



MEOPAR's Marine-Focused Communities of Practice Make Lasting Impacts Through Science Communication, Public Engagement and Knowledge Sharing Strategies

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ABSTRACT



To mitigate research and innovation within the ocean sector from being hampered by practitioners working in silos, the Marine Environmental Observation, Prediction and Response Network of Centres of Excellence (MEOPAR NCE) has been connecting cross-sectoral researchers working on related subjects across Canada. This article identifies knowledge sharing (KS) activities and knowledge management systems (KMS) applicable to integrated ocean research and responses. Through case studies, this article qualitatively assesses five of MEOPAR's most mature Communities of Practice (CoPs) to evaluate science communication and public engagement strategies; knowledge sharing methods to inform scientific decision-making; and ways to develop innovative and solution-driven approaches. The strategies and KS methods used by these CoPs can improve ocean governance by enabling evidence-based decision-making, research, user-driven products, and policies that meet community needs. While the practices and strategies stem from the Canadian ocean sector, they are broadly applicable to other sectors and countries.

KEY THEMES

communities of practice, knowledge sharing, coastal resilience, science communication, risk communication, scientific decision making

CONFLICT OF INTEREST

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Introduction

Academic science has traditionally been confined to singular disciplines and methodological approaches following a siloed mentality (Shaw and Frost 2015). However, since the turn of the decade, technological advances have allowed researchers and practitioners to connect on larger scales (i.e., nationally and globally), enabling science to become more accessible and inclusive to meet the growing demand for interdisciplinary and intersectional research (Goodman and Blake 2006; van Knippenberg and Dwertmann 2022). These types of collaborations are essential in developing effective evidence-based solutions to address today's complex and multi-faceted challenges. To achieve this, knowledge translation, which is defined as methods bridging the gap between knowledge and practice (Straus et al. 2009), is essential. Knowledge brokers address this need by facilitating collaboration and breaking down inter-organisational barriers. Communities of Practice (CoPs) supported by the Marine Environmental Observation, Prediction and Response Network (MEOPAR) have taken on this role by creating new platforms and strategies to share knowledge and technology. This paper outlines how Canadian CoPs supported by MEOPAR have contributed to transformative science and governance through case studies outlining their knowledge sharing products and activities. Through analysis of the strengths and weaknesses of the interactive nature of CoPs, this paper provides direction for science policy and offers recommendations for future work.

What are Communities of Practice (CoPs)?

CoPs are working groups composed of people and organisations united by a similar topic or interest, who interact regularly to share knowledge and resources to advance research and action in their respective fields (Wenger 2011). They are strongly focused on knowledge exchange and have been used as the foundation of knowledge management systems (KMS), which refer to ways to leverage knowledge (Wenger and Snyder 2000). Not all CoPs are the same. As a result of their specific objectives and overarching goals, they can differ in their creation processes (top-down or bottom-up), their membership compositions (i.e., researchers, practitioners, non-governmental organisations, elected officials, public members), and their leadership types (Bourhis et al. 2005).



Network members participating in a workshop.

Although CoPs can sometimes be costly to initiate and maintain, especially for geographically diverse memberships and large organisations (American Productivity & Quality Center [APQC] 2001), they stimulate inter-organisational collaboration, which can lead to innovation (Amisse et al. 2011; Cusin and Loubaresse 2015, Whitefield et al. 2021) and help increase and maintain interest in the work (Cohendet et al. 2011). Further, they democratize information and promote standardization (APQC 2001; Canonico et al. 2019), which are particularly relevant for Canada's vast geography and its diverse ocean sector. Crucial factors that ensure CoPs' success and longevity include: continuous support from management to foster an enabling environment; access to necessary resources (i.e., funding, equipment or materials, and personnel); and choosing the right people for the right roles, especially in leadership positions (Wenger and Snyder 2000; Bourhis et al. 2005).

Marine Environmental Observation, Prediction and Response (MEOPAR)'s Community of Practice (CoP) Program

MEOPAR is a national network of researchers and practitioners in Canada that supports innovative research and training on ocean and coastal topics, while helping to overcome barriers to inter-institutional collaboration. In 2016, MEOPAR started investigating how to initiate CoPs within the ocean sector, drawing

inspiration from the health sector's success in advancing knowledge sharing (KS), viz. the creation of the Public Health Information Network Communities of Practice and the USA National Cancer Institute professional networks. In 2017, MEOPAR started offering funding under their Core Research Program Areas (Observation, Prediction and Response). In 2019, they developed a CoP Funding Program to expand the scope to its current form, which supports ten uniquely innovative CoPs in the ocean sector (page 7).

MEOPAR-supported CoPs are typically overseen by designated Lead(s) with direction from a steering committee or board of directors, and are operated by a coordinator. MEOPAR's Administrative Centre assists in providing support, for example during the initiation of new CoPs and for growing their governance capacity. Leads are responsible for the overall management of their respective CoPs, and for guiding CoP activities. This typically includes: developing and executing workplans; ensuring sufficient personnel support is identified; managing respective budgets and partnerships; and reviewing the annual progress report in collaboration with the MEOPAR Administrative Centre. Other CoPs external to MEOPAR's Program (i.e., coalitions or working groups) may have slightly different structures, but their roles and functionalities remain similar. For example, some CoPs operate more similarly to a not-for-profit organisation, with a board of directors rather than a steering committee.

Community of Practice Program at a Glance



Research and innovation within the ocean sector are hampered by practitioners working in silos.



Communities of Practice (CoPs) create bridges to facilitate collaboration and knowledge mobilization.



Canadian Marine Shipping Risk Forum (CMSRF)



Canadian Coastal Resiliency Forum (CCRF)



Canadian Ocean Mapping & Research Education Network (COMREN)



Canada's Ocean Acidification (OA) CoP



Canadian NEMO Ocean Modelling Forum



Coast & Ocean Risk Communication (CORG)



Ocean Data Management (ODM)



Network on Coastal, Ocean & Lake Optics Remote Sensing (NetCOLOR)



Ocean Gliders Canada (OGC)

26% annual membership growth



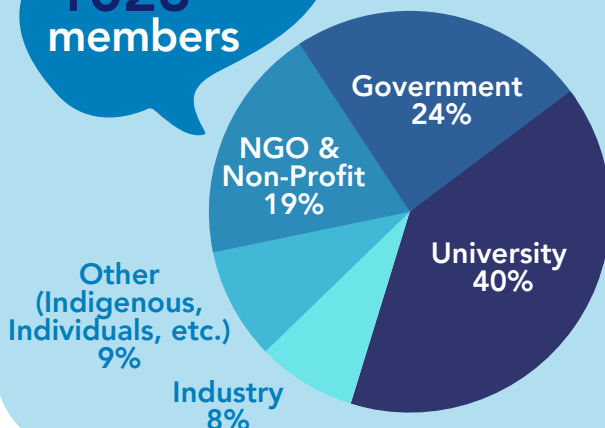
\$2+ million in MEOPAR funding



60% leveraged MEOPAR funds for additional funding



1028 members



292+ media outputs & projects



comprised of:

- 81+ events
- 124+ blogs
- 20+ research projects
- 35+ reports & publications
- 23 newsletters
- 2 policy briefs
- 7 other undertakings



featured in

The Guardian
NATIONAL POST

THE GLOBE AND MAIL

The New York Times



Based on 2021 & 2022 reporting information.

In addition to financial support, the benefits of MEOPAR's CoP Program include: providing personnel to help with administrative duties and activities; offering support during the creation, building and maturity phases of managing a CoP; and consultation between the Scientific Directors and CoP Leads on leadership development. Since MEOPAR started supporting CoPs in 2017, their advancements have collectively been improving the strategies and practices used to share knowledge within and beyond the ocean sector in Canada and abroad (MEOPAR 2023).

MEOPAR-supported CoPs help connect researchers and highly qualified personnel (HQP; i.e., students and early career practitioners), in concert with industry, government and community partners, in addition to other external individuals and organisations. Together, members share expertise and opportunities to learn as CoPs provide a place for discussion and co-production of knowledge and innovative projects. As the strategies, practices and technology used and created by the CoPs have improved over time, this article sheds light on innovations about inter-organisational KS and KMS that could be adopted by other sectors or by existing CoPs. These lessons can in turn be used to improve ocean governance by enabling evidence-based decision-making, research, user-driven products, and policies that answer community needs.

Defining successful baselines

To assess why and how MEOPAR's CoPs have been successful, this article presents case studies from the earliest CoPs (Table 1) to exemplify their unique methods (Table 2) used to create impact within their sectors and beyond (Figure 1). The case studies were selected based on proven track records of fruitful collaborations and effective KS efforts. To support this paper's claims, information (i.e., additional quantification metrics and anecdotes) were gathered from MEOPAR's Annual Reports (2019-2022), feedback and retrospectives (i.e., learned experiences), and Excel was used to compile CoP metrics (e.g., membership research and stakeholder composition; Table 1). To support the collaborative approach used in writing this article, an adapted method from Liboiron et al. (2017) was used to determine equitable author order.



Public panel discussion hosted in collaboration with community.

Table 1. Summary of MEOPAR-supported Communities of Practice (CoPs) featured as case studies, including their goals, establishment, membership information (total members and composition) from the last fiscal year (2021-2022), and their major projects since 2019.



COMMUNITY OF PRACTICE (COP) NAME	FOCUS & GOAL(S)	EST.	TOTAL MEMBERS	MEMBERSHIP COMPOSITION	MAJOR PROJECTS (SINCE 2019)
COAST AND OCEAN RISK COMMUNICATION (CORG)	Strengthen Canadian coastal and marine risk communication, promote knowledge sharing, facilitate member interactions, and drive growth in priority areas.	2017	270	<p>28% academia 38% government 9% industry 16% NGOs 10% other</p> <p>Geographically distributed across Canada (80%), the USA (9%) and 12 additional countries (11%)</p>	<p>National Forum on Coastal Community Resilience</p> <p>Canadian Hazards Emergency Response & Preparedness Initiative (CHERP)</p>
CANADIAN COASTAL RESILIENCY FORUM (CCRF)	Strengthen resilience to climate change hazards in Canada's Coastal Regions by identifying policy and governance strategies for reducing and managing the consequences of natural hazards.	2018	109	<p>40% academia 11% government 15% industry 26% NGOs 8% other (e.g., Indigenous peoples and/or communities, independent individuals, etc.)</p> <p>Composed of 60+ organizations</p>	<p>Events: Coast 2 Coast 2 Coast Trivia Challenge, MEOPAR National Forum, Flood Resilience Challenge Game</p> <p>Webinars: Fathom – Industry Insights into Flood Modelling, Resilient-C: What are peer communities doing to build resilience?, Deltares – Introducing Deltares Circle & Adaptation Support Tools</p>

Table 1 (continued).

CANADIAN MARINE SHIPPING RISK FORUM (CMSRF)	Promote data sharing, collaboration, and innovation in maritime risk assessment and management.	2016	225+	<p>24% academia 34% government 21% industry 12% NGOs 8% other</p> <p>Comprising a network of marine shipping risk professionals and researchers focused on data, modeling, and assessment.</p>	<p>Inventory resource of shipping risk Canadian analyses and analysts</p> <p>Annual workshops: Creating an Inventory of Marine Shipping Risk Resources</p>
NETWORK ON COASTAL, OCEANS AND LAKE OPTICS REMOTE SENSING (NETCOLOR)	Create a collaborative Canadian network of ocean colour experts and develop a national strategy for research, training, and knowledge dissemination in aquatic remote sensing.	CSA-founded in 2015, supported by MEOPAR since 2018.	139	<p>52% academia 40% government 8% industry</p> <p>Composed of Canadian ocean colour experts.</p>	<p>Presentations, database of all Canadian field campaigns to collect bio-optical measurements for Ocean Colour applications</p>
CANADA'S OCEAN ACIDIFICATION COP (OA)	Foster science-user connection, combat ocean acidification, and facilitate collaborative discussions and knowledge production on the subject in Canada.	2018	151	<p>38% academia 9% government 15% industry 13% NGOs 25% other</p> <p>Comprised of the public, stakeholders, policymakers, nonprofits, and academics.</p>	<p>Inventory and map of OA resources in Canada</p>

Table 2. List of online and in-person platforms used by Communities of Practice (CoPs).

	CORC	CCRF	CMSRF	NetCOLOR	OA
WEBSITE	corccop.com	uwaterloo.ca/canadian-coastal-resilience/	clearseas.org/en/programs/canadian-marine-shipping-risk-forum-cmsrf-initiative/	netcolor.ca	oceanacidification.ca
EMAIL LIST	corccop.com eepurl.com/dD0tKD	'Join our community' section at uwaterloo.ca/canadian-coastal-resilience/	https://tinyurl.com/3ckzapca		oceanacidification.ca/join-us
FACEBOOK	CORC_CoP				meoparoacop
TWITTER	@CORC_CoP	@coastriskcanada	@cmsrf	@NetcolorC	@meopar_oacop
TIKTOK					@meoparoacop
INSTAGRAM					meopar_oacop
YOUTUBE	Coast and Ocean Risk Communication CoP	Canadian Coastal Resilience Forum			
LINKEDIN	Coast and Ocean Risk Communication Community of Practice (CORC CoP)				
OTHER					https://www.oainfoexchange.org/members/people/teams/725?tag=725

Table 2 (continued). List of knowledge mobilization tools used by Communities of Practice (CoPs).

	CORC	CCRF	CMSRF	NetCOLOR	OA
BLOGS	✓	✓			✓
WEBINARS / WORKSHOPS	✓	✓	✓	✓	
RESOURCE REPOSITORIES	✓	✓	✓	✓	✓
SCIENCE HIGHLIGHTS					✓
RESEARCH ARTICLES				✓	✓
INFOGRAPHICS					✓
EDUCATIONAL VIDEOS / EVENTS			✓		✓
COMMUNITY DISCUSSIONS	✓		✓		✓
PUBLIC SURVEYS					✓
NEWSLETTERS	✓	✓	✓	✓	
NEWS STORIES		✓			
NETWORKING EVENTS	✓	✓	✓		

Case Studies

MEOPAR's ability to unite and recruit selected CoP leads and coordinators for this publication shows its capacity to support interdisciplinary cooperation and act as a knowledge broker, as these CoPs generally work in isolation from each other (MEOPAR 2023). All MEOPAR CoPs aim to advance KS across and within sectors, where CoP membership generally reflects all stakeholder groups, including academia, industry, government, non-governmental and non-profit organisations, and Indigenous communities (Table 1). The nature of independent organisations such as non-profits helped the CoPs access and build a diverse network. This broad reach is in turn useful for communicating to various audiences through a range of platforms tools (Table 2) and enables the inclusive collaboration needed to solve complex challenges in the ocean sector. Depending on the target audience and desired outcome (i.e., improved policy, results dissemination, access to information), the tools and platforms used vary. However, all CoPs use at least one social media platform to engage with their network, primarily on Twitter, in addition to their websites that act as repositories of information.

From 2019 to 2022, MEOPAR invested more than \$2 million CAD towards CoPs supported under their Program, and during the last fiscal year (2021-2022), 60% of these CoPs obtained additional funding from external sources by utilizing their communities' networks. Of the CoPs receiving financial support from MEOPAR, the Canadian Coastal Resilience Forum (CCRF), the Canadian Marine Shipping Risk Forum (CMSRF), the Coast and Ocean Risk Communication (CORC) CoP, Canada's Ocean Acidification (OA) CoP, and the Network on Coast and Ocean Lake Optics Remote Sensing (NetCOLOR) have stood out due to their maturity over time and their successful implementation of KMS, which are summarized through case studies presented below.

Coast and Ocean Risk Communication (CORC)

CORC offers a forum for people and organisations to build knowledge and best practices around communicating the risk of coastal hazards. As one of MEOPAR's first CoPs, the preparatory work supporting its development helped establish a flexible framework adopted by the organisation's subsequent CoPs (MEOPAR 2022). The framework was primarily based on the conceptual underpinnings and practical guidance developed by Etienne Wenger, Beverly Wenger-Trayner and colleagues over the past decades (Wenger 2004, 2000; Cambridge and Suter 2005).



Although CORC's in-person events at MEOPAR Annual Scientific and Training Meetings garnered strong interest and attendance by MEOPAR network members and external attendees, their online presentations have proven to be one of the most effective means of disseminating research and knowledge and attracting membership. This trend is driven by the CoP's efforts to organise events that appeal to both current and prospective members, to record and publish presentations, and to publicize through diverse platforms.

Moreover, the network enabled CORC members and leadership to get involved with other MEOPAR-related events and initiatives such as the Canadian Hazards Emergency Response and Preparedness Initiative (CHERP) and the MEOPAR National Fora.

The Canadian Hazards Emergency Response & Preparedness Initiative (CHERP)

CHERP is a research outreach and engagement project from the University of British Columbia that seeks to make it quicker and easier for community residents to learn about, prepare for, and respond to local environmental and climate-related hazard threats (Reynolds 2022).

To do this, the research team integrated its knowledge of hazard risk and risk communications with extensive on-the-ground knowledge from CORC's network and community partners to develop a mobile application combining community geospatial

risk information with household-specific profiles to help residents learn about, prepare for, and respond to hazard events with emergency plans tailored to their family's unique requirements. By doing so, the team succeeded in building a locally relevant yet nationally and internationally informed tool that dramatically simplifies household emergency planning.

Canadian Coastal Resilience Forum (CCRF)

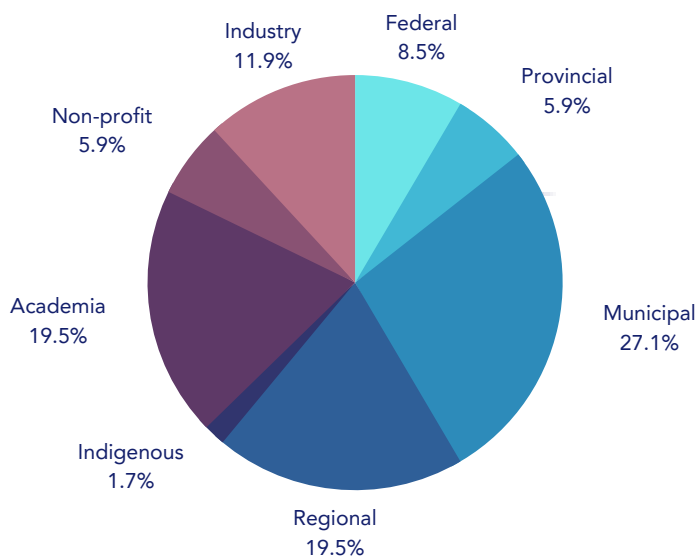
Based out of the University of Waterloo, CCRF aims to develop policy and governance strategies for reducing and managing the consequences of natural hazards in coastal areas. This effort involves clarifying the roles and responsibilities across government levels, for-profit and non-profit organisations and the public in risk prevention, reduction, and disaster recovery; identifying risk reduction policies that align with local hazard and community contexts; locating exposed and vulnerable populations; and identifying achievable measures of self-protection.

CCRF regularly engages with its audience through activities, such as events (like the National Forum on Coastal Community Resilience, see section below), webinars, blogs, social media (primarily Twitter), and newsletters (see Table 2). Topics are related to climate change adaptation, disaster risk reduction, flood risk policy and governance, data production and analysis, and mapping for Canadian and international audiences. CCRF has been successful in facilitating dialogue

between communities undergoing climate adaptation processes and subject matter experts by providing avenues for discussion and exchange. Events like the National Forum offer space for the public sector to receive feedback, making their services more meaningful and effective in addressing practical issues, while the private sector gains insights into opportunities for collaboration.

National Fora on Coastal Community Resilience

Held in 2020 and 2022, these fora were informed by researchers from MEOPAR's network that included CCRF and CORC members to facilitate knowledge exchange and networking among practitioners and researchers involved in coastal adaptation efforts, and decision-makers, to exchange knowledge and experiences with one another while discussing evolving coastal resilience concerns requiring cooperation across jurisdictions. With careful programming, targeted outreach, and marketing strategies, the 2020 Forum attracted a wide range of stakeholders, as shown below.



Previous CoP activities had served to gradually build networks with adaptation practitioners, planners, and decision-makers, examine adaptation needs, and identify existing successes. This groundwork enabled the organising committee to collate and mobilize knowledge of adaptation needs and activities when designing the events, and to recruit a range of non-academic presenters and panelists. Thus, these fora offer valuable contributions to evolving discussions of complex coastal challenges and serve other instances where diverse collaboration is needed to solve complex challenges.

The Canadian Marine Shipping Risk Forum (CMSRF)

As previously mentioned, the natural tendency of research within disciplines is more inward-looking than outward, which leads to concentrating globally valuable information within single fields of study or organisations. The need to overcome interdisciplinary collaboration barriers requires a commitment to open KS, necessitated by the diverse fields and stakeholders engaged in shipping risk, including waterway traffic management, remote sensing, environmental science, geospatial modelling, transportation regulation, and risk analysis and management. The CMSRF has delivered multiple webinars and workshops to support these aims.

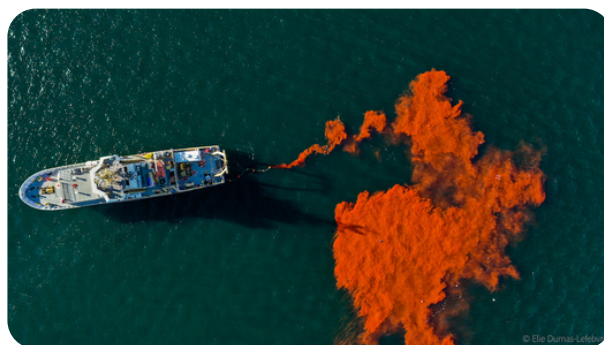
Recognizing the rapid accumulation of data related to vessels at sea and the interdisciplinary nature of its potential applications, the CMSRF is developing a shipping risk inventory to support open KS.

This online database will allow people to efficiently find studies and analysts on shipping risk in Canada, and to submit further information for inclusion. When complete, the open access inventory will support finding past examples for specific geographical areas and types of risk assessments, provide accessible reference material to understand legal and regulatory aspects of shipping risk management, and contribute to understanding how maritime risk is managed in Canada by providing processes and precedents to consider for different risk challenges. With the support of this tool, decision-makers will be able to implement risk mitigation solutions based on evidence from prior analyses.

Network on Coastal Ocean and Lake Optics Remote Sensing (NetCOLOR)

NetCOLOR's success has resulted from several activities that gathered the community, providing a platform for exchanging resources and information among members, supporting KS and increased communication. Despite its relatively small membership (Table 1), it has a far-reaching community of end-users as satellite imagery is abundantly used in aquatic science (e.g., habitat mapping, water quality monitoring, fisheries, and climate change impact assessment). The workshops, conferences and collective reporting made possible by the four-year support from MEOPAR has allowed NetCOLOR to grow and engage more with the Canadian aquatic remote sensing community.

NetCOLOR faces three main challenges: the geographical spread of the community, a small number of HQPs, and communication with end-users. Support from MEOPAR has been instrumental in addressing these challenges, in particular by engaging the community and training HQPs through workshops (both face-to-face and virtual), publishing a first report on Canadian aquatic remote sensing priorities (Devred et al. 2019), and amplifying communication (mailing lists, newsletters, tweets). A key legacy of this CoP is its partnership with the Canadian Space Agency (CSA) which recognizes NetCOLOR as an authority in satellite observation of aquatic environments and as an advisory community. As such, NetCOLOR has a direct channel to voice community needs and concerns to the federal agency. In addition, NetCOLOR provides strategic guidance to CSA at both the national and international levels. The NetCOLOR CoP provides a valuable stakeholder service by publishing guidance to all stakeholders for satellite ocean color products used to track status and trends in coastal and ocean water productivity, map shallow-water habitats, monitor water quality, assess fisheries status, and provide data input for climate assessments.



Canada's Ocean Acidification (OA) Community of Practice (CoP)

Canada's Ocean Acidification Community of Practice (OA CoP) focuses on connecting science with knowledge users, such as the public, stakeholders and rightsholders, governance entities, non-profit and academic members, while promoting support and action on ocean acidification. A leading goal for this CoP is communication and connection, utilizing a variety of online platforms and tools to promote OA literacy for a broad audience (Table 2). Through these community connections, the CoP disseminates best practice guidelines for reporting OA data (e.g., Sustainable Development Goal [SDG] 14.3.1.), and links Canadian efforts into larger initiatives such as the Global Ocean Acidification Observing Network (GOA-ON) North American Hub and bilateral federal science agencies like the Department of Fisheries and Oceans and National Oceanic and Atmospheric Administration [DFO-NOAA] Working Groups, and through the Ocean Acidification Research for Sustainability (UN Ocean Decade of Ocean Science for Sustainable Development). Within Canada, the CoP aims to connect end-users requiring science to inform their decision-making with relevant scientific expertise (e.g., a project linking a community college with local aquaculture operators to deploy OA sensors), to promote scientific connections leading to OA adaptation planning, and to support

coastal community resiliency (BC Fisheries & Aquaculture Ocean Acidification and Hypoxia [BC OAH] Action Plan).

Another key activity to increase successful knowledge mobilization is developing and delivering educational materials aimed at advancing OA science literacy to a wider audience either through using direct delivery (educational videos, activity sheets, webinars, and infographics) or mediated delivery through teachers in classrooms. The OA CoP uses multiple methods of science engagement tools and integration within the education systems, and enables sharing the latest scientific developments and best practices. A variety of tools and platforms are used, which translate information in multiple ways, addressing the needs of the CoP's diverse membership, thereby enabling the network to promote community-led action beyond the capacity of single members.

The OA CoP has continuously explored new ways of engagement with its network, with different pathways attaining varying levels of success. The OA CoP has found that its most effective content utilizes passive engagement over active engagement. Passive engagement requires no input from its audience, such as watching a video or reading a blog post. Active engagement is the antithesis of passive engagement, requiring input from the participant, such as filling in surveys and leaving comments. An example of the heightened effectiveness of passive engagement can be seen when comparing the

OA CoP's blog posts with its discussion posts. Discussion posts, which consisted of a topic or question for the community to discuss, required active participation and received few comments per post. Blog series continue to outcompete this level of engagement; even the lowest engagement blog series, OANews, outperform the engagement of discussion posts. Much higher levels of engagement can be seen with more successful blog series such as the Scientist Spotlight series which receives an engagement significantly higher than those of OANews. This contrast in viewership shows that CoP coordinators need to consider the proper use of passive engagement when attempting to engage with a large network.

International Comparisons

Through efforts to coordinate governance in addressing climate change and other ongoing environmental drivers within Canada, MEOPAR-supported CoPs have enabled science to be translated into policy and decision-making tools for a variety of stakeholders (government, academia, industry, and local communities). To overcome the barriers limiting international collaboration, a growing number of Canadian CoPs are expanding their interdisciplinary networks and establishing a strong online presence (MEOPAR 2023).

International information sharing on ocean acidification has made considerable progress. A community of practice approach is being used in Oregon, USA, to inform policy decisions about ocean acidification and

hypoxia and facilitate developing an action plan (Whitefield et al. 2021). Canada's OA CoP, as described above, networks with other science-based community-integrated efforts, such as the Oregon-based group, the UN Ocean Decade and global ocean networks (GOA-ON), promoting global knowledge exchange through shared goals and amplifying early-career professionals.

In response to the complex needs of the Salish Sea, the Canadian Marine Shipping Risk Forum convened the Salish Sea Transboundary Working Group (SSTWG) in 2022. In this forum, Canadian and US government agencies, academia, indigenous groups, and non-governmental organisations with an interest in marine shipping and the risks associated with it can exchange ideas, concerns, and questions about marine shipping in transboundary Salish Sea waters.

Similar to MEOPAR-supported CoPs, the Global Ocean Observation CoP has established broad partnerships, shared approaches, and best practices that are now "being organised in order to implement an integrated observing system that serves information to resource managers, decision makers, scientists, and educators" (Canonico et al. 2019). Other marine focused international CoPs, such as the Coastal Resilience and the various Observations CoPs that are part of the US Interagency Arctic Research Policy Committee, have accomplished similar goals (i.e., implementing the US Arctic Research Strategy) using similar outreach tools.

Although MEOPAR focuses on Canadian contributions to marine science, CoPs active in other countries have also contributed to improving KS and KMS in their respective fields (e.g., education, health care). A future paper could compare these CoPs with Canadian CoPs.

Limitations & Challenges

While the practices and strategies exemplified in this study are based on the Canadian ocean sector, they can be applied to other countries and sectors as well. A second important point is that the findings of this paper were derived using western scientific methods rather than traditional knowledge ones. When people employ the two-eyed seeing approach, they will be able to leverage the two complementary sources of knowledge. Further research could compare CoP KS tools and traditional KMS methods.

Member-to-member engagement remains challenging within CoPs, since it requires considerable effort from individuals (e.g., seeking and providing feedback). Virtual participation also comes with challenges despite lowering barriers to physical meetings. After anti-spam laws came into effect, some CoPs had to rebuild their membership list as platforms adapted to technological advancements. In line with Bourhis et al.'s (2005) findings, technological challenges persist, but now they have moved from teaching users how to use the online system to choosing appropriate platforms that can reach all membership groups in timely and effective ways (e.g., one CoP had to resort to

conference calls rather than use an online meeting platform because some members were unfamiliar with its operation). Following COVID-19, the remote participation issue continues to be explored, and new best practices are emerging (Mohalik and Poddar 2020). Measuring far-reaching impacts could be explored in the future by MEOPAR CoP leads.

Recommendations

As environmental disruptions disproportionately impact the most vulnerable populations that are the least responsible for global emissions (UN Environment 2019), ensuring diversity in all steps of policy elaboration will be essential for driving innovation, decision-making and investment respectful of equity and justice. As part of knowledge mobilization and governance, it is important to include voices from Indigenous groups and communities, so innovative, cost-effective and bottom-up solutions can be developed (UN Environment 2019). CoPs provide such a space for moving towards this goal, as demonstrated by the National Fora on Coastal Community Resilience case study and Figure 1.

Existing and future CoPs should utilize social media as engagement and information-sharing platforms, and treat websites as repositories of information to improve KS. Tailoring communication methods to purpose and audience is crucial to ensuring timely knowledge sharing and community resilience (see recommendations by Holmes and Lock [2010]), even more so given the digital transformation accelerated by COVID-19

(see Mohalik and Poddar for more information and best practices [2020]). The most suitable platforms depend on the target audience, where passive communication tool (i.e., blogs, newsletters) have shown stronger engagement in some milieus, as experienced by the OA CoP.

Collaborative initiatives such as the DFO-NOAA OA Collaboration and SSTWG are useful for interagency coordination as they standardize effort and products. To improve access to scientific findings and information for all levels of society, decision-makers should further invest in open-access inventories, like the Shipping Risk Inventory and the one developed by the OA CoP.

CoPs require time to develop fully inclusive knowledge-sharing systems, community-led and purposeful intention, and sustained resources to succeed and promote inclusive outcomes. Funding should be available, consistent, and allocated to CoP staff (i.e., a coordinator), the expert panels and supported activities, depending on their active or passive involvement. Paid top management is only as strong as the base of the triangle of science experts and community participants. Coastal communities may also need financial support (such as stipends) to participate in CoP activities.

Final Remarks

When coordination of national efforts in the ocean sector was lacking, MEOPAR acted and continues to be a crucial knowledge broker by facilitating connections between researchers and practitioners working in different sectors on similar subjects, as well as by providing funding for the establishment and maintenance of CoPs.

The case studies presented in this article show how the networks formed by CORC, CCRF, and NetCOLOR have enabled members to develop products (applications like CHERP, reports like Canadian aquatic remote sensing priorities, and CCRF YouTube webinar recordings) that effectively break down knowledge barriers between researchers and end-users. The CMSRF and the OA CoPs are leveraging their collective networks to build open-access inventories that map knowledge and identify gaps. By doing so, these projects increase ocean literacy, and promote inclusive sectoral and community knowledge mobilization. In addition to improving access to information, such KS and knowledge transfer also strengthen community resilience by improving understanding and preparedness for coastal hazards (such as erosion, storm surge, sea level rise) and climate threats (such as warming oceans, ocean acidification).



The work that CoPs do within these knowledge ecosystems has enabled them to transition from knowledge-intensive networks to social innovation networks that help solve problems related to social and environmental issues. MEOPAR-supported CoPs have broken down barriers between and within organisations by creating new platforms and implementing innovative strategies to share knowledge and technology that had previously been siloed.

To ensure that knowledge brokers continue to advance knowledge translation and bridge the gap between researchers and practitioners, granting agencies need to recognize their value for communities and provide them with adequate and sustainable resources, and many other sectors should continue to engage and support relevant CoPs.

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