Welcome to the Fall 2016 issue of the newsletter of the Coastal Zone Canada Association, **THE ZONE**.

In this issue

THE ZONE

Message from the President

2016 was an exciting year for the Coastal Zone Canada Association (CZCA)! In June, we hosted our biennial conference in Toronto, which featured presentations and delegates from across Canada, the United States, the Caribbean Region, and beyond. The conference theme, Resilience through Collaboration, highlighted the important work we do to protect our coastal resources and enhance resilience to climate change. We also added five new Directors to our Board at the Annual General Meeting in Toronto, that will help lead the work of the association in the future.


Peter Zuzek

This is my first message to our membership as your new President, with Dr. Peter Ricketts, Provost and Vice-President (Academic) at Carleton University, moving to the role of past-President after leading the association for many years. As we approach the end of 2016, I would like to take a few minutes to highlight five strategic activities ongoing within your association:

1. Our website is undergoing a needed modernization and will be released under a new domain in early 2017. Stay tuned for more information in an upcoming issue of The Zone.

2. Following the positive support for the Natural and Nature Based Features Workshop at the 2016 Conference, we are exploring funding and partnership opportunities for a Living Shorelines Community of Practice hosted by the CZCA.

3. We have also committed to regularly publishing this updated newsletter to raise awareness of the latest coastal issues and summarize the ongoing work of your association.

4. I was recently asked to represent the CZCA on the Natural Resources Canada Coastal Management Working Group, which is part of their Adaptation Platform (http://www.nrcan.gc.ca/environment/impacts-adaptation/adaptation-platform/10027). If you have any ideas or issues you would like to share regarding climate change adaptation in Canada's coastal zones, please contact me directly to start a conversation.

5. And finally, we are actively planning for the CZCA 2018 Conference on the campus of Memorial University in St. John's, Newfoundland and Labrador. Contact Keith Mercer directly to discuss partnership opportunities and your ideas for our next great conference (keith.mercer@mi.mun.ca).

I look forward to working with our Board and members to advance the work of the association in 2017. Please don't hesitate to contact me with new ideas on ways we can better serve our membership and promote the critical role of coastal management across our great country.

Have a great holiday season!

Peter Zuzek, President, CZCA
pzuzek@zuzekinc.com

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pzuzek@zuzekinc.com

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peter.ricketts@carleton.ca

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Keith.Mercer@mi.mun.ca

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Kavik-Axys Inc.
dchiperzak@kavik-axys.com

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Andrew.Day@vanaqua.org

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lh@wmu.se

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1939 Fairbanks Avenue
MichaelParkes001@gmail.com

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Brad Barr (USA)
Senior Policy Advisor
NOAA Office of National Marine Sanctuaries
Brad.Barr@noaa.gov

Kiley Best
The Centre for Fisheries Ecosystems Research
Fisheries and Marine Institute of Memorial
University of
Kiley.Best@mi.mun.ca

Leah Brown (Arctic)
Central and Arctic Region
Department of Fisheries and Oceans
Leah.Brown@dfo-mpo.gc.ca

Victoria Fernandez
Water Resources Engineer
CBCL Limited
vfernandez@cbcl.ca

Peter Harrison (Great Lakes)
School of Policy Studies
Queen's University
peter.harrison@queensu.ca

Nicole Hynes
Sustainable Fisheries and Oceans Policy
nicolehynes@gov.nl.ca

Grant Murray
Vancouver Island University
Research and Scholarly Activity Office
Grant.Murray@viu.ca

Emily Rideout
NS Department of Fisheries & Aquaculture
rideoueh@gov.ns.ca

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Natural Resource And Environmental
Management Specialist
Jamie Alley and Associates, Consulting
Geographers,
jamiealley@shaw.ca

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rosmarie@helpingnatureheal.com

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rbrushett@grenfell.mun.ca

Danker Kolijn
AG UAV

danker@aguav.ca

Judy Sullivan
President, Aqua Solutions 5 Inc.
aquasolutions5@rogers.com

CZC 2016 · TORONTO

Toronto set the stage as the host city of the biennial Coastal Zone Canada Conference, where a very exciting set of presentations addressed coastal and ocean management and climate change adaptation measures.
An exciting nature based shorelines field trip showcased successful examples of integration of coastal protection and natural features. The youth employer forum provided a great opportunity for networking and discovering of professional opportunities for young talent.

The H.B. Nicholls award was presented to Peter J. Ricketts and recognized his influential role as an advocate for integrated coastal and ocean management across Canada and globally as well as his leadership as President of the Coastal Zone Canada Association (2002 - 2008, 2012 - 2016).

Nature Based Shorelines Field Trip, led by Gord MacPherson, Toronto and Region Conservation Authority

H.B. Nicholls Award

Youth Forum

Gala Dinner Boat Cruise

New Report on Climate Change in Canada's Marine Coastal Regions

In April 2016, the Government of Canada released its newest science assessment 'Canada's Marine Coasts in a Changing Climate'. The report addresses questions such as: "How is the climate changing in coastal regions?"; "How are these changes affecting the physical coastline, communities, ecosystems and economic sectors?"; and "How are Canadians adapting to these changes to reduce risks or take advantage of potential opportunities?"

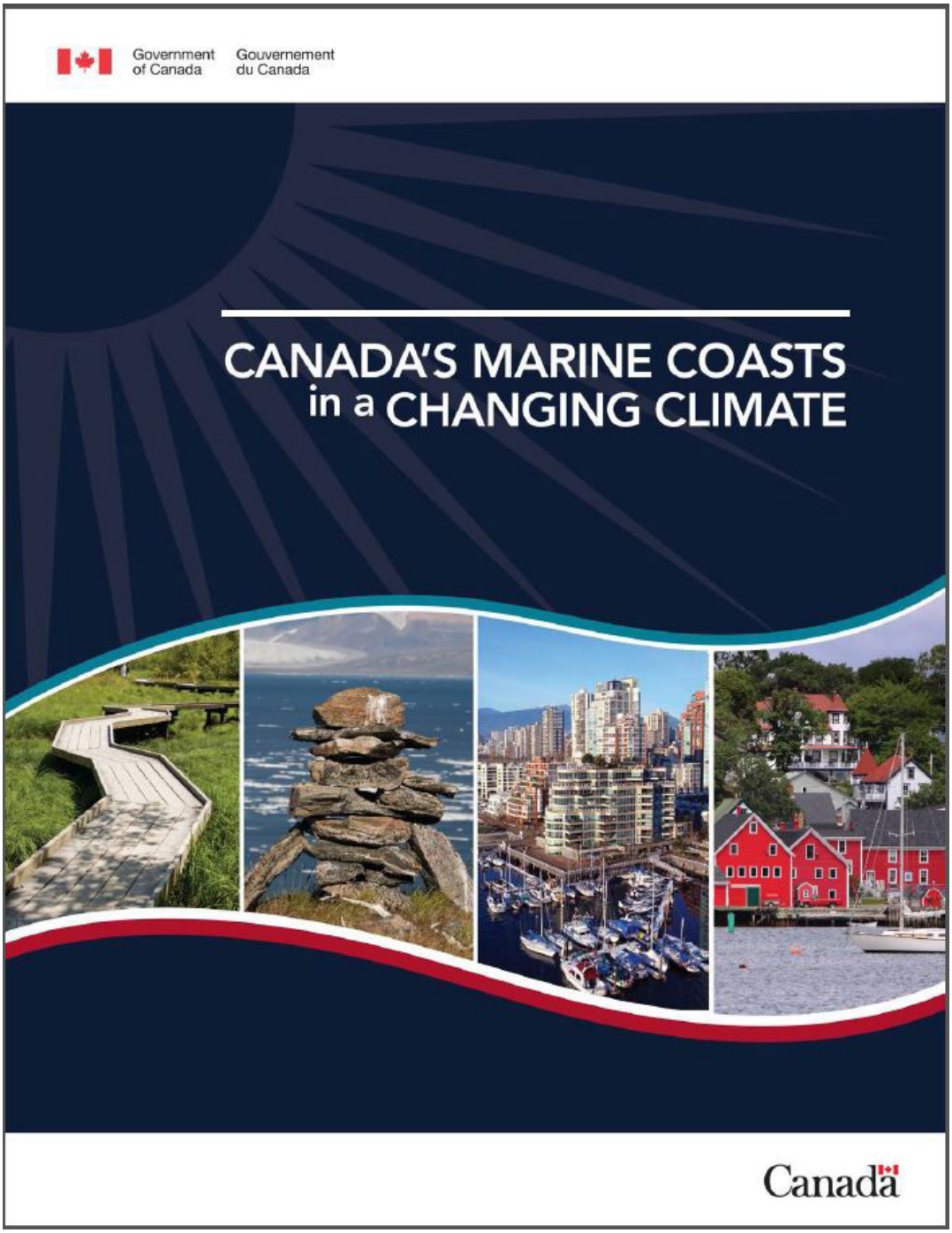
The assessment is based upon a critical analysis of the scientific and technical literature, as well as expert (including traditional) knowledge. It assesses over 1300 publications, to discuss the key issues facing the marine coastal regions of Canada. The report includes an integrative synthesis, an introduction, two background chapters that provide context relevant at a national scale (Dynamic Coasts in a Changing Climate and the Coastal Challenge), three regional chapters that discuss climate change risks, opportunities and adaptation approaches, and a concluding chapter of Frequently Asked Questions. Case studies are used throughout the report to help readers to better understand specific climate change impacts, and to provide adaptation examples that are already in the works or currently being discussed.

The process was led by Natural Resources Canada as part of Canada's Adaptation platform. The Adaptation Platform brings together representatives from government, industry, and professional organizations to collaborate on adaptation priorities. Developing the report involved over 60 authors and 70 expert reviewers, with representatives from universities, provincial/territorial and federal government departments, and private organizations.

The report shows that climate change is increasingly affecting the rate and nature of change along Canada's highly dynamic coasts, impacting natural and human systems. Key issues discussed in the assessment include the impacts of changes in sea level, sea ice and extreme events. Progress on adaptation is evident, as many local and regional governments have started to implement adaptation measures to reduce the risks of a changing climate. Continued progress will require monitoring and assessment of the effectiveness of actions taken to date, as well as research to fill data and knowledge gaps.

If you're interested in learning more, please check out the full report. Also, consider marking your calendars for our three part webinar series on the results of the assessment. There will be presentations by the lead authors on each regional chapter of the report, as well as the supporting chapters.

Submitted by Mujtaba Ali, Policy Analyst, Climate Change Impacts and Adaptation Division, Natural Resources Canada



GET IN THE ZONE

Submit your news items for the next issue of The Zone (Spring 2017). 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

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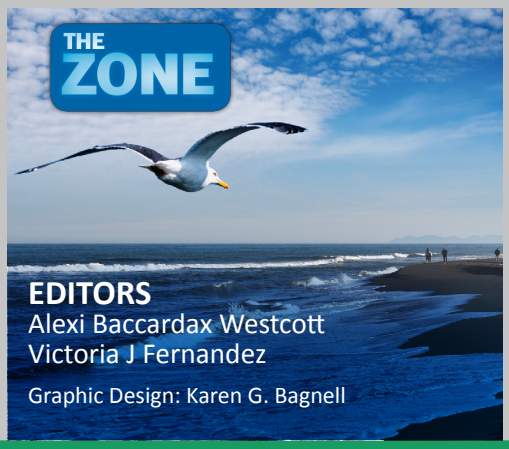
We would like to sincerely thank all of the contributors to this edition of the Zone, the authors of the papers and articles herein, as well as the reviewers.



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 February 28, 2017. Papers will be due March 31, 2017.

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

Rethinking Public Engagement and Governance of Marine Protected Areas in Pacific Canada

Jamie Alley[1]

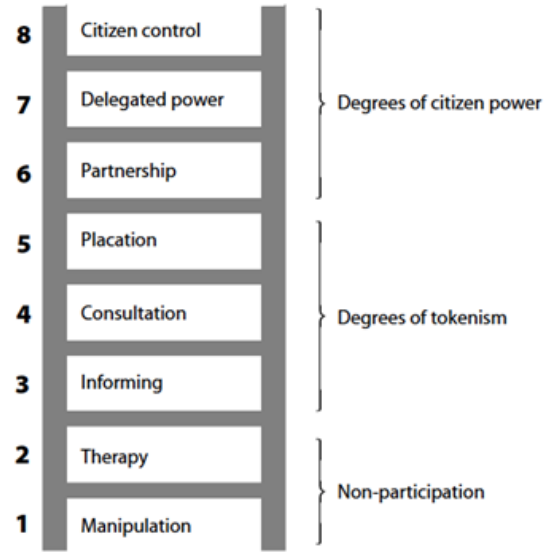
Coastal and marine resource management agencies in North America and other parts of the world are facing increasing challenges in developing governance approaches to actively engage key stakeholders in the ongoing management of marine protected areas (MPAs), and in developing durable partnerships to achieve long-term conservation and sustainability objectives. Recently, the author undertook a review for the Pacific Region of Fisheries and Oceans Canada (DFO) of global and local experiences in MPA public engagement and governance to provide options for future initiatives. The research highlighted the need to expand beyond existing models of engagement and governance, and to adopt a greater diversity of approaches with a focus on the needs of the stakeholders they wish to engage.

Canada's Oceans Act and other federal and provincial legislation provide a clear statutory authority to establish MPAs for the benefit of all Canadians. While these mandates and strong authorities may appear to favour state-led approaches to governance, current legislation and the Oceans Act in particular, are also clear in directing agencies to engage other orders of government and interested stakeholders in this endeavour. Currently in British Columbia, agencies with authority and accountability for oceans management and MPA implementation, utilize a variety of inter-department and inter-governmental committees and public advisory processes. These committees form a major part of the governance structure for coastal and oceans management, and ensure the flow of information among agencies and between their stakeholders. Over time however, this large and potentially confusing array of initiatives and processes may be proving costly to operate and difficult to service, with uncertain or unknown outcomes.

Despite these activities to engage stakeholders and develop durable and beneficial partnerships, governments are facing declining budgets, conflicting demands and experiencing stakeholder fatigue, while at the same time, the connectedness of the "wired world" places increasing demands on all parties for their time and attention. This research suggests that the over-reliance on traditional mechanisms such as advisory committees produce uncertain or unsatisfactory results, while the stakeholders themselves are increasingly demanding a seat at the table and a meaningful and active role in governance. In many jurisdictions, stakeholders are suspicious of government motives and fear that participation in established mechanisms will co-opt their interests, and some may fear that governments are only interested in gaining support for their programs and obtaining a "social license" for the status quo. While stakeholders are sophisticated, well informed and digitally connected, they also experience consultation fatigue and burnout, and have limited capacity to serve on the array of committees that require their attention.

Rethinking engagement; ladders and stars

Recent literature on public consultation and engagement breifly summarized below, has highlighted a transition from previous models based on increasing levels of shared or delegated power, to citizen-centred models based on the needs of the participants. In the past, engagement mechanisms have often been understood through the lens of Sherry Arnstein's well known "ladder of participation" (Arnstein, 1969), that envisioned eight stages or levels on a ladder ranging from manipulation and therapy at the bottom of the ladder, to delegated power and citizen control at the top (see Figure 1).



Source: Arnstein 1969

Figure 1 Arnstein's Ladder of Participation

For Arnstein, "participation of the governed in their government, is in theory, the cornerstone of a democracy", and by implication, the more participation you have, the healthier your democracy is. At the root of Arnstein's work, is the question of power, and implied in the ladder is that the higher up the ladder you go, the more power you have, and the better your degree of participation and engagement is. More recent commentaries (Wilcox, 1994 and May, 2006), have deconstructed Arnstein's ladder and focussed instead on approaches less concerned with power, and more on the various stances or needs of the participants. For example, John May (May, 2006), notes that while Arnstein's ladder can be a useful metaphor for thinking about public participation and engagement processes, he suggests that the ladder model helps to explain some of the disillusionment and cynicism that accompanies many public

participation exercises where the sponsoring agency and the stakeholders may have very differing views on where they are situated on the ladder. Conflicts can arise when the public may come to the table expecting to have a meaningful influence on the outcome of the consultations, whereas the agency may simply be trying to provide information on a direction that they have already taken, leading to the frustration of both parties. In reality, what the ladder represents in practice, is an engagement continuum, and that it is not necessarily morally superior or more desirable to be at either the top or the bottom of the ladder, or at either end of a horizontal continuum.

In developing a non-hierarchical and discontinuous metaphor for engagement, May proposed a more useful five pointed "Star of Participation", (see Figure 2). In his model, Arnstein's steps on the ladder, have been transformed into the various stances or needs of the participants in an engagement or governance process which he characterizes as: informing, consulting, deciding, acting and supporting. Here, some participants may simply want information, while others may wish to be consulted and provide advice and feedback. Others may wish to engage the agency directly in the decision-making process, while others have the willingness and capacity to undertake joint activities together, or even to deliver programs on behalf of the agency with their support. He notes that unlike Arnstein's ladder, there is no natural way to orient the star and that it can be rotated so that any of the points are at the top. In this model, the logical place for the potential stakeholder to begin is to place themselves at the centre of the star and make a choice among five equally valid options for their engagement depending on their specific interests, needs, objectives and capacity.

Figure 2: May's Star of Participation.

In these non-hierarchical models, all stances are seen as legitimate, and the challenge for management agencies is to employ a variety of approaches to actively engage a range of partners in a way that is meaningful to them. Most importantly is the emphasis on thinking beyond traditional engagement models focussed on the use of coordinating and advisory committees, and considering instead the differing needs and objectives of the full range of interested participants, from those simply seeking information to those capable of delegated program delivery, and the importance of using a variety of tools and techniques for their engagement.

International Experiences in MPA Governance

At the same time as agencies in Pacific Canada are rethinking their approaches, research on MPA governance internationally is receiving a great deal of attention particularly through initiatives by UNEP (Jones et al, 2011) and the IUCN (Borrini-Feyerabend et al, 2014). This is particularly important in cases where the control of harvesting of marine resources is a central focus of the MPA as it is in many third world countries, and where enforcement capability is weak and management capacity is limited. In these circumstances, governance arrangements that encourage partnerships and community involvement are essential. The basic conclusion of these reports is that "governance systems are similar to ecosystems, in that it is the diversity of incentives and linkages that builds resilience, provides a novel perspective and is envisioned to stimulate debate and interest".

Given the variety of approaches and incentives involved in MPA management, the UNEP and IUCN work encourages MPA managers to "get the balance right" through a combination of approaches appropriate to the objectives and management needs of the MPA, where deciding and acting together through co-management, becomes "a framework for such debates rather than an answer or a conclusion". This echoes the new thinking on consultation and engagement and argues for a greater diversity in approaches to governance. In a review of international MPA governance experiences in research conducted for the Kitasoo/XaiXais First Nation and the Great Bear Initiative Society (which focussed on MPA network design principles), (Burt el al, 2015) the authors suggest a principled approach to MPA governance based on the themes of legitimacy, inclusion and fairness, capacity and performance, coordination and collaboration, knowledge integration and adaptability, and transparency and accountability. Within this framework, approaches to MPA governance and their success in actively engaging stakeholders can be tested based against these principles.

Figure 2: May's Star of Participation.

Moving Ahead with MPA Governance and Engagement in Pacific Canada

In 2014, Canada and British Columbia jointly released the Canada – British Columbia Marine Protected Area Network Strategy, (Canada – British Columbia, 2014) which committed to a "consultative process that is balanced, open, inclusive, transparent and provides opportunities for meaningful involvement" in the development of a bioregional network of integrated MPAs in Pacific Canada. In moving ahead with this commitment, it is acknowledged that sponsoring agencies will also need to recognize the existing legal obligations and rights of First Nations and their deep historic relationship with coastal and marine resources. The Strategy also notes that "new governance frameworks may need to be developed or modified where they do not exist or where they are not inclusive of key partners". Opportunities exist in Pacific Canada to build upon existing formal and informal mechanisms including in particular, the marine spatial planning processes underway on the north and central coasts and on the west coast of Vancouver Island, which also have their own governance and engagement mechanisms.

Best practices are seen to be critical and that "transparency and accountability in engagement and decision-making will be critical to ensuring effective governance of processes and outcomes".

In developing options for engagement and governance, MPA managers in Pacific Canada currently face a variety of issues and challenges including:

- Coordinating with existing consultation processes, particularly those related to fisheries management,
- Building partnerships for marine protection,
- Considering the role of individual MPAs in a larger network of protected areas,
- Providing for statutory decision making within collaborative governance models,
- Creating flexible and adaptive approaches,
- Responding to ecosystem threats and challenges,
- Establishing clear objectives, and
- Creating management plans and reporting frameworks in a clear and timely manner.

In this context and keeping in mind May's Star of Participation and the need to use a diversity of stakeholder-centred approaches, DFO and other federal agencies such as Environment Canada and Parks Canada, along with the provincial and First Nations governments, have the opportunity to make greater use of web-based approaches to engagement, particularly for the information and consultation stances on May's star. For deeper levels of engagement such as making collaborative decisions, undertaking management actions and supporting independent initiatives, more efficient use should be made of existing structures and processes, and a variety of techniques utilized.

The research concluded that agencies involved in MPA development and management in Pacific Canada utilize stakeholder-focussed approaches, employ a variety of different tools and techniques for governance, and make use of existing mechanisms as much as possible to avoid duplication and overlap.

Moving forward, it will be essential to provide a high degree of clarity on the objectives for the management of MPAs and to create a common vision or sense of direction among all the participants. The report also suggests that DFO and other agencies ensure governance linkages between Oceans Act MPAs and protected areas established by other coastal and marine management agencies, provide a clear and transparent reporting framework that is accessible to all partners and stakeholders, and make regular reports on management outcomes. Sponsoring agencies should also provide flexibility in governance approaches, provide clear direction on how statutory decision-making will be undertaken within MPAs, and enhance the use of web-based tools for engagement.

There are many challenges ahead for coastal and marine mangers in overcoming the contemporary barriers to effective engagement and durable and successful partnerships for MPA management in Pacific Canada. This research suggests that approaches that are more focussed and centred on the needs of the interested parties that they wish to engage, and applying a variety of tools and outreach mechanisms, could lead to an engaged and supportive citizenry. Here, MPA managers can supplement their understandings of traditional governance approaches and learn lessons from conservation biology and ecosystem-based approaches. As stated in the UNEP report, "governance systems are similar to ecosystems, in that it is the diversity of incentives and linkages that builds resilience".

[1]*Jamie Alley is the former Vice President-Pacific of CZCA and is a Consulting Geographer based in Victoria BC. He was formerly the co-chair of the National Oceans Task Force under the Canadian Council of Fisheries and Aquaculture Ministers and the co-chair of the Canada/BC Oceans Coordinating Committee. He currently teaches coastal and marine management at the University of Victoria and the University Centre of the Westfjords in Ísafjörður, Iceland.*

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Canada's Dirty Dozen: A Canadian policy framework to mitigate plastic marine pollution

Tony R. Walker[1] *, Shauna Pettipas[1], Meagan Bernier[1], Dirk Xanthos[1], Andrew Day[2]

Abstract

Marine pollution from plastic debris is a global problem causing negative impacts in the marine environment. Plastic marine debris as a contaminant is increasing, especially in Canada. While the impacts of macroplastics are well known in the literature, there are relatively few policy studies related to mitigating microplastic toxicity in the environment. Despite overwhelming evidence of the threat of plastic in the marine environment, there remains inadequate or limited policies to address their mitigation, particularly microplastic debris. Existing policies for waste management, marine debris monitoring and awareness campaigns were evaluated from other jurisdictions. Recommendations for inclusion in future policies were developed for the Canadian context. Recommendations include improved practices for: (1) law and waste management strategies; (2) education, outreach and awareness; (3) source identification; and (4) increased monitoring and further research.

Introduction

Plastic marine debris pollution is a pervasive global problem causing negative impacts in the marine environment (Cressey 2016). Marine impacts include entanglement or entrapment of seals, turtles and seabirds, ingestion, habitat destruction, transport and bioaccumulation of contaminants (Walker et al. 1997; Barnes et al. 2009). Additionally, marine plastic pollution may decrease the esthetic appeal of coastal areas (Walker et al. 2006). Plastics are highly durable, degrade slowly and create widespread environmental and waste disposal problems (Cole et al. 2011). Macroplastics (>5 mm) enter the marine environment via rivers, poor waste management or by being simply dumped into the ocean (Barnes et al. 2009). Degradation of macroplastics into microplastics (<5 mm) has received increased attention recently (Andrady 2011). Microplastics are the most abundant plastic in the ocean and exist in two forms, primary and secondary. Primary microplastics are tiny plastic granules (e.g., scrubbers in cosmetics), while secondary microplastics are derived from degradation of macroplastics (Cole et al. 2011). Marine microplastics are pervasive and ubiquitous with the potential to cause harm to biota (Andrady 2011; Desforges et al. 2014; IMO 2015; Ross and Morales-Caselles 2015).

Current international policy frameworks for reducing macro- and microplastic pollution

Environmental impacts of macroplastics are well known, with established programs designed to remove macroplastics from beaches, waterfronts, and oceans (Walker et al. 1997; 2006; UNEP and NOAA 2011). While management strategies for macro- and microplastics are lacking in Canada (Ross and Morales-Caselles 2015; Cressey 2016; Pettipas et al. 2016), a few global initiatives do exist that further knowledge on plastic contamination, disposal, and pollution prevention. However, because plastics are globally persistent, development of both international and Canadian management strategies are required to address the issue.

Although legislation aimed at preventing disposal of waste at sea is limited, the International Convention for the Prevention of Pollution of Ships (MARPOL) Annex V prevents pollution of plastic waste by ships through international agreements and domestic legislation (IMO n.d.). Some countries have their own domestic legislation (e.g., US Marine Plastic Pollution Research and Control Act), requiring all waste to be disposed of or recycled properly on shore (USEPA 2012). Many ports across North America have also adopted the Green Marine environmental program, requiring participants to provide adequate reception facilities at ports for ship generated waste (Walker 2016).

The United Nations Environment Programme (UNEP) governs the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities, which provides a mechanism for development and implementation of initiatives to address transboundary issues. Microplastic and other marine debris issues are addressed by this program. Additionally, UNEP collaborates with the International Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization to develop guidelines to monitor marine litter. The National Oceanic and Atmospheric Administration (NOAA) and UNEP developed the UNEP Honolulu Strategy, which has three main goals to reduce pollution from marine debris:

- Reduce amount and impact of land-based litter and solid waste introduced into the marine environment;
- Reduce amount and impact of sea-based sources of marine debris including solid waste; lost cargo; abandoned, lost, or otherwise; discarded fishing gear; and abandoned vessels introduced into the sea; and
- Reduce amount and impact of accumulated marine debris on shorelines, in benthic habitats, and in pelagic waters (UNEP and NOAA 2011).

Some non-governmental organizations (NGOs) also monitor marine debris and promote waste management education practices. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an organization that "advise[s] the UN's system on the scientific aspects of marine environmental protection" (GESAMP n.d.). GESAMP has developed ecological quality standards and outlined standards that vary between countries. The International Coastal Cleanup (ICC) is a movement guided by Ocean Conservancy that unites volunteers around the world to clean up aquatic and marine environments. The goal is to strengthen science, engage people in solutions and promote sound policies (Ocean Conservancy 2015).

Recent discoveries by Vancouver Aquarium's Coastal Ocean Research Institute have attracted widespread scientific and media interest

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(Ross and Morales-Caselles 2015). The first of these studies revealed shockingly high concentrations of microplastics in seawater in the NE Pacific Ocean, with the highest levels nearshore (Desforges et al. 2014). Most of these microplastics were fibers, fueling speculation that land-based activities, possibly sewage, are releasing microplastics into coastal waters. The second of these studies found that two key species of zooplankton were ingesting microplastic particles, raising fears that sealife at the bottom of the ocean food chain may be impacted by microplastics (Desforges et al. 2015). This research is complemented by extensive education and direct action work. One example of education and direct action started the Great Canadian Shoreline Clean-Up (GCSC) in 1994, which grew to become one of Canada's largest direct action conservation programs, with approximately 60,000 volunteers cleaning close to 3000 km of shoreline annually. In 2010, the World Wildlife Fund Canada (WWF Canada) became a full partner in the Shoreline Clean Up (Shoreline Cleanup n.d.).

Current Policy Frameworks for Mitigating Plastic Pollution in Canada

Adding Microbeads to the List of Toxic Substances Under the Canadian Environmental Protection Act (CEPA) 1999

The Canadian government classified plastic microbeads (≤ 5 mm in size) as a toxin under Schedule 1 of the Canadian Environmental Protection Act (CEPA), 1999 on June 17th, 2016 (CEPA 2016). Declaring microbeads as a toxin under CEPA establishes preventative measures to mitigate their release into the environment. The order was accompanied by a notice of intent to develop microbead regulations, similar to other jurisdictions in the European Union or the United States (US) to prohibit the manufacture, import and sale of certain exfoliating personal care products. In the US legislation was passed by the US Congress in December 2015 to control microbead plastics (Schwartz 2015).

Waste management strategies in Canada

The majority of law and management regarding marine plastic pollution applies to macroplastics. Managing waste is an ongoing goal across Canada, where citizens are encouraged to sort and recycle waste. Throughout Canada, a four-bin garbage system is used to separate waste. These management practices transfer responsibility to consumers and aid in reducing plastic pollution, but enforcement is lacking (Pettipas et al. 2016). Without enforcement, consumers will likely refrain from sorting, reusing and recycling waste. While there have been some management practices to control macroplastic waste in Canada, microplastic waste management has received little attention. Since microplastic pollution is an emerging topic, many people are unaware of the impacts, making it difficult to force change. While primary microplastics may be mitigated through implementation of prohibitions to their use or through wastewater treatment, secondary microplastics can still accumulate in the environment through the degradation of macroplastics (Cole et al. 2011; Ross and Morales-Caselles 2015).

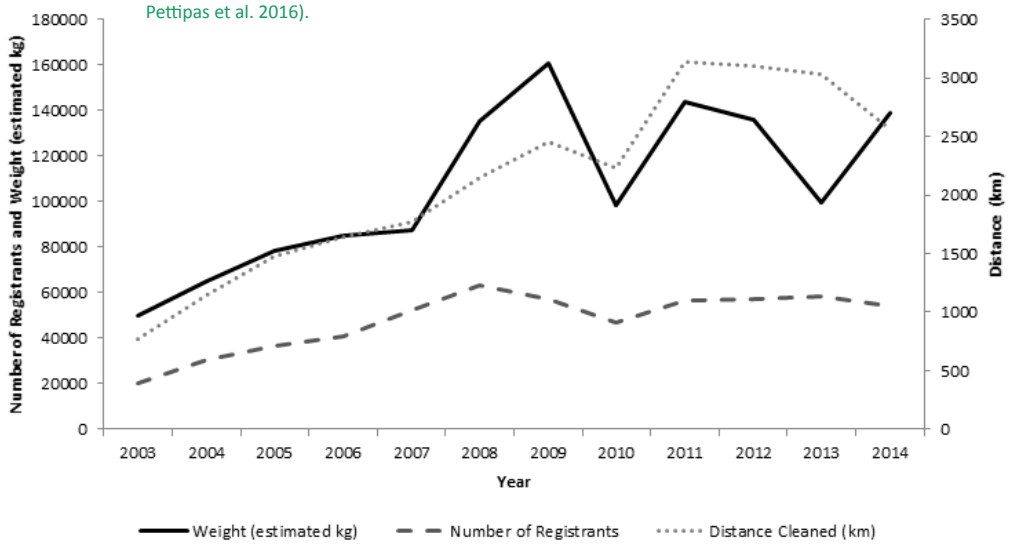
Education, outreach and awareness

Education, outreach, and awareness are effective ways to promote change to limit indiscriminate disposal (Pettipas et al. 2016). Promoting and including oceans education and awareness in schools would be a valuable method to mitigate plastic pollution. By targeting youth habits, practices can be fostered that may indirectly involve ocean protection (e.g., choosing alternatives or practicing efficient waste disposal). A growing number of NGOs in Canada focus primarily on ocean education and awareness. The Oceans Nova Scotia (Oceans NS) organization aims to promote oceans education and awareness in youth. It offers workshops and projects for students to learn more about oceans and associated issues. It also educates youth on how to protect oceans, get involved, and pursue marine related careers. Oceans NS also works with the International Ocean Institute (IOI)-Canada, Department of Labor and Advanced Education, Dalhousie University, Education and Early Childhood Development, and Ocean Technology Council of Nova Scotia. Other organizations in Canada, like the IOI-Canada works to "promote responsible ocean governance and the stewardship and sustainable use of coastal and ocean resources in Canada and around the world" (Pettipas et al. 2016). The Vancouver Aquarium Marine Science Centre runs school programs for over 60,000 students a year, and has developed and distributed school curriculum focused around marine debris. In addition, it hosts an annual Canada-wide event, the Great Canadian Shoreline Clean-Up. This is done in partnership with WWF Canada, which also focuses on improving ocean management. The aim of the event is to "promote understanding and education about shoreline litter issues by encouraging Canadians to rehabilitate shoreline areas through cleanups" (Shoreline Cleanup 2014).

Source identification

Through initiatives such at the GCSC, volunteers across Canada come together to clean up marine debris from shorelines. Vancouver Aquarium and WWF Canada categorize types of debris according to province. Since 2003, the amount of waste, distance cleaned, and number of volunteers has increased (Figure 1). Recent data from 2014, indicates that 2563 km of coastline was cleaned, representing only a fraction of the total Canadian coastline (~1%) (Shoreline Cleanup 2014). After each clean-up, the GCSC partners assess collected debris and compose a list of the 12 most common items collected. In 2014, >80% of waste collected from all provinces and territories was comprised of plastic (Figure 2). While the GCSC program only focuses on macroplastics and covers only a small fraction of the overall Canadian coastline, it provides valuable data to help promote behavioral changes. Ocean Conservancy has a similar yearly event with similar goals to the GCSC, the International Coastal Cleanup (ICC 2015). Unlike the GCSC, the ICC event is global. In 2014, over 1/2 million volunteers (mostly from developed countries), collected 7,357,616 kg of waste along over 21,376 km of coastline. Common debris items found globally compared

Figure 1. Overall total distance (km) cleaned, estimated weight of waste collected, and number of registrants for the Canadian Shoreline Cleanup from 2003-2014 (adapted from Pettipas et al. 2016).



favorably to the 2014 GCSC results (e.g., cigarette butts, food wrappers, plastic bottle caps, straws/stirrers, and plastic beverage bottles) (ICC 2015). For more information regarding volunteering for GCSC and for 2015 GCSC data, readers should refer to http://shorelinecleanup.ca/search/cleanups, and http://shorelinecleanup.ca/sites/default/files/gcscstaff/GCSC_AnnualReport2015_160211-online.pdf.

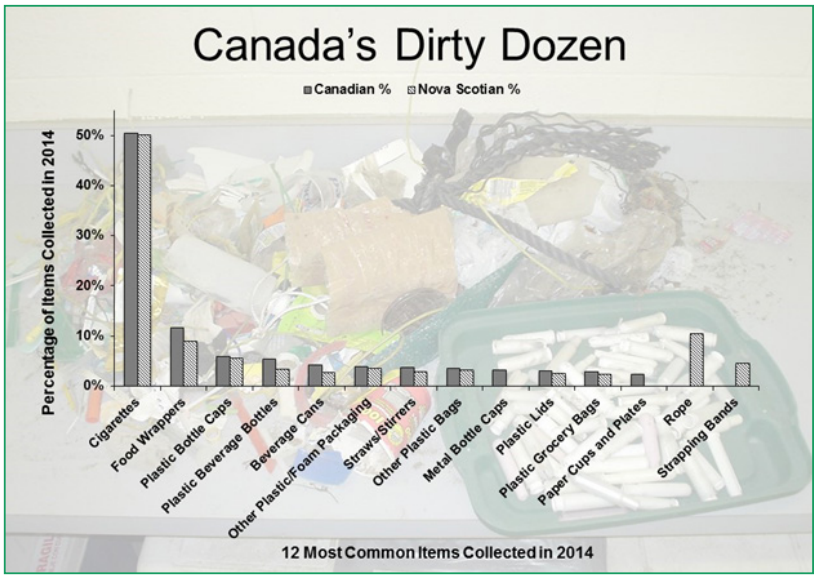
Source identification of specific items is necessary to mitigate and reduce plastic pollution. Initiatives like the GCSC and the ICC get individuals involved and provide an understanding of adverse effects of poor waste management practices. These initiatives provide information where further management efforts are required by determining the types of waste in the marine environment. By using this data, mitigation measures can be implemented to target and reduce specific waste items.

Future considerations for macro- and microplastic contamination

• Waste management strategies- Although some jurisdictions across Canada have banned disposal of plastics in landfills and littering, there is little enforcement, particularly for microplastics. Household plastic disposal cannot be easily regulated because of inadequate resources for auditing. Comprehensive programs to improve waste management need to be implemented. Programs could include improved design and application of deposits or levies on single-use plastics, increased consumer awareness and behavioral changes through environmental education, improved recycling and reuse, and the introduction of economic incentives to reduce littering and promote secondary uses of plastic debris as well as enforcement. Additionally, secondary microplastics may be managed by manufacturing more sustainable plastics. The next generation of plastics could be designed to be more biodegradable to decrease their half-life; therefore, decreasing their potential to accumulate in the marine environment and biota. Wastewater treatment may also be an important strategy, particularly for some microplastics (Ross and Morales-Caselles 2015) and the Vancouver Aquarium is working with partners including Metro Vancouver to explore this further.

• Education, outreach, and awareness- Education and outreach programs to encourage industry sectors and the general public to modify behavior and assume greater responsibility for individual actions should be adopted (Pettipas et al. 2016). Incorporating ocean education, pollution, and waste management into schools through curriculum changes and events, could be extremely effective. Schools can directly incorporate ocean and pollution education into lesson plans, enforce proper waste management, and help increase awareness, like Oceans Day. All Canadian stakeholders must continue to encourage and enforce innovative plastic management practices. Partnerships with organizations could be adjusted to host events, such as shoreline cleanups. These events would raise more awareness, educate, and encourage change.

• Source identification- Source identification is invaluable to control and mitigate marine plastic pollution effectively. Identifying common items at sea and along shorelines can help establish specific targets and goals. Advanced analysis, as is being conducted by the Vancouver Aquarium's Coastal Ocean Research Institute, can help 'fingerprint' microplastic sources (Ross and Morales-Caselles 2015). Further action can then be taken to eliminate these items and/or provide a basis for future research into alternatives and mitigation. Targets and goals will likely be highly specific and will require behavioral change, although



most will apply to macroplastics, rather than microplastics. The GCSC and the ICC events will hopefully continue to expand throughout Canada, and the world, covering coastline through increased participation. The GCSC 'Dirty Dozen' list will hopefully inspire people to choose alternatives to plastic products and packaging and be more aware of proper disposal practices.

• Monitoring and future research- Further research concerning sources, distribution, estimated quantities, fate, potential impacts of plastics, or effectiveness of plastic bans have on the marine environment, especially microplastics, is imperative. For example, the ability to count and characterize microplastics in environmental samples represents a crucial component of identifying sources and devising mitigative options. But isolating and identifying microplastic fibers and fragments from environmental samples is difficult, necessitating the use of new technologies and methods (Ross and Morales-Caselles 2015). Further, there are limited studies related to policies that aim to reduce single-use plastic consumption or examining the effectiveness of microbead bans. Research should be focused at local, regional, and global scales because sources, circumstances, capabilities, and mitigation strategies will vary at each level. Further knowledge of plastic composition (through widespread monitoring programs) will help develop concrete policies involving a broad spectrum of plastic contamination and its impacts (Desforges et al. 2014). Banning microbeads (recently added to the list of toxic substances under CEPA in Canada) will help reduce their continued input into the ocean in some locales. However, the broader issue of microplastics is not addressed. It is likely difficult to completely abolish them as they are so pervasive and there are currently few alternatives for those used in fields such as medical applications. Additionally, banning microbeads will not help mitigate secondary microplastic contamination in the ocean because they also result from the degradation of larger plastic pieces. Understanding the composition of plastics found in the marine environment through research will help develop policies that need to be implemented across Canada and internationally.

[1] School for Resource and Environmental Studies, Dalhousie University, Halifax, NS, Canada

[2] Coastal Ocean Research Institute, Vancouver Aquarium Marine Science Centre, Vancouver, BC, Canada

** E-mail address: trwalker@dal.ca*

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U.S. Army Corps of Engineers Research into Natural and Nature-Based Features for Coastal Resilience

Julie Dean Rosati , Katherine Touzinsky[2], and Jeff King[3]

Natural and nature-based alternatives that reduce coastal erosion are increasingly of interest to coastal engineers, managers, scientists, and communities. These alternatives are diverse and include wetlands, reefs, islands, living shorelines, beaches and dunes and combinations of approaches. Both the natural properties and constructed designs of these features can potentially reduce the impacts of storm waves, wind, and surge, and provide habitat as well as aesthetic, recreational, and economic benefits. The recent focus on Natural and Nature-Based Features (NNBF) has occurred for several reasons: the world-wide recognition that built infrastructure has reduced the diversity and the size of the world's ecosystems (e.g., BBC 2015), the occurrence of recent hurricanes that have devastated U.S. coastal zones such as Hurricane Katrina and Superstorm Sandy, and the acknowledgement of the protective role that natural features may provide in reducing storm and climate change impacts (Sullivan 2005; The Nature Conservancy 2013). In 2015 in the United States, President Obama directed Federal agencies to "where possible….use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration" (Presidential Executive Order 13690, 2015).

The U.S. Army Corps of Engineers (USACE) has nine Civil Works missions, with the largest being Navigation, Ecosystem Restoration, and Flood Risk Management to reduce the risk of floods and coastal storms. In a typical year, the USACE dredges more than 200 Million cubic yards of clean sediment to maintain navigability of more than 25,000 miles of federally authorized inland and coastal channels, and more than 900 coastal, Great Lakes, and inland harbors (Fig. 1). The three primary USACE missions are often synergistic as sediment dredged from navigation channels is utilized to restore environmental features such as wetlands, or is utilized to reduce the risk of coastal storms through building beaches and dunes, as examples.

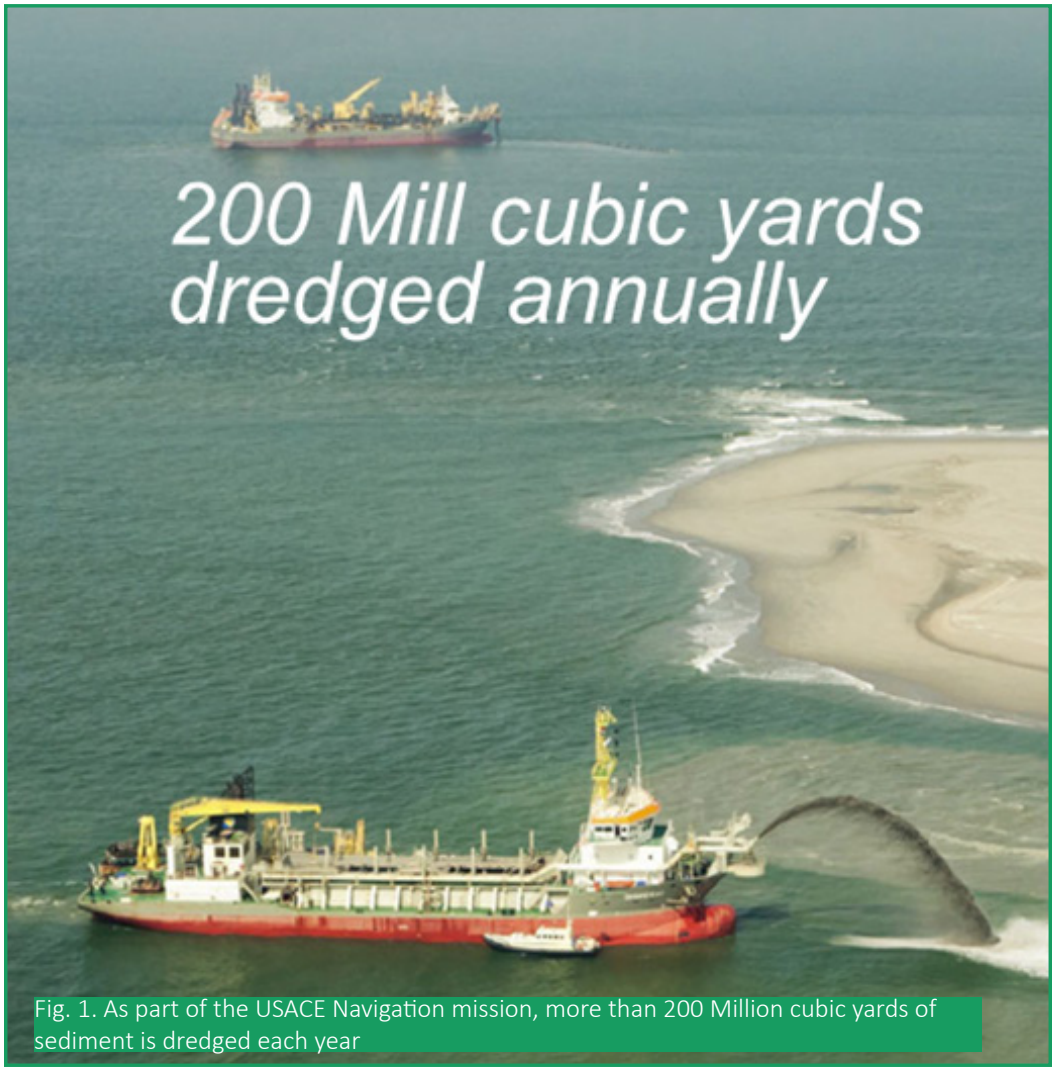

Fig. 1. As part of the USACE Navigation mission, more than 200 Million cubic yards of sediment is dredged each year

Historically, since the 1930s ,the USACE has utilized nature-based solutions in the form of beach and dune restoration to reduce the risk of coastal storms. The implementation of NNBF has expanded in recent decades to utilize clean dredged sediments to create, restore and enhance ecological habitat. Dredged sediments are critical to ensuring the viability of coastal habitats and communities, especially in an environment of increasing coastal populations, sea level rise, and changing climate. The USACE has several basic and applied research programs directed towards creative utilization of dredged sediments through Regional Sediment Management (RSM, http://rsm.usace.army.mil/) and Engineering with Nature (EWN, www.engineeringwithnature.org). Two examples of projects initiated within these programs include thin-layer placement of dredged sediment to provide amenable increases in elevation for existing wetlands, and placement of dredged sediments in nearshore berms (mound formations) to foster wave dissipation and sand transport to beaches.

Recently, the USACE has expanded research into advancing knowledge of the coastal engineering and ecological benefits of NNBF. Three ongoing research activities are briefly summarized here, beginning with local scale

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research and extending to more regional analyses.

- Impact of Vegetation on Wave Characteristics. Laboratory and field studies are quantifying the dissipation of wave energy caused by submerged and emergent vegetation. The impacts of vegetation on wave runup, storm surge, and winds are also being examined. These research findings are being incorporated into numerical models to quantify how vegetation characteristics and spatial extent, together with hydrodynamic forcing, modify the erosive forces on vegetated coasts.

- Storm Benefits of Coastal Dunes. Several USACE-funded studies are directed towards quantifying the short- and long-term capacity for dunes to reduce erosion and flooding, recover following storms, and adapt over long temporal scales. These projects include evaluations of the benefits of vegetated dunes, comparisons of different vegetation types, studies of the evolution of natural vs. constructed dunes, and adjustments to numerical modeling technology to consider a broader range of processes in short- and long-term dune evolution- surf zone processes, Aeolian transport, precipitation and moisture of the beach, and vegetation response.

- Metrics for Evaluating the Resilience of Coastal Vegetative Features. Utilizing historical knowledge and documenting vegetation type, coverage, record of storm forcing for a region, and performance of the region; this study seeks to understand the metrics that are good predictors for the resiliency of vegetated features in reducing storm hazards over years to decades. Resilience of the features is intended to characterize how well they withstand storm hazards, recover following disturbances, and adapt over longer time periods.

These three examples are a small sample of the spatial and temporal range of studies underway within the research laboratories of the USACE, and within academic institutions that have been funded by the USACE. This research comprises a continuum from 1) basic coastal processes, or understanding the physics, geology, biology, or some other scientific question that generates novel and raw data to be utilized in modeling and other studies; to 2) project-scale research that is focused on specific questions to benefit project design and operations; culminating in 3) performance metrics to understand the system, the performance of projects within the system and future benefits. Any research that is undertaken by the USACE must incorporate flexibility to be applied to these ranges of spatial and temporal scales. This is necessary because of the complexity of coastal systems and the wide range of disturbances that they face.

NNBF evolve through time and are subjected to extreme environmental forces. "Experiments of Opportunity" occur regularly as NNBF features are created, enhanced, or restored after extreme events as part of the USACE's Navigation, Environmental Restoration, or Flood Risk Management missions. Collaboration with outside researchers is also of critical importance; several ongoing partnerships with academic institutions and European researchers are being utilized to leverage existing knowledge, guidance, and tools. For example, the post-Super storm Sandy performance of beaches and dunes within the Atlantic and Great Lakes region was evaluated and results concluded that beaches and dunes reduced, but did not eliminate storm damages, despite storm surge and waves exceeding project design and/or condition prior to the storm (USACE 2013). One of the recommendations from the post-Katrina and Sandy studies in the Gulf of Mexico and Atlantic coast was that a comprehensive approach with multiple lines of redundant and reinforcing features was the preferred concept to reduce future storm risks (Fig. 2) (USACE 2009, 2015, 2016). With additional investigation and monitoring following construction or focus in evaluating response of NNBF features, these opportunistic experiences can greatly expand conventional knowledge.

Other examples of USACE expanded NNBF research and subsequent application are located within the Great Lakes. USACE's Engineer Research and Development Center (ERDC) partnered with the USACE Buffalo District to design and implement modifications to the Cleveland, Ohio, east arrowhead breakwater, which was scheduled for normal maintenance/repair procedures. The structural modifications were designed to produce greater environmental benefits to invertebrate and fish communities than would be present otherwise using standard practices (Fredette et al. 2014). This work was funded through the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative managed by the Great Lakes National Program Office. A similar example of NNBF-derived improvements for breakwaters is located in Lake Michigan in the vicinity of Milwaukee Harbor. Although results

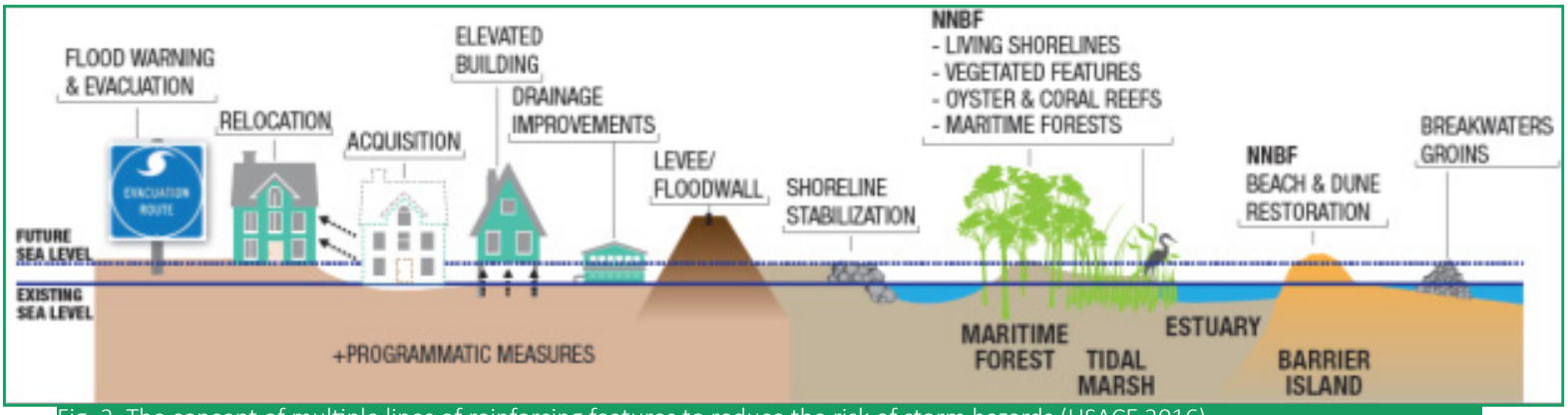

Fig. 2. The concept of multiple lines of reinforcing features to reduce the risk of storm hazards (USACE 2016)

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have not been published to date, an ERDC technical report that includes monitoring data from 2014-2016 is anticipated in December 2016 (personal communication, Dr. Burton Suedel). However, it is likely that this project (and the Lake Erie breakwater project) will demonstrate how the USACE can integrate additional ecosystem service benefits into navigation infrastructure through simple design changes during ongoing maintenance activities.

Many USACE Districts have demonstrated success with the design and construction of nature-based features in coastal environments. For example, USACE's Philadelphia District has used dredged sediment to construct a coastal island adjacent to Beach Haven, New Jersey. Through planting of Spartina in conjunction with the placement of sediment, this project continues to mature and yield numerous engineering and ecosystem services. The USACE's Baltimore District has completed a similar project using sediment derived from maintenance dredging within the Susquehanna River to restore island habitat associated with Fishing Battery Island, near Havre de Grace, Maryland. This project resulted in creation of shallow water habitat as well as migratory bird nesting habitat. Finally, the USACE's New Orleans District has also achieved success with the beneficial use of dredged material. Using an NNBF approach to island design and construction, the district has placed a linear series of islands within Atchafalaya Bay, Louisiana. Strategic placement of the islands increased the current flow adjacent to the federally-maintained navigation project, and has reduced the frequency with which dredging operations are required. The project has also resulted in improved ecological function within the Atchafalaya Bay by expanding bird nesting grounds and creating sheltered waters that protect existing, submerged aquatic vegetation and/or enabling the establishment of emergent plants (Suedel et al. 2015). NNBF projects initiated by the USACE are generally collaborative in nature and typically include partnerships with state and county governments, non-governmental organizations (NGOs), port authorities, and/or other state and federal resource agencies.

The USACE is working with other US and international organizations to develop a common understanding and approach to implementing NNBF in coastal environments. The following section summarizes some of the recent activities to leverage ongoing knowledge and research.

- NNBF and EWN Multi-Agency U.S. Workshops. Thirty-eight participants from USACE, the National Oceanic Atmospheric Administration (NOAA), and NOAA-National Marine Fisheries Service (NMFS) engaged during two workshops to strengthen understanding and application of NNBF and facilitate appropriate implementation of NNBF solutions for fish habitat using principles of EWN.
    - The first USACE-NOAA workshop was held in March 2016 in Charleston, South Carolina to identify high priority needs and gaps in science, engineering, and management to reduce uncertainties and increase confidence in NNBF design, construction, performance, and ecosystem services. Ongoing USACE and NOAA projects and activities were identified as opportunities for coordinated action to address these gaps. Workshop participants developed an initial prioritization of specific collaborative opportunities within a mixed portfolio of near- to long-term efforts that extend across a range of geographic areas and include a variety of habitat types (USACE-NOAA 2016).
    - The second workshop held in October 2016 in Gloucester, Massachusetts, to identify opportunities to use the principles and practices of EWN to further the missions, projects, coordination, and Endangered Species Act section 7 and Essential Fish Habitat consultations undertaken by USACE and NOAA-NMFS. Collaborative actions using EWN concepts were identified, refined and prioritized based on impact to mission execution for the two agencies and near, mid and long-term tasks were identified for joint teams (USACE-NOAA-NMFS in preparation).
- October 2016, Workshop to Initiate Development of International Guidelines for NNBF. Recently, the USACE initiated a collaborative effort to develop international guidelines to inform the conceptualization, planning, design, engineering, construction, and maintenance of NNBF that are used to support resilience and flood risk reduction for coasts, bays, and estuaries. An international team of 30 authors representing government agencies, private sector engineering and construction companies, universities, and NGOs from the US, United Kingdom, The Netherlands, the Republic of Korea, and New Zealand met in October 2016 to initiate development of topics and an outline for the guidelines. Guidelines are in the process of being drafted and will be discussed during the next working meeting in spring 2017.

In conclusion, although there are many examples of successful projects in the U.S., challenges remain for engineers, scientists, and practitioners that are designing, constructing, and adapting NNBF to provide coastal engineering, environmental, ecological, social and other benefits. Documentation of what worked well and lessons learned in the design, construction, monitoring, and adaptation of NNBF features greatly benefit the NNBF Community of Practice. From this information, design and adaptation guidance for NNBF features can be tested and refined. There is a continual need to disseminate accurate information about how well these features perform with given forcing conditions to decision-makers, engineers, scientists, and laypersons.

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