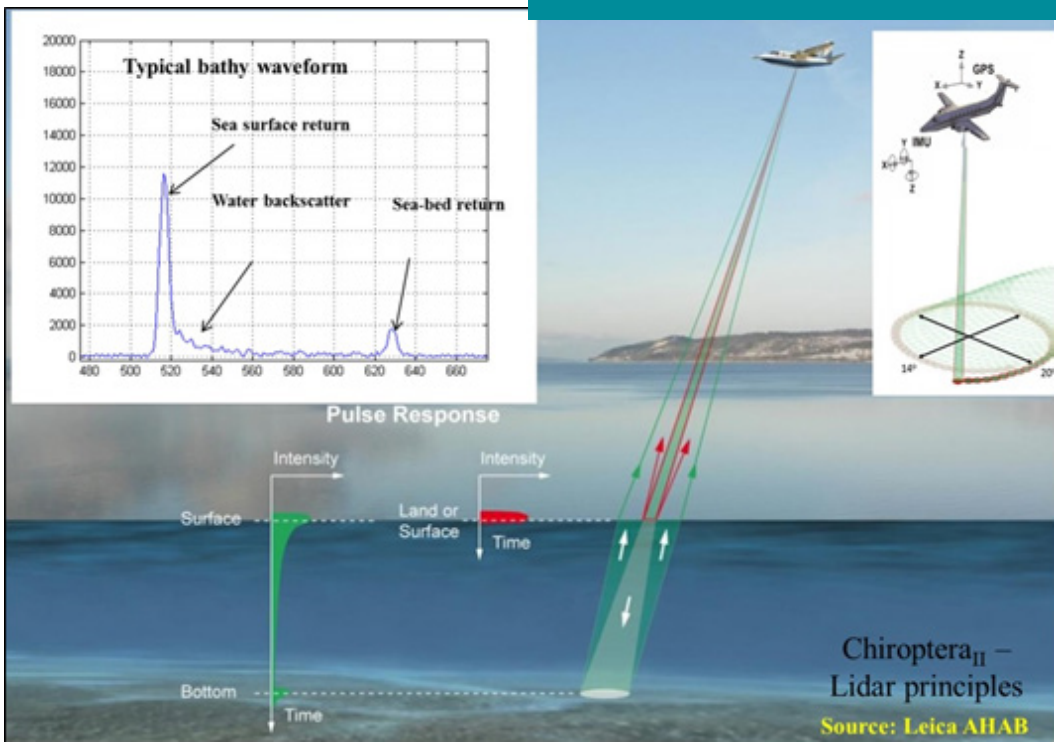
Photo below:
IOI-Canada 2015 Training Program participants in a classroom at Dalhousie University during the summer of 2015.

Using a Topo-bathymetric LiDAR Sensor for Coastal Zone Projects in Atlantic Canada

Candace MacDonald[1]

In 2013, the Applied Geomatics Research Group (AGRG), part of the Nova Scotia Community College (NSCC), acquired Leica-Airborne Hydrography's Chiroptera II (CHII) system, an airborne shallow water topo-bathymetric LiDAR sensor capable of mapping the topography on land and the shallow submerged bathymetry. Similar to traditional Light Detection and Ranging (LiDAR) sensors, the CHII uses a near-infrared (NIR) laser to survey the topography. However, water absorbs near-infrared light, rendering it incapable of surveying below the water. For this, the CHII uses a green laser to survey the nearshore bathymetry. The depth to which the sensor can reach is dependent on water clarity, but in clear water the maximum depth is roughly 15 m. The system also has a high resolution multispectral (RGB+NIR) RCD30 camera capable of taking 5 cm resolution images at 400 m altitude. The LiDAR system was purchased through a grant from the Canada Foundation for Innovation (CFI) and Nova Scotia Research Innovation Trust. Since then, NSCC-AGRG has collaborated with various government organizations and private companies to conduct research projects which demonstrate the utility of this technology to solve real-world problems faced by companies.

Figure 1. LiDAR principles of the Chiroptera II



The Chiroptera II is an airborne shallow water sensor designed to target the nearshore coastal zone and freshwater environment, particularly the region commonly referred to as the 'white ribbon gap' – a strip along the

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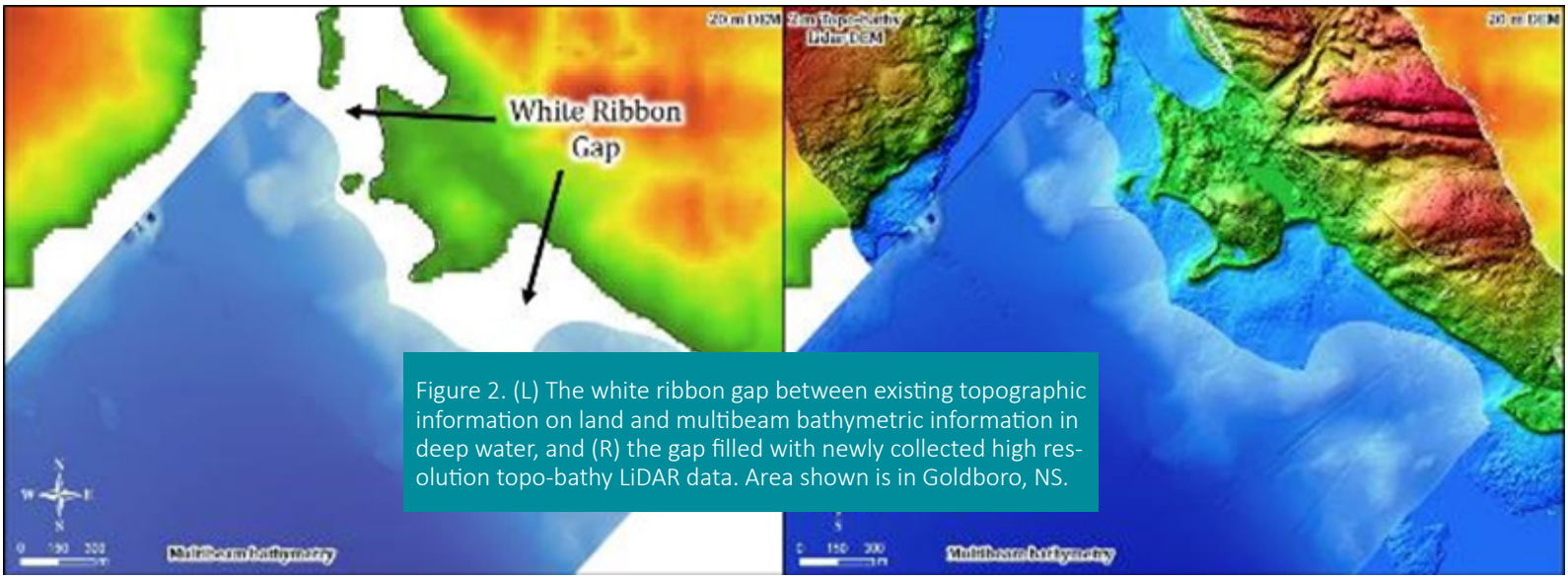


Figure 2. (L) The white ribbon gap between existing topographic information on land and multibeam bathymetric information in deep water, and (R) the gap filled with newly collected high resolution topo-bathy LiDAR data. Area shown is in Goldboro, NS.

Continued from previous page

coast that is too shallow for boats to safely collect high resolution bathymetry data, yet not mapped with traditional topographic LiDAR systems. The resulting data can be processed to high resolution elevation models with a seamless land-water interface, ideal to support various applications, from flood mapping to aquaculture studies.

Figure 2. (L) The white ribbon gap between existing topographic information on land and multibeam bathymetric information in deep water, and (R) the gap filled with newly collected high resolution topo-bathy LiDAR data. Area shown is in Goldboro, NS.

NSCC-AGRG, who has partnered with Leading Edge Geomatics (Fredericton, NB) to provide the aircraft, has completed two extensive topo-bathy LiDAR surveys covering various study areas across the Maritimes in 2014 and 2015 to support ongoing research in various fields of study. One industry partner, Acadian Seaplants Limited, is interested in quantifying harvestable seaweed from the intertidal zone. Another industry partner, Pieridae Energy, had completed a multibeam survey of a harbour to support building a terminal for a Liquefied Natural Gas project, however they lacked the nearshore data to compute volumetric estimates of land displacement for the pre-engineering study of infrastructure required. Thus, they partnered with NSCC-AGRG and NSERC to investigate the potential of the system to fill in this gap and assist with such volumetric estimates. An ongoing project with the Department of Fisheries and Oceans (DFO) in New Brunswick and Nova Scotia and Stantec Consulting focuses on mapping eelgrass in shallow sensitive ecosystems with aquaculture present, and yet another project with the DFO Tanker Safety program utilizes the topo-bathy LiDAR sensor and accompanying multispectral aerial photography to support shoreline feature classification and complex particle-tracking modeling in the event of a tanker oil spill. NSCC-AGRG is interested in new partnerships with industry through the NSERC ENGAGE grants or expanding existing partnerships through NSERC Applied Research and Development (ARD) grants.

Dr. Tim Webster, lead coastal zone research scientist at NSCC-AGRG, best summarized the potential of the topo-bathy LiDAR system when he said, "The possibilities of the topo-bathy LiDAR sensor are as vast as the waters we will be charting."

[1]*Research Associate, Applied Geomatics Research Group*

Greenwich Beach, Prince Edward Island National Park by Alexi Baccardax Westcott

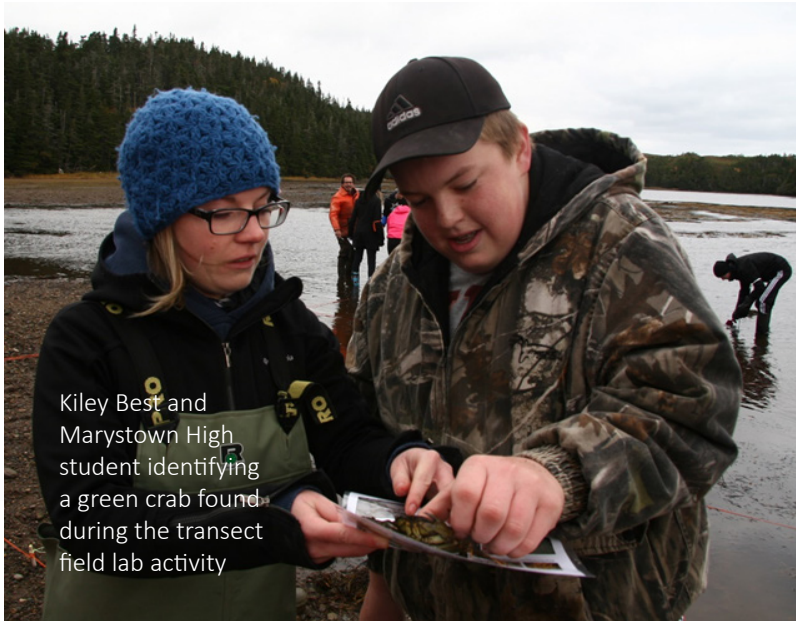
Engaging youth on the effects of Aquatic Invasive Species and the health of the intertidal zone in Placentia Bay Newfoundland

Kiley Best[1], Nicole Hynes[2]

There are many coastal marine environments around the world vulnerable to the introduction of nonnative aquatic species due to the increase in global mobilization through industry and recreation. Many areas of the Newfoundland and Labrador coastline feature these vulnerabilities and aquatic invasive species (AIS) have been observed as a growing concern in the province over the past 15 years. There are many stakeholders currently involved in monitoring and surveying the local ecosystem and researching methods for preventing and controlling the spread of AIS. Education and outreach is increasingly important to create awareness of ways to minimize the potential damage AIS can cause in the aquatic environment. A High School event held in the fall of 2014 in a community on the west coast of Placentia Bay Newfoundland is a great example of these efforts.

The Newfoundland and Labrador Provincial Department of Fisheries and Aquaculture (DFA) planned to initiate AIS education and awareness activities in collaboration with the Fisheries and Oceans Canada (DFO) AIS Lab in St. John's. The Marystown High School was contacted to discuss holding a field lab to explore the effects that AIS (specifically green crab) were having on the local ecosystem. There was interest in the project specifically from the grade 10 science teacher. The project would contribute to fulfilling aspects of the high school class 'Science 1206' curriculum topics including invasive species, food chains, and ecosystem sustainability. DFO contacted additional stakeholders involved in AIS research and education to assist in planning and executing a daylong event in the Marystown area. Additional groups included: Memorial University's scientific dive team and graduate students; a youth engagement group from Marine Institute called MI Ocean Net; and the Food Fish and Allied Workers (FFAW). DFA also provided $1,000 in funding to the school to help cover costs associated with the field lab.

The AIS field lab activities started with an information session at the school to provide the students with background on the topics to be addressed during the day. The students were prompted to apply the new information by participating in a field experiment, data collection and activities on the beach and intertidal area of nearby Spanish Room. The Spanish Room field site was on an estuary adjacent to a beach facing the open ocean of Placentia Bay.



Kiley Best and Marystown High student identifying a green crab found during the transect field lab activity

The information session lead by Kiley Best included information on the meaning of 'invasive' and AIS, which aquatic species to watch for and to monitor in the local area, and the steps to follow in case of encountering a species that could be on the NL species of concern AIS list.

The species of concern discussed in Newfoundland include a list of tunicates and crustaceans, with four species of interest in the Marystown area. European green crab *Carcinus maenas* is the most threatening to Newfoundland waters as it is a very aggressive crab that prefers bivalve shellfish. This is a voracious generalist predator that destroys eelgrass beds that are important in supporting the early life stages of many commercial fish species, and displaces competing native species. Colonial tunicates such as the violet tunicate *Botrylloides violaceaus* with rows of individuals, and the Golden Star tunicate *Botrylloides schlosseri* with circular clusters of individuals, attach to manmade and natural surfaces and have a smothering effect on organisms inhibiting their growth or suffocating them. They can reproduce via fragmentation or by free swimming larval release naturally or when disturbed. Solitary tunicates with comparatively much larger individuals include the Vase tunicate *Ciona intesinalis*, which also attaches to manmade and natural surfaces and cause the same damage as colonial tunicates. Additionally, the tunicates add extra weight to marine structures possibly causing a number of difficulties related to the infrastructure's use and stability. Armed with this information the students witnessed how scientists monitor, capture and identify green crab. The students witnessed firsthand some of the damage that green crabs cause. On site, the students had the opportunity to observe different techniques by visiting stations displaying inshore marine biological sampling techniques.

Beach seining is a widely used technique to determine the abundance of shallow water habitat species directly from the shore. The students observed a beach seine deployment and pull demonstration from shore near the estuary and eelgrass beds. Students learned

how to identify the finfish species captured, as well as the other species in the beach seine sample. The sample biodiversity included spined stickleback, winter flounder, rock gunnel, white hake, cunners, sculpin, Atlantic silverside (unique to that site), and green crab. The students were particularly excited to find salps or "blue goo" which had recently bloomed and turned an area of the bay a bright blue. The phenomenon was reported on television the previous week. All finfish were released after each haul. The salps and green crab were kept for samples and later activities onsite.

'Ocean viewers' are large tubes with plexi glass bottoms and handles used to look through the surface of the water while standing in shallow water. The students deployed the ocean viewers in water 2-3 feet deep while wearing hip waders and lifejackets. The ocean viewers were used to observe the bottom habitat type and identify any species or AIS previously encountered in the seine.

Studying Oceanographic conditions are a large part of ocean research and are important to understand when determining the environmental conditions an organism requires to survive. The students learned about mini loggers used at NL monitoring sites to measure temperature and salinity profiles with the tides and weather conditions. A mini logger was deployed at Spanish Rooms 24 hours previous, and during the field lab the students were shown how the data is interpreted after uploading to a computer on site.

A collapsible Fukui trap of Japanese design, used in Canada as a standardized green crab survey catch method, was displayed. Students baited and set traps, as well as hauled preset traps in the estuary. This allowed them to see how the fishing technology aspect of collection works and the trap effectiveness for catching crabs (short time frame). The crabs captured using this method were used in later demonstrations.

Green crabs have a number of unique identifying characteristics demonstrated to the students using the live specimens captured on site. Topics included green crab morphology, reproductive biology, and how to internally identify the different sexes and structures with dissections. Students were given the opportunity to dissect their own green crab.

After this extensive crash course in ecology and invasive species with a concentration in green crab, all of the students came together after a lunch break and participated in a transect/quadrat activity looking at the different species in the area at low tide. Students used identification keys to classify and quantify generally all the organisms and sediment types in each quadrat. All green crabs collected were sexed, measured, and bagged for DFO records. The students shared the data with the DFO team onsite, to be included in DFO's green crab database. The students also used the information they collected to write a laboratory report for their 1206 Science course.

The students enjoyed this opportunity and participated in all the activities. Additionally they showed interest and excitement in conducting hands on tasks and working with live animals. The students learned how to identify green crabs, and the type of habitat and conditions they prefer. The students also witnessed some of the damage that green crabs have caused to the eelgrass beds in Spanish Room. In addition to contributing data to the DFO green crab database, the event was also part of a stewardship project with Vale Inc. and the FFAW aimed at removing green crab from areas in Placentia Bay. Participation had a significant impact on students because it provided a hands on opportunity and was practical and applicable to issues and industries surrounding the ocean in their own back yard. Participants witnessed the negative environmental consequences of the introduction of a species like green crab, and learned control and monitoring techniques. Students are now able to relate to the issue of AIS more easily, have become more invested in spreading the word about AIS thereby contributing to keeping the invasion spread down, and therefore contributing to reducing AIS damage. Positive feedback from the students and from media interviews provides evidence the event was a great success and it appears that a new group of ocean conservationists has resulted.

Teachers and organizing stakeholders were more than pleased with the smooth running day, diversity of activities, and data collected on that cloudy chilly day in October. Success of this activity has peaked interest in other areas and teachers and students at Marystown High are interested in hosting more activities such as this to follow up on work done in 2014.

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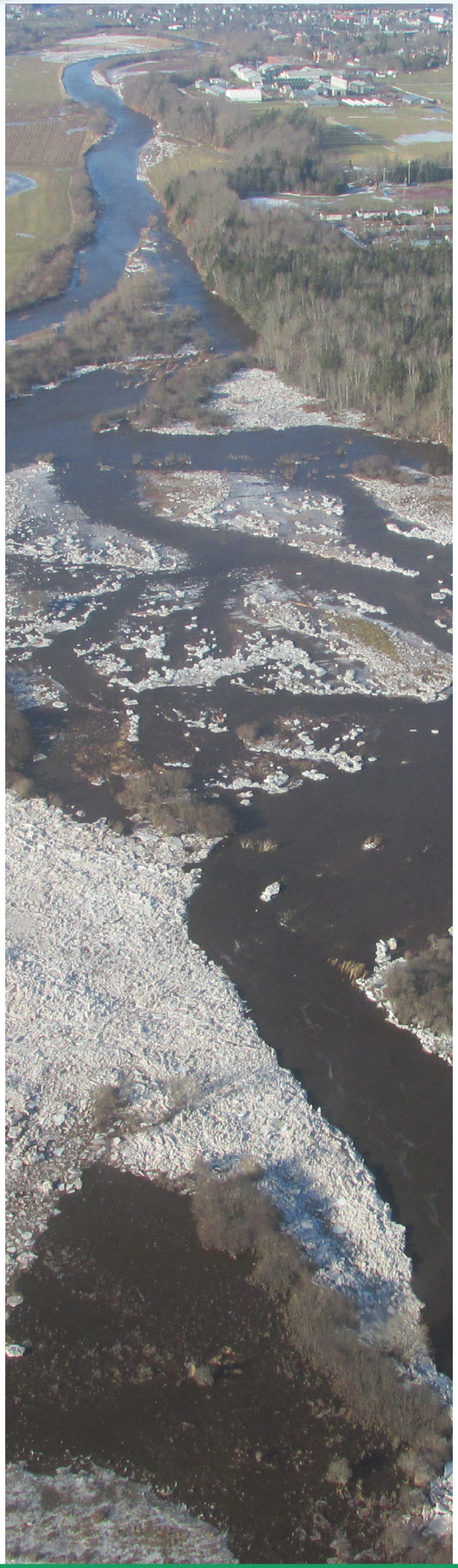
Teachers, students and organizers after a successful day in the field in Spanish Room, Placentia Bay, Newfoundland and Labrador



The Truro Flood Risk Study- Managing Flood Risks in the Bay of Fundy

Alex Wilson, P.Eng, M. SC[1]

Introduction

The Bay of Fundy has the highest tides in the world, as the tidal frequency is close to the bay's natural frequency of oscillation, creating a strong seiching effect (Greenberg 1979). Many communities in Nova Scotia such as the Town of Truro are located within the floodplains of tidal rivers that discharge into the Bay of Fundy and are affected by the complex interaction between the rainfall-generated surface river water flowing towards the ocean and the tidal waters flowing upstream during the rising tide. Tidal sedimentation and ice jams are contributing factors that further worsen flooding risks (FATAC1971).

The Town of Truro is located in the floodplain of the Salmon River, that discharges into the Cobequid Bay in the eastern end of the Minas Basin, in the Bay of Fundy. Residents of this community have endured repeated flooding damage, with the earliest record dated in 1792 (FDRP, 1988). Within the year 1979 alone, the area experienced five flood events, four between January and March (FDRP, 1988). Schools, residences, road access to essential services, commercial areas and industries are impacted regularly. Costs of damage have not been well documented, as money was spent by various provincial and sometimes federal departments, both in reparations and flood protection (FDRP, 1988).

The past history of Truro shows that following through on recommendations from previous studies is always a challenge in the time after major floods (FDRP 1988). An example is the Central Colchester Area Floodplain Study (MRMS 1974), which recommended preventing development in the floodplain by the Town of Truro or the County of Colchester. It would seem that development within the floodplain has in fact historically increased following large flooding events (EMW 1997). Other than land use controls, previous reports have noted that the complexity of the mechanics of flooding has prevented the study and identification of effective flood protection measures (DREE 1971). Current flood mitigation efforts are focused on removing sediment from the rivers and raising the height of dykes in localized areas (Municipal Council Minutes Sept. 2014). However, the high tidal range and natural sediment concentration levels in the channels results in sediment accumulation rates of up to 5 cm per tide during the summer (pers. comm. R. McLellan), which equates to 1 m per month.

Objectives

The Truro Flood Risk Study goal was to review past recommendations for flood mitigation, identify potential opportunities, as well as evaluate cost effectiveness of options, for their potential to protect the most vulnerable areas. An evaluation of the effectiveness of current spending will support channeling funds where they are most needed. Understanding the complex mechanics of flooding in the area is a central focus of this assessment, by using more extensive and higher resolution data than previously available. This includes Lidar data coverage, bathymetric survey of the main channels, suspended sediment characterization and sediment sampling, radar-rainfall data and more extensive records of recent flood extents.

It is important to explore the full range of potential approaches that include flood protection structures, to management of rainfall through infiltration, flood forecasting to improve emergency management, development of land use and planning tools or doing nothing. In essence, the overall goal can be separated into two main objectives: understanding the network of vulnerabilities of each stakeholder involved, and identifying solutions to reduce vulnerability and protect the stakeholders.

Stakeholder Consultation

The first part of the project involved identifying and consulting with many stakeholders. In-depth discussions were held during meetings and workshops to extract the full depth of concerns, goals, objectives and challenges that related to this project.

Table 1: Ranking of priority areas from meeting with the Joint Flood Advisory Committee

Results from JFAC Meeting
Decreasing Order of Priority

PROTECTION OF LIFE	SOCIAL JUSTICE	PRESERVATION OF ACCESS TO EMERGENCY FACILITIES	MAINTENANCE OF ACCESS TO AN AREA	ACCESS TO NECESSITIES OF LIFE	PROTECTION OF REGIONAL ACCESS ROUTES	PROTECTION OF LIVELIHOOD	SHORT AND LONG TERM IMPACTS	PROTECTION O ENVIRONMENT FROM CONTAMINATION
PROTECTION OF HOSPITAL	PROTECTION OF SENIOR HOMES	PROTECTION OF SCHOOLS	PROTECTION OF RESIDENTIAL PROPERTIES	PROTECTION OF OFFICE USES	PROTECTION OF RETAIL PROPERTIES	PROTECTION OF INDUSTRIAL LANE PROPERTIES	PROTECTION OF AGRICULTURAL LAND	PROTECTION OF RECREATIONAL FACILITIES
PROTECTION OF COMMUNICATION INFRASTRUCTURE	PROTECTION OF BRIDGES	PROTECTION OF ROADS	PROTECTION OF WATER SUPPLY / TREATMENT	PROTECTION OF POWER SUPPLY	PROTECTION OF POTABLE WATER INFRASTRUCTURE	PROTECTION OF WASTEWATER TREATMENT	PROTECTION OF MARSH LANE INFRASTRUCTURE (DYKES, ABOITEAUX)	

An example of ranking priority areas is shown below in Table 1. The stakeholders with whom discussions were held included the County of Colchester, the Town of Truro, Millbrook First Nations, NS Department of Agriculture, NS Environment, NS Natural Resources, NS Transportation and Infrastructure Renewal, Environment Canada, the councillors for both the County and the Town, NS Power, CN Rail, and the public. This process led to the development of a prioritized matrix of vulnerable infrastructure, that can then be used to evaluate the effectiveness of various flood mitigation measures.

Hydrologic and Hydraulic Modelling

As identified in previous reports (MRMS, 1974, FDRP 1988, DREE, 1971), flooding is the result of extreme rainfall, tides, sediment levels and ice jams, in isolation or in combination, producing complex hydrodynamics that are challenging to resolve and predict.

One of the other significant challenges in this study related to dealing with the very large amount of data available, for example identifying specific watershed characteristics for each of the watersheds modelled. For this task, custom-built GIS tools were developed to automatically delineate 127 sub-watersheds within the major watersheds of the Salmon River, the North River and McClure's Brook from the Lidar data. Manual review of this data was necessary to confirm the effect of culverts on the delineation. Automatic extraction of hydrologic characteristics included soil characteristics, watershed surface roughness based on land cover delineation (using LandSat IR photography, Lidar point density and return signal strength, and aerial imagery), as well as automated slope calculation (using a flow accumulation-weighted algorithm).

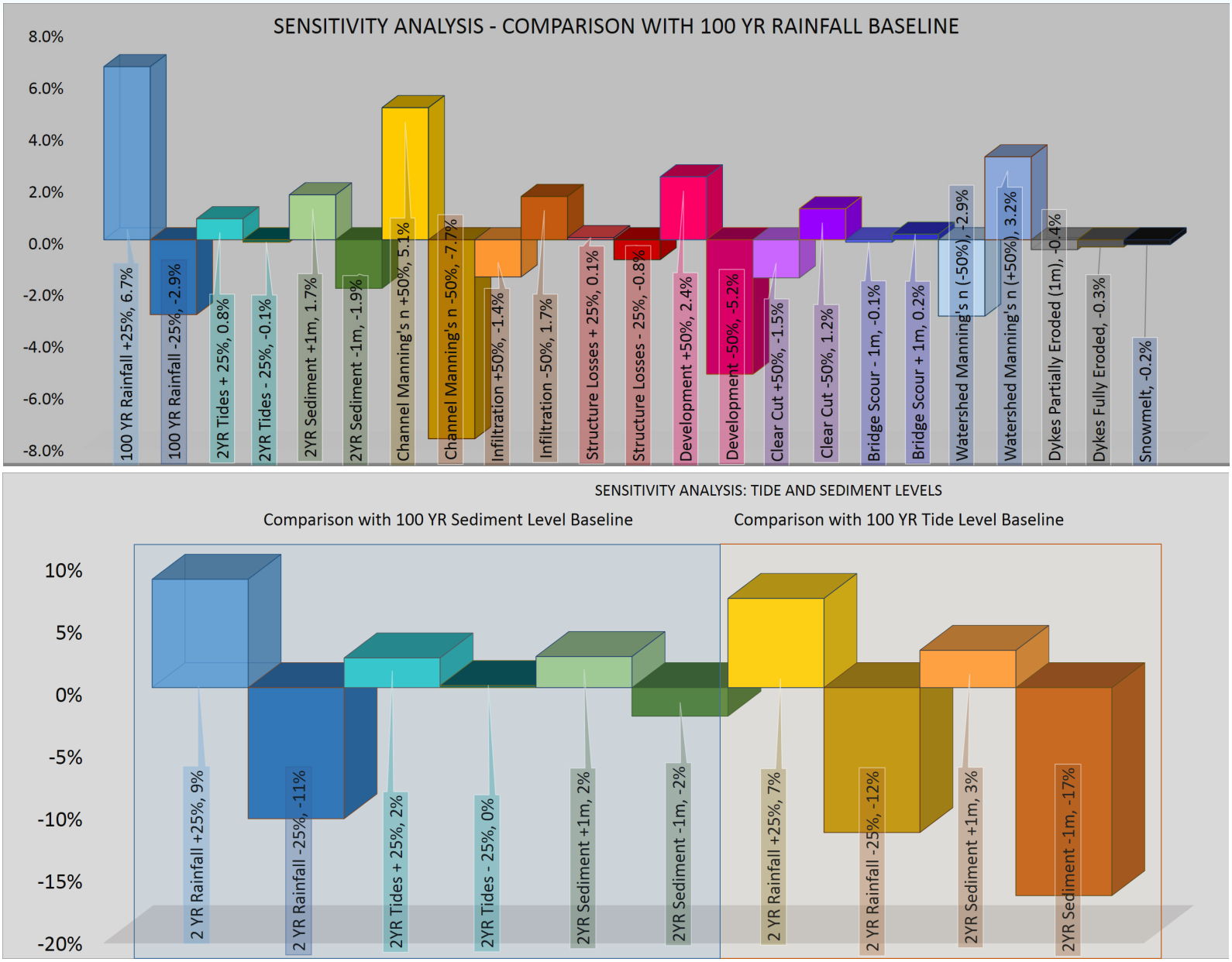
A 1D-2D Storm Water Management Model (SWMM, developed by the US Environmental Protection Agency in 1971) dynamic model using a finite difference solution to the Saint-Venant equations was assembled to study the river and floodplain system. The river channel was modelled in 1D, supplemented with 1D connections every 20m to represent the dyke overtopping capacity. To include the potential for the dykes breaching and collapsing, control rules were set to automatically open new channels through the dykes during the simulation if the dykes were overtopped by more than 300mm.

A computer model with Ice Jam capabilities was assembled using the HEC-RAS (Hydraulic Engineering Center – River Analysis Software) model: a 1D, steady-state, hydraulic model used for calculating water levels given a flow input, developed by the US Army Corps of Engineers and released in 1985. Customized Visual Basic routines were developed to convert the models built with the SWMM model into a 1D steady state HEC-RAS model in order to use the Ice Module, developed by the USACE Cold Regions Research and Engineering Laboratory, and study the risks of formation of ice jams in various locations for various flow conditions.

A 3D hydrodynamic model (MIKE3 from the Danish Hydraulics Institute) of the Bay of Fundy was assembled to resolve the tidal intrusion dynamics into the Cobequid Bay, as there are

Figure 1: Ranking of influential parameters following sensitivity testing

Figure 2: Percent change in flooded area by changing sensitive parameters for various baseline conditions



no tidal gauges close to Truro. The Bay of Fundy model was calibrated on the Burntcoat Head and Saint John tide gauges, as well as 4 tidal gauges placed by a team of engineers in a field program. This improved our understanding of tidal ingress processes relative to the Truro area.

Following this, a 3D, finite element, cohesive sediment transport model (MIKE3 with the Mud Transport Module, Danish Hydraulics Institute), was assembled for the near field Truro estuary study area. The model was calibrated with data from tide gauges, Acoustic Doppler Current Profilers (ADCP), total soluble solids (TSS) probes and sediment samples, from varying seasons and locations along the length and width of the estuary.

Finally, the 1D-2D SWMM model was calibrated using two approaches: the 1971 hurricane Beth, highest flood on record, which included flow gauging records, to calibrate flows, and a recent known flood event (12 September 2012) with the calculated tide and rainfall conditions, used to calibrate the resulting flood elevations.

The climate change impacts were included in this study as 1m sea level rise (SLR) (Zhai et al 2014, Richards et al. 2011) for the year 2200 and 29% increase for a 24 hour duration rainfall based on the Greenwood estimates in Lines et. Al, 2008 and RFAC, 1985. Site-specific SLR allowances recently developed by DFO (IPCC AR5, Zhai et al 2014) are consistent with values from Richards et al., 2011, which would translate into a recommended SLR allowance of 0.96 m (± 0.46 m) for Truro from 2015 to 2100. Richards et al., 2011, also developed storm surge return period estimates for Truro, based on values extrapolated from the long term tide gauge in Saint John, New Brunswick.

The model results were used to update the floodline delineation that had been carried

out in 1988 in the Flood Damage Reduction Program (FDRP, 1988), and which now includes the following aspects:

- Delineation and modelling based on highly detailed Lidar topographic data (1m grid resolution);
- Delineation and modelling of the full length of the main rivers tributary to the floodplain;
- State of the art two dimensional hydraulic modelling;
- Modelling of extreme flows in a dynamic setting;
- Modelling of tidal ingress in a dynamic setting;
- Modelling of extreme sediment levels;
- Assessment of Climate Change impacts on extreme rainfall amounts;
- Assessment of Climate Change impacts on extreme tide levels;
- Delineation of the 1 in 2, 1 in 10, 1 in 20, 1 in 50 and 1 in 100 year events;
- Delineation of the 1 in 100 year event with the impact of Climate Change in the year 2100 horizon; and
- Assessment and delineation of the Probable Maximum Flood Event.

Table 2: First Ranking of Flood Mitigation Measures from Model Results

Option Name	Option Description	Cost Effectiveness	% Protection of Priority Areas	Net Cost	Recommend?
RaiseDykes 1	Raise all Dykes by 1 m	0.34%	7.0%	$M 20.5	
Runoff Reduction 4	Construct 1 Dam in Millbrook Area Upstream of Willow St Culvert	1.20%	1.0%	$M 0.8	Recommended
Runoff Reduction 5	Implement BMPs to Reduce Runoff to Pre-Development Conditons	0.01%	38.4%	$M 2.7	Recommended, but through policies and by-laws
FloodPlain Restoration 2	Widen Dykes to Larger Floodplain, Add Dykes to Reduce Flooding in McClures Brook & Pump	0.29%	28.6%	$M 99.0	Recommended
Floodway By-pass 1	Floodway Bypass Channel - 100m Wide to McClures Brook (4.3km)	0.36%	9.0%	$M 25.0	Recommended
Floodway By-pass 2	Floodway Bypass Channel - 100m Wide - Extended to the WWTP (6km)	0.41%	13.2%	$M 32.0	
Floodway By-pass 3	Floodway Bypass - Extended to Lower Truro (7.75km)	0.39%	15.2%	$M 39.0	
Priority Area Protection 1	Raise Priority Areas 1 -3 to Elevation 13m	-0.08%	-7.7%	$M 102.0	Recommended where other measures cannot help
Priority Area Protection 2	Raise Priority Areas 1-8 to Elevation 13m	0.56%	79.0%	$M 182.0	
Priority Area Protection 3	Raise Priority Areas 1-8 (excluding Residential) & Purchase and Remove Residential Properties	0.43%	79.0%	$M 220.0	
Priority Area Protection 4	Raise Priority Areas 1-8 (excluding Residential) & Physically Move Residential Buildings	0.43%	79.0%	$M 220.0	
Priority Area Protection 5	Raise Priority Areas 1-4 to Elevation 13m	0.56%	66.0%	$M 158.0	
Priority Area Protection 6	Raise Priority Areas 1-4 (excluding Residential) & Purchase and Remove Residential Properties	0.40%	66.0%	$M 190.0	
Priority Area Protection 7	Raise Priority Areas 1-4 (excluding Residential) & Physically Move Residential Buildings	0.40%	66.0%	$M 190.0	

The Ice Jam model showed highly sensitive and variable results. For this reason, the results were estimated to carry a level of uncertainty that was too high for land use and policy purposes. Ice-jam related floodlines were therefore not produced for this model.

Sensitivity testing was carried out on 12 parameters, to improve the current understanding of the main drivers behind the risks of flooding. Parameters were varied within a range of +/-20% to +/-100% depending on natural variability, and the impacts on total flooded area were calculated and compared. This step was helpful to improve the understanding of the influence of various parameters on flooding risks. The parameters were ranked by level of impact on flooding risks, as shown on Figure 1. The results of the testing for each parameter is shown on Figure 2. One important finding was that the most influential parameters were naturally changing parameters, such as rainfall, sediment levels and channel surface roughness, not affected by anthropogenic impacts. Development was found to be the fourth most sensitive parameter and clear-cutting the seventh. Interestingly as well, failure of the dykes was shown to have very little impact on flooding

during events that overtop the dykes, such as the 1 in 100 year rainfall.

This step also informed the selection of flood mitigation options to test with the model. For example, since sediment level is shown to have a notable influence on flooding risks, more options involving dredging or increasing natural channel scour were tested. A list of options was assembled by reviewing measures discussed in previous reports, discussions with the various stakeholders, and previous experience of flood mitigation options at CBCL Limited.

The evaluated options were grouped into main types of flood mitigation approaches including:

- Constructing Aboiteaux to contain the extreme tides.
- Raising the existing dykes to contain river floods.
- Widening the dykes to restore some of the river floodplain to increase its capacity and reduce peak water levels upstream.
- Removing sediments or improving the river section to increase its drainage capacity.
- Widening and/or straightening the river to increase its drainage capacity.
- Constructing a floodway bypass to double the drainage capacity of the river.
- Reducing upstream flows through infiltration, storage, or in-river dams.
- Protecting specific areas at risk through measures such as building new localized dykes.
- Protecting specific services at risk, such as roads, by raising their height.
- Protecting, at the lot scale, specific areas at risk.

Each of the 40 options were modelled and tested against extreme rainfall, tide, sedimentation and ice events. Various levels of implementation and combinations of the above measures were also modelled and tested,

Results

An initial flood reduction potential, weighted by the ranking of priority areas, was calculated for each option. Life-cycle costs were estimated for each option, such that a measure of cost-effectiveness could be produced. This was calculated using the percentage of protection of the priority areas, divided by the life cycle cost, for each option. The results are shown in Table 2.

This ranking only provides cost and efficiency related considerations. The full list of criteria used to evaluate each flood mitigation option considered included the following:

- The ranking of priority areas obtained through coordination with the public and other stakeholders;
- The protection level provided by each option during each type of event (rainfall, tide, sediment or ice jam);
- Initial cost as well as “life cycle cost” of each option, which is the capital, operation and maintenance cost of a system of protection over the expected lifetime of the system;
- The value of the land protected. A necessary question is: “does it make sense to spend more money to protect land than the land is worth?
- Comparing the cost of options to the funding potential that can be leveraged;
- Environmental and permitting requirements: some options may have significantly negative impacts on the environment;
- A “fair balance” test which consisted of discussions of the various options with members of the Town of Truro and County of Colchester and Millbrook First Nation Joint Flood Advisory Committee (JFAC), trying to be fair to each stakeholder;
- Investigating the disturbance caused to each stakeholder who may oppose certain options;
- The long term value of the option through its integration within the natural context of a tidal floodplain. From this perspective, for example, widening the floodplain would be preferred over raising dykes.

One of the measures that emerged as a feasible approach that would be well accepted, can be implemented in the long term for a nominal cost, provide more than 30% flood reduction and enhances the natural ecosystem is the implementation of stormwater infiltration systems (or Best Management Practices) in the form of rain gardens, infiltration swales, permeable surfaces, perforated pipes and any measure that allows stormwater to infiltrate wherever possible. Even though extremely expensive if implemented in the next 5 years, its cost will be minimal if implemented as part of other repair and maintenance programs, i.e. any new stormwater pipe should be perforated, which will only include the additional cost of drilling holes in the new pipe. New developments should similarly include such systems, since detention ponds will not reduce flooding unless they can hold all site runoff for more than 72 hours.

If funding becomes available and needs to be spent through a large, short term capital infrastructure program, then the study shows that the most suitable flood protection infrastructure would involve moving the dykes outwards to widen the river channel and pumping stormwater into the main river to restore a wider, more natural floodplain and salt marsh, while protecting vulnerable infrastructure. Its high cost and need for regular maintenance and operation are its main limitations.

The Most Effective Options

The most effective solutions identified through this analysis included the following various components:

- Land Use Planning and By Laws (restricting development in the updated floodplain, and drafting flow and volume control regulations for new developments in the entire watershed);
- Design of Runoff Control Measures at the Town and County Scale (Reducing runoff volumes to reduce flooding, such as by promoting stormwater infiltration);
- Flood Protection Measures (Protecting areas at risk from the water by building dykes and berms);
- Relocation of residences and other vulnerable structures at risk (moving structures away from the water); and

- Accepting the risks and building resilience (includes implementing forecasting and warning systems, preparing for flooding, and preparing for recovery).

Conclusions

The state-of-the-art modelling effort provides a scientifically sound and defendable basis for various conclusions related to flooding, and for testing recommendations for flood mitigation measures. This study combines previous analyses and information with the latest numerical methods to provide a clearer picture of the issues, and the potential value of a wide range of flood mitigation approaches.

It was found that should funding only allow large capital infrastructure spending to occur, widening the dyke system and pumping stormwater may be the most suitable approach. If funding is limited, however, other approaches could perhaps suit better the current local conditions, as shown by considering other valuable aspects. These aspects include long term socio-economic impacts and long term safety risks associated with climate change, environmental effects of any proposed solution, regulatory considerations, as well as long term impacts on the ecology of the river and its shores. In light of the currently available JFAC budget, the first recommended priorities did not include the construction of large flood protection infrastructure, but rather improvements on the emergency management plans, including flood monitoring, forecasting and warning systems. Transitioning the present approach of sediment removal to a more effective long term approach of promoting infiltration systems is then recommended as the main flood reduction approach. Where individual homes are at unsafe levels of risk, locally purchasing and relocating homes is then recommended as the best solution for long term local protection.

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Harbour divestiture in Canada: Passing the buck or passing the puck to new custodians

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Abstract

Legislation aimed at protecting the marine environment has direct impacts on environmental management of port and harbour operations. Environmental management of harbours requires a great deal of technical and financial resources to operate effectively. In Canada, this technical expertise and governance is provided by federal agencies for federally owned harbours. Federally owned harbours in Canada are increasingly divested to provincial, municipal, or private owners, but sediments in these harbours are often contaminated from historical industrial activities and pose potential risks to marine ecosystems. Following divestiture there may be consequences associated with change of governance, because new harbour managers may lack technical and financial resources to follow existing management protocols. Harbour uses often do not change appreciably once divested, thus impacts to sediments, or requirements for maintenance and upgrades will typically continue following change of authority. Policies to implement education and training are, therefore, essential following change of authority in order for new custodians to properly understand historical contamination impacts and associated environmental liabilities. Adhering to established management protocols will enable new harbour managers to more effectively manage potential environmental liabilities associated with divested harbours.

Introduction

Canada's ports and harbours, including small craft harbours (SCH) for fishing and recreational users, are vitally important for transportation and the economy (DFO 2014; GC 2014). Until recently, the federal government managed and maintained a vast network of ports (>400) and harbours (>1000) providing critical transport infrastructure and regional economic development across Canada. However, few of these harbours were profitable, so in 1995 the federal government made port and harbour divestiture an official policy (Dion et al. 2002). The Canada Marine Act received Royal Assent in 1998, and implemented the National Marine Policy, which introduced commercial principles for managing marine infrastructure to achieve greater efficiencies (Padova 2005). The goal of divestiture was designed to improve the efficiency of Canadian marine transportation by rationalizing port systems and placing decision-making in the hands of users and local interests best placed to operate them (DFO 2014).

Since implementing the National Marine Policy, the federal government has attempted to strengthen the public port and harbour system by transferring management and operation of major ports to not-for-profit organizations. The *Canada Marine Act* allowed for divestiture of public port facilities to local interests, provincial or municipal governments, allowing communities to own and control local facilities and determine appropriate levels of service and maintenance. However, current divestiture policy needs to consider future management implications of harbours, many of which have environmental liabilities, such as marine debris (Walker et al. 2006), or associated with widespread sediment contamination (Walker et al. 2013a,b). Furthermore, new owners may ultimately bear financial and technical burdens associated with maintaining and managing these facilities in the future (Debrie et al. 2007). This paper examines the federal harbour divestiture policy, including divestiture of large port facilities and smaller fishing or recreational harbours (e.g. SCHs).

Current Federal Responsibility of Harbour Divestiture in Canada

In 2014, the Canadian government proposed to provide $33 million (CAD) over two years to support divestiture of remaining port facilities and the continued operation and maintenance of federally owned ports; and a further $40 million to facilitate repair and maintenance work in SCHs across Canada (GC 2014). Port (or harbour) divestiture allows for local communities to own and operate their own facilities, but the federal government is performing subsidiarity downloading of responsibility to local third parties (Debrie et al. 2007).

Fishing has historically been very important to the Canadian economy and culture (Healey and Hennessey 1998). As such, the DFO-SCH program operated and maintained over 1000 harbours (comprised of 900 fishing and 135 recreational harbours) across Canada to provide commercial fishers and recreational users with safe and accessible facilities (GC 2008). The DFO-SCH program retained only essential harbours to the commercial fishery and expanded private sector involvement in the management of core harbours. Each year the Canadian government spends significant funds on maintaining these harbours, including sediment dredging to maintain navigable access to many of these harbours throughout Canada (Walker et al. 2013c). Prior to divesting harbours, DFO-SCH is responsible for performing all designated repairs and environmental clean-ups, by undertaking the work or supplementing new owners with financial grants. In order of priority, harbours are offered to: other federal departments; provinces; municipalities; or local non-profit groups (e.g. First Nations). New owners pay nominal fees to ensure that public have access to harbours and services for at least five years. To date there have been 710 recreational and 400 fishing harbours divested by DFO-SCH. An additional 134 recreational harbours are in progress of being divested (Walker et al. 2015a) (Figure 1).

Since adopting the National Marine Policy, Transport Canada (TC) has been transferring a diverse suite of Canada-wide marine assets (e.g. ports, wharves, docks, breakwaters and harbour bottoms). Harbour bottoms are water lots where TC has no port facilities, but ships load or unload at private, provincial or

municipal wharves or docks, or transfer goods from ship-to-ship. To date, TC has divested 180 ports, and is poised to divest a further 60 (TC 2014; Walker et al. 2015a).

Current Management Frameworks for Federally Operated Harbours

In Canada, there are thousands of federally owned contaminated sites, for which the federal government is responsible. Harbour sediments are typically impacted by contaminants at levels often in excess of regulatory standards, placing significant potential financial liabilities on third party owners, especially if harbours require dredging for maintenance purposes or because of potential ecological risk (Walker et al. 2013a,b; 2015b). Risk based management approaches are used at federally owned harbours (Chapman 2011). Risk assessments can trigger proactive remedial actions, such as dredging or capping, or in some cases, passive remedial action which involves long term monitored natural recovery (Walker et al. 2013b).

Federal agency expert support provides scientifically sound and nationally consistent advice to custodians during early planning, environmental site assessments, ecological risk assessments, remediation, risk management, and long-term monitoring of federal contaminated sites for effective and cost-efficient contaminated site management. However, there have been inconsistent approaches across different regions (Walker et al. 2015a). Greater consultation within the federal expert support program when using similar approaches would lead to more effective harbour assessment and management.

Potential Issues of Divestiture

Many divested harbours have legacy contaminant issues, requiring costly maintenance for dredging, disposal of contaminated sediments, or long term monitoring (Walker et al. 2013c, 2015b). Therefore, divestiture transfers a variety of potentially complex environmental liabilities to new custodians, who may lack specific risk assessment experience or resources to implement costly contaminated sediment remediation or monitoring programs. For many federally owned harbours undergoing divestiture, the choice of dredge disposal options is limited, because sediment contaminants often exceed sediment quality guidelines (SQGs) (Walker et al. 2015b). Dredge disposal at a licensed waste disposal containment cell facility (on land) or removal to a conventional landfill site are viable, but expensive options (Walker et al. 2013c). Because of these issues, many third party groups are reluctant to assume ownership due to liability concerns related to environmental contamination due to limited financial resources.

The issue of limited resources is further compounded because harbour authorities originally would have been responsible for all operating costs. However, harbour authorities do not have ownership over the facilities and, therefore, cannot use them as collateral to generate revenues. As a result, harbour authorities have limited access to additional sources of capital. Many authorities have not become financially self-sufficient or are still not completely effective on an organizational level. The majority of authorities struggle to cover the operating costs and often do not have enough funds left over for capital expenditures. Furthermore, SCH funding for maintenance is minimal, meaning that in reality, harbour authorities generally do not have the additional revenue necessary to repair or improve existing resources and infrastructure (CCN 2004). Under the *Canada Marine Act*, the federal government

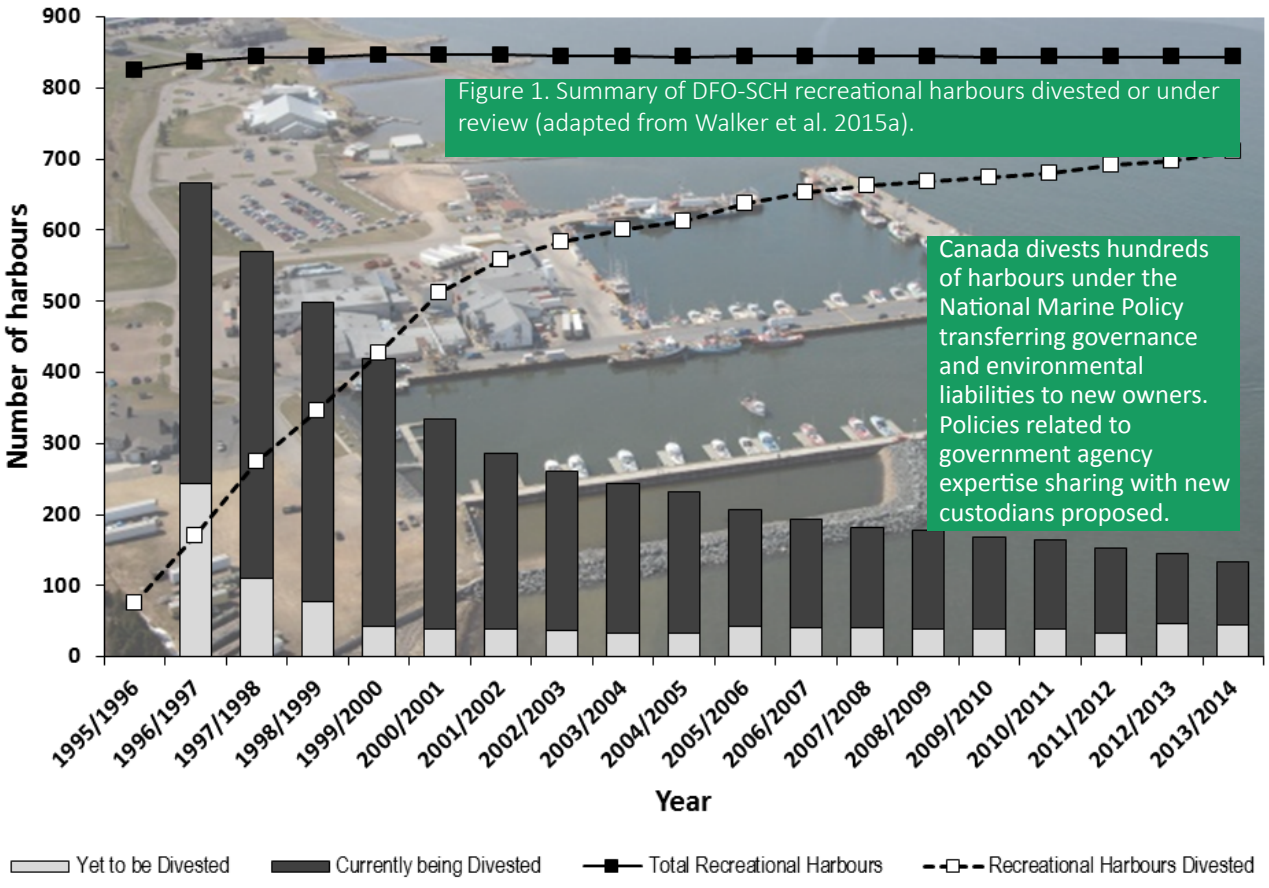

Figure 1. Summary of DFO-SCH recreational harbours divested or under review (adapted from Walker et al. 2015a).

can divest ports to local authorities, but once divested, the federal government does not allow local authorities to charge harbour fees (Ayers 2014). The recent divestiture of Sydney Harbour is currently under negotiation between TC, Cape Breton Regional Municipality (CBRM) and local First Nations communities (Walker et al. 2015a). The transfer process has been further hindered because the federal government failed to properly consult with local First Nations communities, which is required whenever the crown transfers crown land or water lots (SCC Haida 2004).

Future Policy Recommendations for Federal Harbour Divestiture

There may be some areas of the federal harbour divestiture program that could be improved to lessen the burden of governance on new managers. Although maintaining a large number of assets that are no longer economically viable is unsustainable, with improved policy practices, these transferred harbours might not pose the same burdens for future owners. The following recommendations may help raise policy questions regarding the efficacy of the current federal divestiture program if communities continue to be reluctant to acquire environmental liabilities.

- Allow new custodians to generate new sources of revenue to cover management costs- Once divested, there is concern that new owners may lack technical and financial resources to adequately monitor, manage or mitigate sediment impacts which typically continue even after harbours change governance. The federal government should increase financial grants or allow local authorities to charge harbour user fees to cover future harbour management costs and cleanup costs.
- Provide adequate training and mentoring of new custodians by government agencies- As new custodians transition into new harbour management roles, training provided by federal agencies may be required to ensure that new owners understand federal environmental legislation requirements, sediment contamination issues and associated environmental liabilities.
- Follow established management protocols- Risk assessments that follow established sediment assessment frameworks can help new owners to ensure monitoring, assessment, management and mitigation actions occur in an informed, adaptive and tiered manner.
- Consultation between federal government and First Nation communities- To avoid unnecessary delays and costs associated with divestiture the federal government should consult with First Nations prior to transfers of crown land or water lots as part of their duty to consult.

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