

Evaluating Ocean Perceptions and Ocean Values: The Canadian Ocean Literacy Survey

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Abstract

This paper describes the development, validation, and key findings of the Canadian Ocean Literacy Survey. Led by the Canadian Ocean Literacy Coalition (COLC) and its research partners, this survey was developed as part of a Canada-wide, mixed methods research initiative examining how ocean literacy is understood and practised across different regions and sectors. The survey included items linked to ocean perceptions, values, and actions as reported by two categories of Canadian respondents: “ocean-engaged” (n = 1,359) and “general public” (n = 1,010). The survey objectives were as follows: to determine if Canadians would identify Canada as an “ocean nation”; to uncover meaningful patterns in ocean awareness, perceptions, and values by region and subgroups; and to better understand Canadians’ emotional connections to, and relationship with, the ocean, as well as their behavioural intentions and actions.

Résumé

Le présent article décrit la conception, la validation et les principales conclusions du Sondage canadien de la connaissance de l’océan. Mené par la Coalition canadienne de la connaissance de l’océan et ses partenaires de recherche, ce sondage a été mis au point dans le cadre d’une initiative pancanadienne de recherche à méthodes mixtes examinant la compréhension et la pratique de la connaissance de l’océan dans différentes régions et différents secteurs. Le sondage abordait les points suivants : perceptions, valeurs et actions à l’égard de l’océan. Deux groupes ont été sondés : les « répondants sensibilisés » (n = 1 359) et le « grand public » (n = 1 010). Le sondage visait à déterminer si les Canadiens reconnaissaient leur pays comme une « nation océanique » et à dégager des tendances significatives en ce qui concerne la sensibilisation au milieu marin, les perceptions et les valeurs en fonction des différents sous-groupes et régions afin de mieux comprendre le lien émotif et la relation qui unit les Canadiens à l’océan, de même que leurs intentions et leurs actions.

Keywords: ocean literacy, ocean perceptions, ocean values, ocean action, survey design, Canada

Mots-clés : connaissance de l’océan, perceptions à l’égard de l’océan, valeurs à l’égard de l’océan, actions à l’égard de l’océan, conception de sondage, Canada

Introduction and Background

This paper describes the development and validation of an ocean literacy survey by the Canadian Ocean Literacy Coalition (COLC) and its research partners. Widely accepted internationally, ocean literacy is a term that has been defined as one's understanding of "the ocean's influence on us and our influence on the ocean(s)" (National Oceanic and Atmospheric Administration, 2013, p. 1). Using established psychometric principles, the Canadian Ocean Literacy Survey was developed as part of a larger Canada-wide research initiative led by COLC to better understand Canadians' varied relationships with the ocean and, more specifically, to examine how ocean literacy is understood and practised across the country's different regions and sectors. The aim of the national study was to establish the first baseline of ocean literacy in Canada, and in so doing to co-develop an evidence-based national ocean literacy strategy.

Our relationship with the global ocean, or the interconnection of the world's seas, goes beyond the ocean being a simple source of food and resources. Indeed, this enormous mass of water that encircles the globe influences climate, weather, biodiversity, and ecosystems. Globally, there is a deepening understanding of the importance of our interactions with a diversity of marine ecosystems (Selig et al., 2019). There is also growing evidence that human pressures are increasingly putting the health of these ecosystems at risk (Borja et al., 2016) through unsustainable practices (e.g., plastic pollution, overfishing, carbon dioxide emissions) that contribute to ocean acidification, deoxygenation, and changes in water temperatures (International Union for Conservation of Nature, 2017).

The global ocean is an increasingly important component of national socio-economic development strategies (e.g., Canada's emerging Blue Economy Strategy). However, if these development strategies do not prioritize sustainability and equity, the health of marine and coastal ecosystems could be further jeopardized, along with the communities that depend on them. As policy, academic, technological, and on-the-ground community solutions continue to be shared and implemented to mitigate human impacts on these ecosystems, fostering ocean and climate awareness, connections, and stewardship in citizens is likewise an essential step. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2021), changes in the way we think about and understand our relationship with the ocean can be addressed by an increased focus on ocean literacy.

Ocean literacy was introduced more than 15 years ago in the United States and has since grown into a worldwide movement. Momentum has been particularly spurred by collaborative international policies and agreements. For instance, the *Galway Statement on Atlantic Ocean Cooperation* (2013) has contributed to international ocean collaboration in the "North Atlantic Region," which includes the European Union, Canada, and the United States; the *Belém*

Statement on Atlantic Research and Innovation Cooperation (2017) has done the same for the “All-Atlantic Region,” which stretches north–south along the Atlantic Ocean and encourages collaboration across North and South America, Africa, and Europe.

Ocean literacy in its various forms will be key to influencing (or mitigating) our individual and collective actions in Canada and abroad, as well as to helping us understand how we are directly or indirectly connected to diverse marine environments. Central to the global concept of ocean literacy is ensuring that all citizens gain a better understanding of the importance of the ocean, the varieties of human–ocean interactions, and the opportunities to act sustainably to reduce human impacts on marine systems (Santoro et al., 2017).

Describing and evaluating ocean literacy, then, is an important challenge for all parts of society, including educators, trainers, students, young professionals, civil society, scientists, consumers, industry, and policy makers (Uyarra and Borja, 2016). Developing descriptors and measures for ocean literacy can be seen as an essential part of the strategies needed to change human behaviours and practices, while also creating opportunities for sustainable development (Gelcich et al., 2014). Ocean literacy has been identified as one of the seven societal outcomes for the current United Nations Decade of Ocean Science for Sustainable Development (UN Decade 2021–2030), of which the seventh and final outcome promotes “an inspiring and engaging ocean where society understands and values the ocean” (oceandecade.org). Measuring “societal understanding” and “ocean values” are thus clearly recognized as important indicators of the UN Decade’s overarching objective of “transformational action.”

Consultation and Research Design

The development of COLC’s Consultation and Engagement Phase formally began in late April 2019 with a strategic planning session led by COLC and attended by 12 participants representing diverse regional, sectoral, and cultural perspectives. Together, the participants contributed to the co-establishment of a preliminary research framework. This framework was centred on a robust consultative process at both a national and regional level (September 2019 to March 2020). The research outcomes were published in June 2020 as a series of reports in the *Understanding Ocean Literacy in Canada* study. The study’s evidence-based findings directly informed the eventual launch of *Land, Water, Ocean, Us: A Canadian Ocean Literacy Strategy* in March 2021.

The Consultation and Engagement Phase of the project was led by COLC’s research team, composed of a national coordinator, five regional coordinators (three post-docs and two graduate students), two research assistants, five artists, and five supporting research professors. Together, the team examined the overarching research goals and scope of the consultations as the foundation of the larger Strategy development process. These early discussions yielded important

outcomes for the conceptualization of the research, including the need to consider broad opportunities and approaches for community engagement, “a spectrum” of best practices, and potential ways to bridge ocean and freshwater literacy efforts. Most importantly, the research needed to ensure, support, and celebrate regional diversity within and across the Canada-wide consultation process.

In our evolving research design, we paid close attention to the complex nature of institutional research as it involved a variety of academic partner institutions (and ethics protocols). Likewise, we closely observed different provincial/territorial processes for the approval of community engaged research. In addition, protocol and care related to the sensitivity and protection of Indigenous knowledge (e.g., as outlined by the First Nations Information Governance Centre and in the National Inuit Strategy on Research) were important considerations for COLC’s research team. Finally, as a pan-Canadian research team, it was paramount that our approach facilitate people coming together to co-create, co-explore, co-develop, and co-identify the salient aspects of ocean literacy in distinctly Canadian contexts.

We used a mixed methods research framework, including a national survey, semi-structured interviews, online organizational asset mapping surveys, document scans, targeted workshops (i.e., youth), and arts-based methods. This article focuses on the instrumental design and resultant key findings of the national survey only.

National Survey Design

Initial conceptions of the national survey included items linked to ocean values, perceptions, and attitudes related to ocean-connectedness as held by two categories of respondents (all 15 years of age or older): self-identified “ocean-engaged” Canadians (either directly or indirectly engaged in ocean literacy or ocean-related work) and the “general public.” We intended to broadly survey Canadians with a short and efficient tool which, at a minimum, would establish the following: how strongly individuals identified as being part of an “ocean nation”; how relevant the ocean is to a citizen’s daily life; and to what extent Canadians could identify, rank, or categorize ocean concerns and actions. We hoped to define a series of constructs that would help to further elucidate our Canadian conceptions of ocean literacy and pair the survey with a mixed methods approach linked to other qualitative methods that could “tell the story” of ocean literacy in Canada.

Briefly, the topics intended for the survey included:

- knowledge about current ocean threats and conservation policies and practices
- awareness of and attitudes toward ocean conservation and the blue economy
- values pertaining to ocean ecosystems and marine ecological services

- perceptions of ocean health and the role citizens play in ocean stewardship
- citizens' behavioural intentions pertaining to ocean sustainability

Specifically, the survey objectives were threefold:

- to determine the extent to which Canadians surveyed would identify Canada as an "ocean nation"
- to uncover response patterns that exist by region and subgroups in order to better understand ocean awareness, perceptions, and values, across Canada, and among its various regions and communities.
- to better understand Canadians' emotional connections to and relationship with the ocean, as well as their behavioural intentions and actions

Survey Instrument Development

Our conceptual framework for the measurement and evaluation of ocean perceptions (and of survey methodology generally) is rooted in the work of early scholars such as Kurt Lewin and Henry Murray (Fraser, 1998). Decades ago, Lewin's (1951) field theory stipulated the key idea for all psychosocial research that followed, namely, that human behaviour has two determinants: 1) the environment and 2) the environment's interaction with an individual's personal characteristics. To illustrate this concept, Lewin (1951) communicated his field theory in which human behaviour is conceived as a function of both a person and their environment. Over the ensuing decades, a wide range of social science research instruments have been constructed, tested, and validated to describe these personal and perceptual elements as they relate broadly to human experience.

Social scientists characterize the development of survey methodology in phases (Creswell & Plano Clark, 2007). In the first phase, the main foci of psychometric research involved establishing reliable and valid instruments for mapping perceptual dimensions as they linked to attitudes, learning outcomes, and other aspects related to human experience. This could include examining links between perceptual measures and learning outcomes, or identifying differences in perceptions across genders, ages, or ethnicities. Much of this research was descriptive or correlational in nature.

A second phase (2000 to the present) includes broader methodologies in which more varied research questions are investigated (Zandvliet and Fraser, 2018). This development has led to greater diversity in research methods and to the inclusion of a range of mixed methods that incorporate both quantitative and qualitative data collection into an integrated research design.

Because learning is not viewed as an individualized phenomenon by social scientists, survey research methods continually stress that learning occurs within and under the powerful influence of strong social factors (Fraser, 2014). Importantly, perceptual studies conducted during the past few decades have

diversified to involve the use of qualitative methods in describing these factors, and in the triangulation of qualitative and quantitative data sets (Tobin & Fraser, 1998). Today, survey methodology has diversified as a variety of approaches, and instruments have been developed, tested, and validated in a range of settings (Fraser, 1998; 2014).

For this study, a key consideration in designing perceptual measures as part of our conception of ocean literacy lay in the latent potential of these measures to be predictive of other outcomes, such as attitudes or behaviours related to the ocean. This, in turn, underscored the need to develop a variety of methods to measure, map, or typify various data sets related to perceptions of marine environments. To this end, we referred to contemporary mixed methods research practices, which combine a variety of information and data sources in their design. Perhaps most importantly, mixed methods can give a voice to diverse demographics, such as age, gender, or ethnicity, regardless of the disciplinary context or knowledge (Zandvliet & Fraser, 2018). Put simply, our perceptions about our experiences are invaluable resources for understanding the complexity of what we will define as “ocean literacy” now and in the future. In the context of this study, our survey methods were complemented by observation, interviews, and other rich sources of qualitative data.

Recent Surveys Related to Ocean Literacy

Recent polling by the World Wildlife Foundation (WWF, 2016; Environics Research, 2019) has primarily focused on public opinion regarding marine protected areas in Canada. The most recent study (Environics Research, 2019) included 22 questions administered to 1,665 respondents (aged 18 years old and over). The constructs measured included Canadians’ values placed on the ocean and perceptions of and support for ocean solutions (e.g., protecting oceans and their ecosystems, including wildlife habitats; reducing use of toxic chemicals). Their report presented compelling evidence that these views have been widely held over time, which was especially evident when comparing the 2016 and 2019 survey results. For the most recent study, a mixed methods approach was used: 1,515 interviews were conducted with an online panel in the Canadian provinces, and 150 interviews were conducted by telephone in the Canadian territories. Quotas for the study were set by region, age, and gender, as well as household income (in the provinces) and Indigenous identity (in the territories). Data were weighted to ensure the final sample was representative of the Canadian population, according to the most recent Census (2016) census data.

Similarly, the International Ocean Literacy (IOL) Survey (Fauville et al., 2019) aimed to serve as a community-based measurement tool allowing the comparison of levels of ocean knowledge among 15- to 17-year-olds over time and across location. The tool was first developed in English and within

a concentrated American and European context. The IOL Survey has faced a number of criticisms, including the following: it is too narrow in its focus (McKinley & Burdon, 2020); it uses only knowledge outcomes as measures; and it only administers multiple choice questions on knowledge ideas that are directly linked to the American-generated Ocean Literacy Principles and Fundamental Concepts specific to the U.S. national science K–12 curriculum (see Cava et al., 2005).

Despite its potential shortcomings, the IOL Survey has been subjected to two rounds of field testing. For the most recent study, data were collected in early 2019 from participants aged 15 to 17 years old with a total of 7,900 respondents across 14 languages: Catalan, Dutch, English, Greek, Italian, Japanese, Korean, Polish, Portuguese, Simplified Chinese, Spanish, Tagalog, Thai, and Traditional Chinese (Chen et al., 2020). Overall, the items in the survey's single "ocean literacy" scale demonstrated high internal consistency, though the scale was unidimensional in that it measured only one latent trait: knowledge outcomes related to a somewhat limited conception of ocean literacy.

Most recently, the Seas, Oceans and Public Health in Europe project (SOPHIE) developed a large-scale, European survey on oceans and human health. This survey was developed with the aim of understanding public perceptions of both the risks and benefits to marine ecosystems for human health and well-being. Their study surveyed the opinions expressed by 14,167 European citizens from 14 countries about their interactions with marine environments and their perceptions of a range of marine activities (SOPHIE Consortium, 2020). These opinions were solicited in relation to a variety of factors, including public health and well-being, health of the marine environment and economy, and overall concerns and priorities related to the marine environment. Data were collected using representative online panels for each country.

This sampling of current ocean literacy survey research helped COLC's research team conceptualize factors to include in the developing the Canadian Ocean Literacy Survey.

Survey Methods

A targeted review conducted by the COLC research team uncovered relatively little empirical research on the measurement of ocean literacy within the Canadian context and noted few studies using validated surveys to measure ocean related factors. This finding drove our need to design and validate our own survey instrument for use in this research. The Canadian Ocean Literacy Survey was designed to gauge factors of interest for all Canadians about *ocean perceptions* and *ocean values* pertaining to a range of issues. As we worked to develop the survey structure, we considered individual items and factors (groups of related items) from published surveys, including those of ocean knowledge, attitudes, values, perceptions, and behavioural intentions.

Referencing normative practices for survey design, the administered structure for the survey eventually included 10 perceptual items to which respondents were asked to respond using a five-point Likert scale (5-strongly agree, 4-agree, 3-neutral, 2-disagree, or 1-strongly disagree). These items were grouped into two potential factors (ocean perceptions and ocean values), which were then augmented by additional items that allowed respondents to check off a range of responses related to their ocean knowledge, attitudes, or intended behaviours. At the end of the survey, participants were given a final text option to respond in an open-ended way by telling an “ocean story.”

A finalized version of the Canadian Ocean Literacy Survey, in both English and French, was made available to the general public and was administered using a web-based platform. Links to the survey were distributed through the COLC network and members’ extended networks to professional communities, most of whom were directly or indirectly engaged in ocean literacy or broader ocean-related work. We referred to this group as “ocean-engaged.” In addition, Nanos Research administered a shortened version of the same survey to poll a random sampling of the Canadian public. We referred to this group as the “general public.”

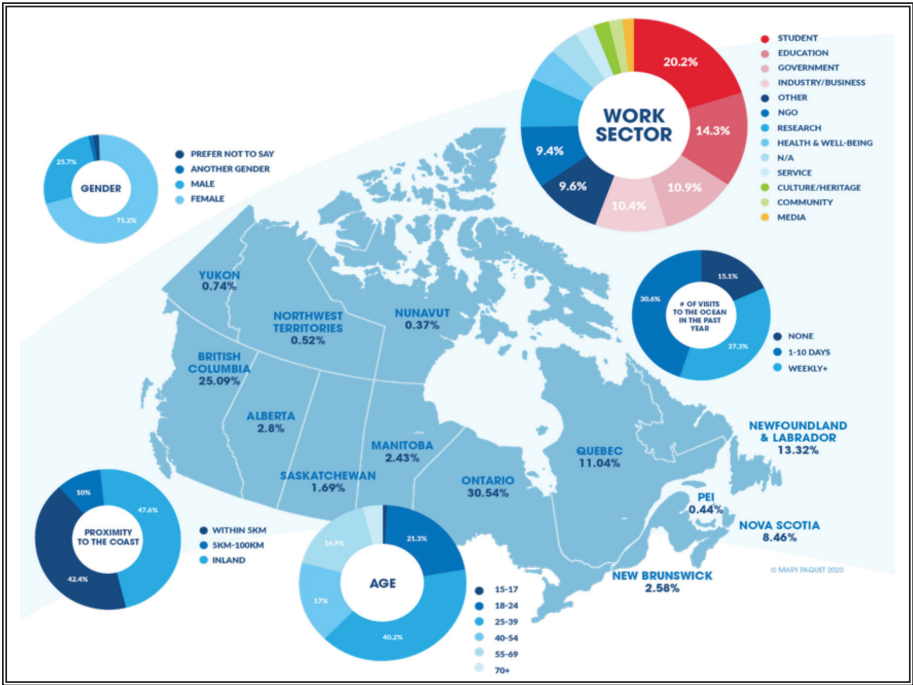


Figure 1. Demographic Breakdown of the Ocean-Engaged Survey Respondents (n = 1,359). Graphic Design: Mary Paquet

Study Sample

The “ocean-engaged” sample for this study consisted of 1,359 Canadians (15 years of age or older) responding to the online survey between September 23, 2019 and January 31, 2020. For this sample, a broad geographical distribution was reached, with the largest response clusters concentrated in Ontario and British Columbia, followed by Newfoundland and Quebec. Figure 1 highlights the demographic breakdown of the ocean-engaged survey respondents. Of the total sample ($n = 1359$), there was an 89.2% overall completion rate of the items, although the response rates varied for each item. In summary, 25 of 26 questions administered were Likert response scale or checkbox. The final question consisted of an open-ended (and optional) comment with a completion rate of 25.2%.

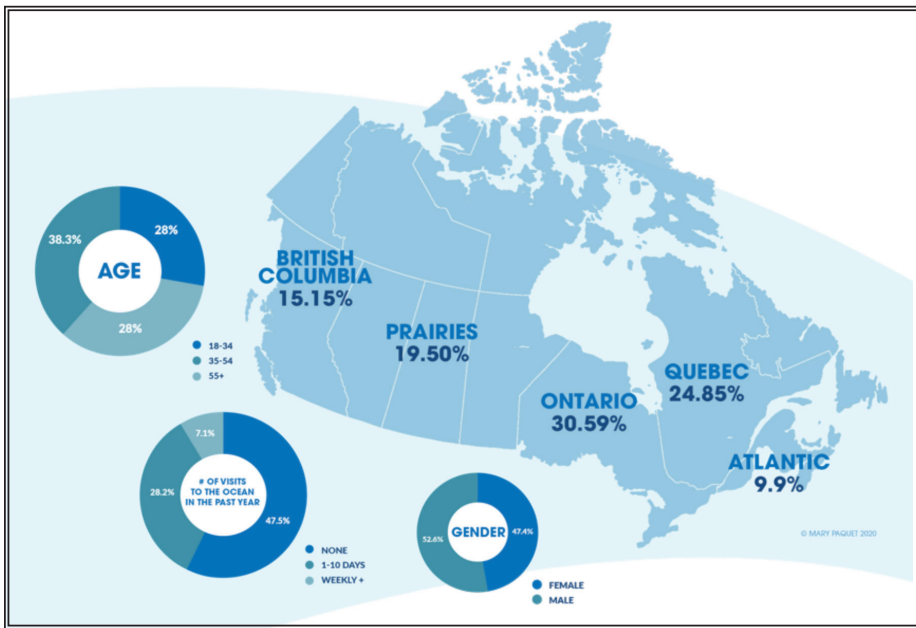


Figure 2. *Demographic Breakdown of the “General Public” Survey Respondents ($n = 1,010$). Graphic Design: Mary Paquet*

For the “general public” sample, 1,010 Canadians were polled. For this group, the survey items were included as part of a larger omnibus survey being conducted by Nanos Research. In its administration, fewer questions were asked and fewer demographic data were gathered. For example, we were unable to collect data on respondents’ proximity to the coast, work/sector breakdown, or ethnic identity. The study participants (aged 18 years or older) participated in a hybrid telephone and online random survey conducted by Nanos Research

between November 29 and December 2, 2019. Figure 2 highlights the demographic breakdown of the “general public” survey respondents.

Validation of Survey Data

The survey instrument developed for use in this study was one that intended to gauge factors of Canadians’ *ocean perceptions* and *ocean values* as few recent studies have included validated surveys to measure these factors in the Canadian context. The survey proved to be a reliable and valid tool for measuring these constructs for the two population groups sampled. As the items are not time or age sensitive, the questionnaire was easily adapted for use with both the “ocean-engaged” and “general public” respondents.

As noted in Table 1, two scales (*ocean perceptions* and *ocean values*) were incorporated as “perceptual” measures into the survey, and the items for each were developed from two sources: 1) previously referenced inventories and 2) data emerging from focus groups with collaborators and the COLC research team. For each of these factors, items were responded to using a five-point Likert scale (ranging from strongly agree to strongly disagree), and the validity and reliability data were independently calculated for each factor for each of the samples.

Scale	Sample Item
Ocean Perceptions	My day-to-day actions impact the ocean.
	The ocean directly influences my day-to-day activities.
Ocean Values	Ocean health is important to me.
	I am willing to make changes to support ocean health.

Table 1. Sample Items from Scales Included in the Canadian Ocean Literacy Survey

Scale	Reliability/ Validity Data	Ocean-Engaged Sample	General Public
Ocean Perceptions	Cronbach <i>alpha</i>	.72	.63
	<i>Discriminant validity</i>	.32	.38
Ocean Values	Cronbach <i>alpha</i>	.73	.66
	<i>Discriminant validity</i>	.32	.38

Table 2. Validity and Reliability Data for Scales from the Canadian Ocean Literacy Survey

The calculated values from the Cronbach *alpha* and *discriminant validity* values for administration of the survey to the “ocean-engaged” and “general public” samples indicate that the measured constructs (*ocean perceptions* and *ocean values*) demonstrate acceptable (within scale) reliabilities and discriminant validity among the other measures on the survey. This demonstrates that these scales are robust and can be used in a variety of contexts (e.g., for educators and/or the general public) wishing to measure, evaluate, or describe these factors as important components of ocean literacy.

Survey Results

Items on the survey yielded rich information about how Canadians view their relationship with the ocean environment. Survey data demonstrated that Canadians strongly identify as an ocean nation and that they are willing to make lifestyle changes to support ocean health. Canadians also indicated that they want Canada to be an international leader in ocean protection. However, Canadians differed on a number of measures, including what actions they take to protect the ocean, what they value most about the ocean, and to what extent they perceive the ocean as influencing their day-to-day lives. These results indicate that there remains a significant gap in the participants’ relational understanding of their personal, day-to-day impacts on the ocean and the ocean’s impact on their daily activities. These ideas are key to our conception of ocean literacy.

Figure 3 presents the findings specific to the ocean perceptions and ocean values statements for both sample populations (i.e., “ocean-engaged” and “general public”). Some findings of particular interest:

- 82 % of the “general public” identify that they would like Canada to be an international leader in ocean protection, which is a similar finding to the “ocean-engaged” sample. However, when asked “What do you value, if anything about the ocean on Canada’s coasts?” the response rates were low as compared to the “ocean-engaged” sample (life-sustaining: 94.9 % vs. 37.4 %; aesthetics and scenery: 72.4 % vs. 15.9 %; health and well-being: 71.2 % vs. N/A). Findings for both data sets, however, were relatively similar across age groups, gender, geographical regions, and proximity to the coast.
- Respondents identified strongly with the idea that the ocean plays an important role in the Canadian economy but less strongly that the ocean directly influences their day-to-day activities.
- 77 % of the “general public” identified that they are willing to make lifestyle changes to support ocean health.

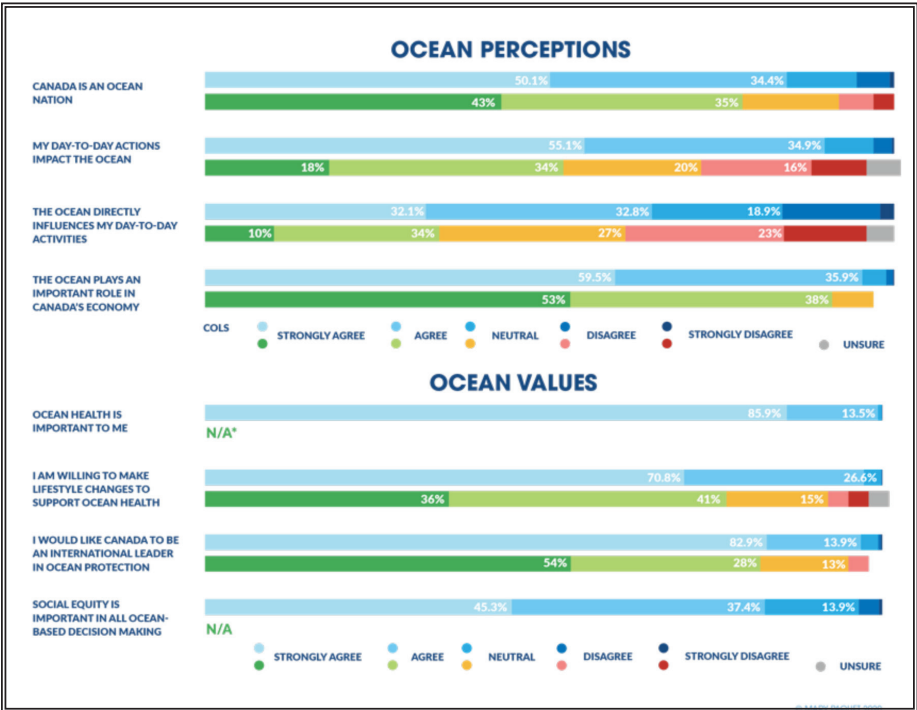


Figure 3. Illustrated Findings of the Ocean Perception and Ocean Values Statements for Combined Sample Populations (i.e., “Ocean-Engaged” and “General Public”). Graphic Design: Mary Paquet

Overall, Canadians shared that they learn most about the ocean through popular media, including print, television, radio, Internet, etc. The survey data indicated that the measures of ocean perceptions and ocean values were fairly homogeneous across age groups, gender, and geographical regions (including frequency of visits to, and proximity to, the coast). With media clearly identified as the most important way that Canadians learn about the ocean, there is a need to better leverage and engage with the media for sharing knowledge and stories that highlight the continuing relationship between people and the ocean.

Discussion

The results of the Canadian Ocean Literacy Survey speak to and describe several issues specific to ocean concerns in Canada. Although 44.1 % of the general public identified ocean pollution as an ocean threat of concern (60.5 %

amongst the “ocean-engaged”), linkages between climate change and the ocean (i.e., ocean warming, ocean acidification, rising water levels, storms) ranked extremely low with this group (9.5%) as compared to the “ocean-engaged” sample (77.4%). This suggests that greater efforts are needed to communicate the intersectionality of climate change with broader ocean literacy concepts.

The survey results also speak to the different types of ocean actions that Canadians must take. Along with better understanding Canadians’ ocean perceptions and ocean values, the broader research goals aimed to learn about behavioural intentions with respect to taking individual and collective action to support ocean health. Overall, more than three quarters of Canadians (77%) agreed that they are willing to make lifestyle changes to support ocean health. Similarly, more than three quarters of the “ocean-engaged” sample (77.4%) identified “engaging in ocean action(s)” as “very important,” ranking this action higher than “cultivating ocean values” (72.6%) and “mobilizing ocean knowledge” (70.6%). This finding is of particular interest when examining ocean literacy (in Canadian contexts), as is referenced by our framework: ocean knowledge, ocean values, and ocean action. The results clearly demonstrate that ocean knowledge alone is not sufficient to enact change. Action (or actionable knowledge) is critical and is also potentially influenced by measures such as ocean values and/or ocean perceptions.

In the context of collective actions then, the “ocean-engaged” sample of the survey clearly ranked five actions (among the listed items) as top priorities: reducing ocean pollution (e.g., banning plastic usage); reducing carbon emissions; supporting a just transition to sustainable economies; increasing public awareness and education; and creating marine protected areas. With respect to individual actions, the “ocean-engaged” sample, once again, clearly ranked five actions as the top priorities, several of which overlapped with the top “collective actions” required: reducing personal waste (e.g., cutting back on use of plastics); raising awareness and teaching others; changing buying habits; taking political action; and reducing carbon emissions.

Finally, in terms of what agencies Canadians look to for ocean protection leadership, the top five were ranked as follows: federal government (67.8%); provincial/territorial governments (44.7%); environmental and conservation organizations (38.6%); industry (31.7%); and First Nations, Métis, and Inuit governments, organizations, and communities (25.3%). Figure 4 illustrates a summary of other insights specific to ocean actions.

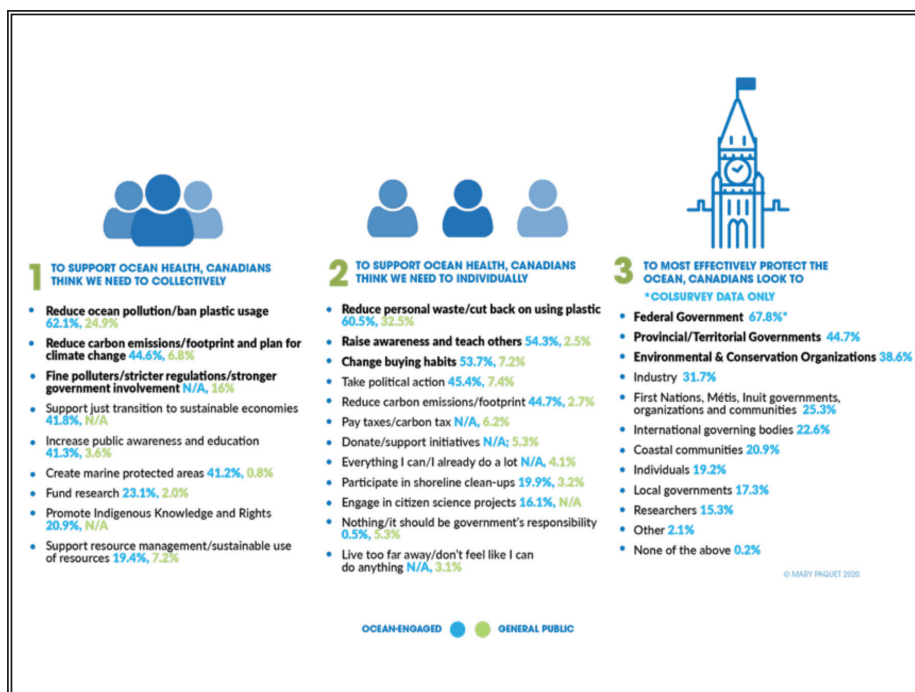


Figure 4. Canadians’ Perceptions on Individual and Collective Ocean Action Priorities As Well As Ocean Protection Leadership. Graphic Design: Mary Paquet

Limitations

This study notes a few limitations in ranking the results specific to which ocean threats Canadians are most concerned about. For example, in the survey (administered to the “ocean-engaged” sample), responses appeared as three separate items: ocean warming, ocean acidification, and coastal hazards (e.g., sea level rise, storms). However, in the Nanos Research poll administered to the general public, these items appeared as one response option—climate change/ rising water levels—and the results represent a combined total of these options. Similarly, ocean pollution appeared in the survey as one response option that included sewage, garbage, and plastic. In the Nanos poll, however, these items appeared as two separate responses: ocean pollution from sewage, garbage; and plastic. Therefore, it is difficult to make comparisons on these measures across the two samples.

Conclusion

The development and validation of the Canadian Ocean Literacy Survey demonstrates that the scales of “ocean perceptions” and “ocean values” are valid and reliable factors in our developing conception of ocean literacy. This finding is consistent in both “ocean engaged” and “general public” populations across Canada. Thus, these factors should be considered as robust items for inclusion in future research in this area. The survey was administered as part of a Canada-wide, mixed methods study examining how ocean literacy is understood and practised across different regions and sectors. It included items to better describe our emotional connection to, and relationship with, the ocean—broadly conceived.

As we look to measuring ocean literacy progress in Canada over the course of the UN Decade (2021–2030), the evidence-based understanding gained from the Canadian Ocean Literacy Survey provides a useful baseline upon which to build capacity in this area. Moving forward, a multi-year mixed methods evaluative framework that includes creative engagement (e.g., community story mapping, arts-based interactions), as utilized in the broader *Understanding Ocean Literacy in Canada* study, will be required. In order to track changes or trends across regions and with a culturally diverse citizenry, surveys can be a useful tool in measuring efficacy or in comparing among different possibilities or strategies for impacting Canadians’ level of ocean literacy over time.

We also recognize that knowledge exchange and evaluative design collaboration with international ocean literacy colleagues is essential to enhancing our work in Canada. This too, is an integral component of the shared global commitments that have been made to ensure that the societal outcomes of the UN Decade are achieved. Currently, these outcomes are aspirational, requiring collective thought leadership with regard to how the global “we” will track and measure “societal understanding and values of the ocean” over the decade, and beyond.

How do we turn aspirational goals into measurable outcomes? How will we know that our objectives for ocean literacy are progressing? And how will these potential successes be shared globally? These are but a few of the questions the COLC research team is now considering and which we will tackle together with our national and international colleagues. These efforts are already beginning; for example, recent work in the United Kingdom (McKinley & Burdon, 2020) is providing a new synthesis of evidence for potential measurement frameworks and evaluative design thinking that is specific to measuring ocean literacy. This and other emerging research (Ashley et al., 2019) will be useful starting points for realizing our collective goal of transforming ocean-climate knowledge into changes in the behaviours and actions that will promote ocean sustainability. Using an evidence-based approach to measuring and describing these factors will be a key part of the future of ocean literacy research.

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References

- Ashley, M., Pahl, S., Glegg, G., & Fletcher, S. (2019). A Change of Mind: Applying Social and Behavioural Research Methods to the Assessment of the Effectiveness of Ocean Literacy Initiatives. *Frontiers in Marine Science*. DOI: 10.3389/fmars.2019.00288
- Belém Statement on Atlantic Research and Innovation Cooperation. (2017). Retrieved from https://www.oceanozulfoundation.org/wp-content/uploads/2017/07/belem_statement_2017_pt.pdf
- Borja, A., Elliott, M., Andersen, J. H., Berg, T., Carstensen, J., Halpern, A.-S., Korpinen, S., Stewart Lowndes, J., Martin, G., & Rodriguez-Expeleta, N. (2016). Overview of integrative assessment of marine systems: The Ecosystem Approach in practice. *Frontiers in Marine Science*. 3:20. doi: 10.3389/fmars.2016.00020
- Cava, F., Schoedinger, S., Strang, C., & Tuddenham, P. (2005). *Science content and standards for Ocean Literacy: A Report on ocean literacy*. From <http://www.cosee.net/files/coseecal/OLit04-05FinalReport.pdf>
- Chen, Y.-F., Cannady, M. A., Fauville, G., & Strang, C. (2020). *Working toward an international assessment of ocean literacy: Validating instrument with Rasch measurement model*. American Educational Research Association (AERA) annual meeting, San Francisco, CA.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.
- EnviroNicsResearch. (May, 2019). *Public Opinion on Marine Protected Areas*. Retrieved from: <https://ml.globenewswire.com/Resource/Download/c815d81d-3f37-48af-860e-030fd1548ee4>
- Fauville, G., Strang, C., Cannady, M.A & Chen, Y. (2019) Development of the International Ocean Literacy Survey: measuring knowledge across the world., *Environmental Education Research*, 25:2, 238-263, DOI: 10.1080/13504622.2018.1440381
- Fraser, B. J. (1998). Science learning environments: Assessment, effects and determinants. In B. J. Fraser and K.G. Tobin (Eds.), *International handbook of science education* (pp. 527-564). Dordrecht, Netherlands: Kluwer.
- Fraser, B. J. (2014). Learning environments: Historical and contemporary perspectives. In N. Lederman & S. Abell (Eds.), *Handbook of research on science education, Volume II* (pp. 104-119). New York: Routledge.
- Galway Statement on Atlantic Ocean Cooperation. (2013). Retrieved from <https://atlanticresource.org/aora/sites/default/files/GalleryFiles/Default/GalwayStatement.pdf>

- Gelcich, S., Buckley, P., Pinnegar, J. K., Chilvers, J., Lorenzoni, I., Terry, G., et al. (2014). *Public awareness, concerns, and priorities about anthropogenic impacts on marine environments*. Proc. Natl. Acad. Sci. U.S.A. 111, 15042–15047. doi: 10.1073/pnas.1417344111
- International Union for Conservation of Nature (IUCN). (November, 2017). *The Ocean and Climate Change*. Retrieved from <https://www.iucn.org/resources/issues-briefs/ocean-and-climate-change>
- Lewin, K. (1951). *Field theory in social science: Selected theoretical papers* (D. Cartwright, Ed.). New York: Harper & Row.
- McKinley, E. & Burdon, D. (2020). *Understanding Ocean Literacy and Ocean Climate-related Behaviour Change in the U.K. – Work Package 1: Evidence Synthesis*. Technical report produced for Ocean Conservation Trust & Defra. Retrieved from: <https://oceanconservationtrust.org/ocean-literacy-evidence-review-understanding-ocean-literacy-and-ocean-climate-related-behavior-change-in-the-uk/>
- National Oceanic and Atmospheric Administration. (2013). *Ocean Literacy: The Essential Principles and Fundamental Concepts of Ocean Sciences for Learners of All Ages* (Version 2). First published June 2005, revised March 2013. Retrieved from: <https://www.coexploration.org/oceanliteracy/documents/OceanLitChart.pdf>
- Santoro, F., Santin, S., Scowcroft, G., Fauville, G., and Tuddenham, P. (2017). *Ocean Literacy for All - A Toolkit*. IOC/UNESCO & UNESCO Venice office Paris (IOC Manuals and Guides, 80 revised in 2018), 136.
- Selig, E. R., Hole, D. G., Allison, E. H., Arkema, K. K., McKinnon, M. C., Chu, J., et al. (2019). Mapping global human dependence on marine ecosystems. *Conservation Letters*, 12(2): e12617. doi: 10.1111/conl.12617
- SOPHIE Consortium. (2020). *Citizens and the Sea. Public perceptions of Oceans and Human Health: A 14-country pan-European citizen survey*. H2020 SOPHIE Project. Ostend, Belgium.
- Tobin, K., & Fraser, B. J. (1998). Qualitative and quantitative landscapes of learning environments. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education* (pp. 623–640). Dordrecht, The Netherlands: Kluwer.
- Uyarra, M. C., and Borja, Á. (2016). Ocean literacy: a ‘new’ socio-ecological concept for a sustainable use of the seas. *Mar. Pollut. Bull.* 104, 1–2. doi: 10.1016/j.marpolbul.2016.02.060
- United Nations Education, Scientific and Cultural Organization (UNESCO). (January, 2021). United Nations Decade of Ocean Science for Sustainable Development. Retrieved from <https://www.oceandecade.org/>
- World Wildlife Fund Canada (WWF). (October, 2016). *Public Opinion on Marine Protected Areas*. Retrieved from http://awsassets.wwf.ca/downloads/wwf_environics_report_mar26.pdf?_ga=2.68735316.451442461.1496678703-306732889.1491409766
- Zandvliet, D. B. & Fraser, B. J. (2018). (Eds.) (2018, Oct.). *Thirty Years of Learning Environments: Looking back and looking forward*. Rotterdam: Brill/Sense.