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Communicating environmental information to the stakeholders in coastal and marine policy-making: Case studies from Nova Scotia and the Gulf of Maine/Bay of Fundy region

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ABSTRACT

This study examined the awareness of, use by, and influence on stakeholders in coastal and marine policy-making in Eastern Canada and the United States of environmental publications produced by government agencies. Research was conducted in collaboration with government agencies and the publications evaluated were: (1) *The 2009 State of Nova Scotia's Coast Report*, released by the Government of Nova Scotia; and (2) *The State of the Gulf of Maine Report*, released by the Gulf of Maine Council on the Marine Environment. Studying the use and influence of such reports is essential to assure accountability for use of public funds and for environmental protection. Interviews and surveys, web analytics, media scans, and citation analysis were conducted shortly after public release of the reports. The views of multiple stakeholders were considered, including policy and decision makers, scientists, industry, and the public. While produced for different audiences and in different formats, the two reports are important sources of baseline information on regional coastal issues. The methods used to promote awareness of the reports targeted the "interested public", which included individuals and groups who usually respond to government requests for input, who may be better able to inform policy, and who are already active in coastal zone conservation. Raising awareness and use of information was challenged by the need to communicate environmental information to diverse audiences and to engage the general public (stakeholders and individuals outside of established networks). Results are presented within the context of communication and information pathways at the "science-policy interface".

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1. Introduction

Attention to the condition or health of coastal and marine environments has increased since the 1972 Stockholm Declaration on the Human Environment and the 1992 United Nations Conference on Environment and Development became platforms for modern environmental conservation and protection [1,2]. Scientific studies on marine and coastal ecosystems have highlighted the declining health of the world's coasts and oceans and the need for action to mitigate the existing and inherent effects of climate change, overfishing, marine pollution, and coastal development, to name a few [3–5]. Governmental and intergovernmental organizations have produced thousands of scientific publications on marine and coastal environments aimed at guiding public policy for sustainable development. The critical need for reliable scientific information to support marine environmental policy and decision making to solve environmental problems is recognized globally e.g., [6,7]. Yet there is an apparent disconnect at the science-policy interface between the information and knowledge produced by scientists and that used by policy-makers [8–10]. Aspects of the science-policy interface related to communication of scientific advice, among others, may influence the uptake of environmental information in policy making [8–10].

Problems at the science-policy interface have gained increasing global attention particularly in the area of environmental sustainability [6,11,12]. Forty years after the 1972 Stockholm Declaration [1], international commitment to study the science-policy interface has intensified [12,13]. Reconnecting science and policy ranks third of 21 priority issues highlighted by the United Nations for the 21st century [12]. At the recent 2012 United Nations Conference on Sustainable Development (Rio+20), states agreed that strengthening the science-policy interface and evidence-based decision making should facilitate global cooperation in pursuit of sustainable development [13]. Working with multiple stakeholder groups to address implementation gaps related to the science-policy interface is seen as a priority along

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with improved access to information; the need for timely, accurate, and transparent scientific information; the exchange of information and knowledge; and more effective use of information and communication technologies [13].

In spite of increased knowledge and international commitment, understanding and enhancing the role that scientific information (new and old) plays in coastal and marine environmental policy and decision-making is still not commonly considered to be an issue for urgent and targeted attention and the role is not clearly defined. Issues of information awareness, use, and influence are seldom visible as critical components necessary to understand information flow at the interface. It is common to read of recommendations to conduct new scientific studies to fill gaps in existing knowledge, or the need to update policy and management based on scientific information. However, it is uncommon to read of recommendations to conduct studies on how existing information is sufficiently utilized in policy making or how to optimize the science-policy interactions. Studies on awareness, use, and influence of existing coastal and marine scientific information are few e.g., [14,15]. Understanding information awareness and use in the processes of coastal and marine resource management is therefore worthy of detailed study rather than being considered to be implicit in management processes.

This paper presents results of two case studies conducted by the Environmental Information: Use and Influence research initiative [16] to determine awareness, use, and influence of coastal marine environmental information published by government and intergovernmental organizations: *The 2009 State of Nova Scotia's Coast Report* produced by the provincial Government of Nova Scotia, Canada, and *The State of the Gulf of Maine Report* produced by the Gulf of Maine Council on the Marine Environment (GOMC), a Canada–United States intergovernmental organization. The two publications are state of the environment reports and are classified as "grey literature" as they are not controlled by commercial publishers [17]. Communication of the two reports to diverse audiences was a primary goal to increase public education and participation in environmental management and coastal policy-making. The case studies provided a unique opportunity to collaborate with the respective government agencies to study the awareness, use, and early influence of their publications by the public shortly after their initial release [18,19].

1.1. Awareness, use, and influence of scientific information available as gray literature

The production of gray literature by government departments, international intergovernmental organizations, and non-governmental organizations for dissemination of information to inform policy and decision making is growing [20,21]. This gray literature may also be increasing in importance partly due to the ready availability of the reports and the accessibility of the language which can facilitate knowledge diffusion in policy settings [14,22]. Information published as gray literature continues to receive considerable global attention, for example, in relation to the Intergovernmental Panel on Climate Change (IPCC) in recent years [23,24] and annual scholarly studies (e.g., international Gray Literature conferences [17]). Yet, the use and influence of this large and growing body of publications in informing public policy is poorly understood. Previous studies on the use of scientific information have shown that diffusion, use, and influence of scientific information published as gray literature are complex and variable processes and are likely subject to a range of influences related to its production and release [25–27].

In this scenario of prolific information, effective communication of existing scientific information is the cornerstone of integrating science, policy, and decision-making and in increasing public participation in decision making [28–30]. The problem of how to utilize existing information better usually does not lie with the information itself, but instead with its communication by scientists to policy and decision-makers and other non-technical audiences [31]. Science and its policy implications need to be "framed" for communication in a way that addresses an intended audience's values, interests, and worldviews [29,30]. Best practices and guidelines to effective communication of technical research to increase the awareness and use of environmental information e.g., [32,33] stress the need for the production of less technical reports to increase their use by policy makers and the use of social networks to enhance information flow for environmental management.

Based on the findings of the Environmental Information: Use and Influence research initiative [16], the public can be categorized as an "interested" public with an active stakeholder role and the "general" public with a less active role to play in decision making. This categorization prompts the question: how can information be communicated to reach both "interested" and "general" public audiences?

1.2. Research on the role of coastal and marine environmental information in policy making

Previous research on awareness, use, and influence of technical information in coastal and marine environmental policy-making is limited, for example, citation studies which depend mostly on peer-reviewed literature e.g., [34–36], and surveys which reach only selected stakeholders e.g., [37,38]. Few governmental, intergovernmental, and non-governmental organizations involved in aspects of coastal and marine management have undertaken an analysis of the use and influence of their publications [39,40].

Given the importance of finding solutions to the environmental problems being studied and reported on, the Environmental Information: Use and Influence research initiative [16] seeks to fill the gap in knowledge on the awareness, use, and influence of environmental publications on policy and decision-making. Research is conducted within the context of environmental management where improved understanding of information diffusion and use can assist action to mitigate stresses on the marine environment. The research initiative focuses on the interface between production of scientific gray literature and its use in policy and decision making. In some cases, the endpoint (policy) drives the research conducted by governmental bodies and production of new information and vice versa, but this mutualism is unclear and un-described in most cases. Given the involvement of diverse audiences in the information flow and policy and decision-making processes, a suite of methodologies is applied in research to measure use and influence of marine information, and to identify barriers as well as enablers to its communication.

The case studies of *The 2009 State of Nova Scotia's Coast Report* [18] and *The State of the Gulf of Maine Report* [19] were initiated by the publishing organizations (respectively, the Nova Scotia Department of Fisheries and Aquaculture, responsible for the first report, and the Fisheries and Oceans Canada, as a member of the GOMC, instrumental in the production of the second). The geographic region of concern for the Nova Scotia Department of Fisheries and Aquaculture, a provincial governmental department, overlaps with the Gulf of Maine Council on the Marine Environment, an intergovernmental organization (Canada–United States). Even though the science-policy interface is a matter of considerable national interest (e.g., 2011 Science Policy Conference [41]), the role(s) of scientific information at this interface is significantly understudied. The two governmental organizations actively sought to address this situation and to determine the

level of awareness and use of their coastal and marine scientific information by multiple stakeholders and managers, policy makers, and the public. The organizations were also interested in knowing the degree to which their publications increased public awareness in coastal issues and participation in public policy making. Both the organizations' motivation to gain an understanding about their publications' influence, and work of the Environmental Information: Use and Influence research initiative, are unique in the marine environmental management field. The results of the two case studies are presented within the context of the similar and yet complementary management responsibilities of the case study organizations, including interaction with the public within Nova Scotia, Canada, and the Gulf of Maine/Bay of Fundy region, shared by Canada and the United States.

2. Case studies and methods

2.1. Case study 1—The 2009 State of Nova Scotia's Coast Report

The 2009 State of Nova Scotia's Coast Report (herein the *Report*) was launched in December 2009 in Halifax, Nova Scotia [42]. It was produced by the Government of Nova Scotia, Canada, through its Provincial Oceans Network comprised of senior representatives of 15 provincial departments. The goal of the *Report* was to provide an overview of the condition of the province's coast and information on six priority coastal issues (working waterfronts, sea level rise, coastal habitats, coastal development, water quality, and coastal ecosystems). The provincial government was particularly interested in promoting awareness of coastal issues in the general public, and encouraging and increasing public participation in development of a new coastal policy, the *Sustainable Coastal Development Strategy* (now known as the *Coastal Strategy* [43]), which was subsequently released in October 2011 [44].

The *Report* was produced in three formats: a 245-page technical report, a 21-page summary, and six 4-page fact sheets. It was available in print and in digital format on the government's "*Our Coast*" web page. The government distributed copies of versions of the *Report* to provincial libraries and a small group of interested individuals, or sent a notification email message containing the Web site address for the *Report* to diverse groups including governmental and non-governmental organizations, academic institutions, specific coastal stakeholder groups, and First Nations communities.

The case study was conducted from March to December 2010 in collaboration with the provincial government [18]. It examined the awareness, use, and influence of the three versions of the *Report* by the public from the date of its release. The primary research question was: how can information produced by a government be disseminated and used effectively in marine and coastal decision making?

2.1.1. Methods

The study used a suite of qualitative and quantitative methods and was conducted alongside government-led techniques to promote awareness of the *Report* [45]. Questionnaires were completed by participants at eight public open houses ($N=350$) hosted by the government in various locations in Nova Scotia in May 2010, and a questionnaire was administered at a multi-stakeholder meeting ($N=28$) of selected invitees representing key stakeholder groups in June 2010. A government-sponsored telephone survey ($N=600$) was conducted to assess province-wide public understanding of perceptions of coastal issues by Nova Scotians. The Provincial Ocean Network created questionnaires to obtain the views on the priority issues in the *Report* of each member of the public attending the open houses, each invited multi-stakeholder at the multi-stakeholder meeting, and the wider Nova Scotia community through the telephone survey. Three questions were prepared by the researchers and incorporated into the Provincial Ocean Network's questionnaires: how did you become aware of the *Report*; how did you use it; and are you aware of others using the *Report*? Direct observations were made at four of the eight open houses and at the multi-stakeholder meeting.

Thirteen participants of the multi-stakeholder meeting (selected by systematic random sampling) were invited to be interviewed by one of the researchers in July 2010. The interview consisted of 10 semi-structured questions designed to measure actual and potential use of the *Report* in its three versions, awareness of usage by others, and indicators of its influence. Interviews, conducted by telephone or face-to-face, lasted approximately 20 min, and were audio recorded and transcribed.

Unique numeric codes, based on each participant's stakeholder group (government, non-governmental organizations, industry, academic organizations, and First Nations communities), were assigned to all questionnaire responses, audio recordings, and transcripts for use in data analyses. Descriptive statistics were generated from the interview data and the content of the interview responses was coded in an inductive approach using NVivo qualitative data analysis software where applicable [46]. Additional methods to detect evidence of use of the *Report* were applied, namely, citation analysis, analysis of links to the government's Web site and holdings of library collections, analysis of Web site tracking statistics, and a review of local print media coverage after the launch of the *Report*.

2.2. Case study 2—The State of the Gulf of Maine Report

The Gulf of Maine Council on the Marine Environment (GOMC), as a bi-national intergovernmental organization (Canada–United States), functions as a regional forum for initiating joint projects, exchanging information, and conducting long-term planning for environmental-based management in the Gulf of Maine/Bay of Fundy region. The GOMC consists of a Council, the Council's Working Group and Secretariat, and several committees, sub-committees, and programs to carry out the Council's work [47]. The Councilors are senior officials in state, provincial, and federal agencies; non-government organizations; and the private sector [48]. The Council's Working Group includes one representative for each of the three states (Maine, Massachusetts, and New Hampshire), and two provinces (Nova Scotia and New Brunswick), as well as American and Canadian federal government Council members, and American and Canadian co-chairs from each of the Council's committees. The Working Group conducts strategic planning, prepares policy options, develops annual work programs and budgets for Council activities under a 5-year Action Plan, and manages approved projects [47]. The geographic focus of GOMC's publications (deemed gray literature) is regional, yet its audiences and publication formats are diverse [49].

The *Gulf of Maine Times*, published online, three times per year, is the GOMC's newspaper and a main communication tool to promote awareness of its work. Over 2,400 persons, covering a wide cross section of the Gulf of Maine's stakeholders spread throughout the Maritime provinces of eastern Canada and the New England states, receive notices about issues of the *Times* [19] (J. Cradock, personal communication).

In June 2010, the GOMC released the first parts of *The State of the Gulf of Maine Report* to inform decision makers on the main issues affecting the Gulf of Maine/Bay of Fundy region [50]. *The State of the Gulf of Maine Report* is produced in a modular format composed of a context paper and issue-oriented theme papers (to date, climate

change and its effects on humans; climate change and its effects on ecosystems, habitats, and biota; coastal ecosystems and habitats; marine invasive species; and emerging issues). The theme papers are published in digital format only and are accessible from the GOMC Web site. An additional theme paper became available in 2011 and other theme papers are being developed in 2012. The GOMC intends to regularly update all of the issued theme papers at appropriate intervals.

2.2.1. Methods

The case study was conducted between January and May 2011 [19] with the main objective to determine awareness and use of *The State of the Gulf of Maine Report* by:

- Identifying the efforts of (a) the Council and (b) the Working Group members to use the context paper and the first five theme papers, and to promote awareness of them.
- Surveying readers of the *Gulf of Maine Times*, to determine public awareness and use of the context paper and the first five theme papers and to determine who is reading them.

Three stand-alone online surveys were developed and administered in Opinio software [51]: one for the members of the Council ($N=21$), another for the Working Group members ($N=27$), and a third for the readers of the *Gulf of Maine Times* ($N=2400$). A message of invitation to complete each survey, which included a link to the online surveys, was emailed to each designated group through GOMC listservs. Readers of the *Gulf of Maine Times* were considered to be a proxy for the interested and general public. The study population for the online survey of the readership of the *Times* included individuals associated with government, non-government, and academic institutions, as well as the general public.

The responses to the three surveys were exported from Opinio into Microsoft Excel and Stata 12.1 [52] for statistical analysis. Unique numeric codes, based on each participant's group (Council member, Working Group member, and reader of the *Gulf of Maine Times*), were used in documenting responses and in data analyses.

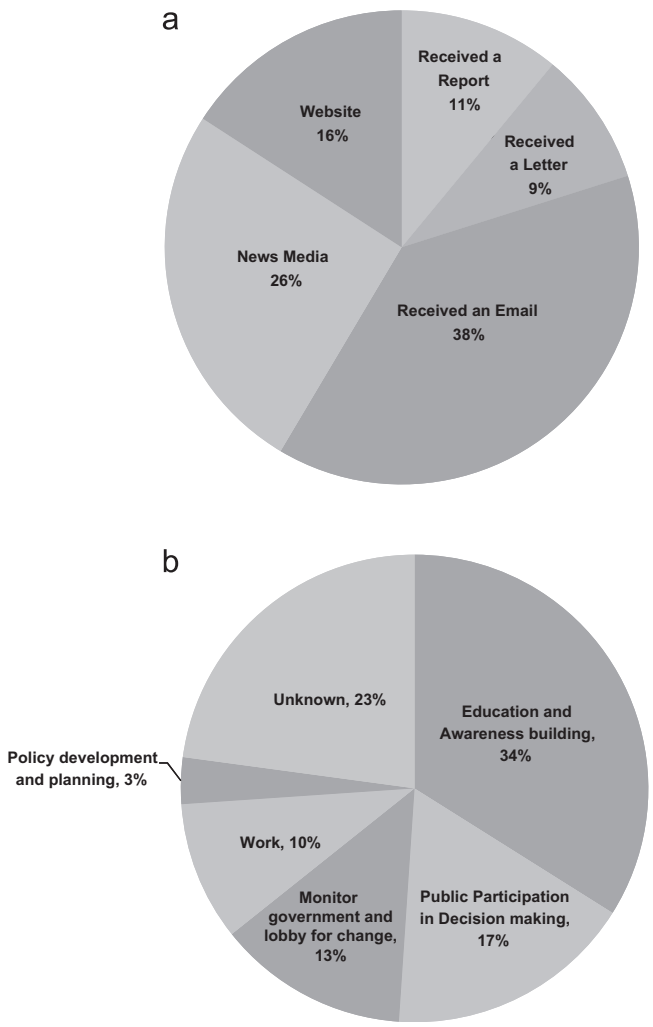

Fig. 1. Overall awareness and use of *The 2009 State of Nova Scotia's Coast Report* ($N=280$): (a) awareness and (b) use.

3. Results

3.1. Case study 1—The 2009 State of Nova Scotia's Coast Report

Approximately 350 people attended the open houses in June 2010 and 73% responded to the questionnaire ($N=256$) [45]. Twenty-eight stakeholders attended the multi-stakeholder meeting and 86% ($N=24$) responded to the questionnaire. Of the 24 respondents at the multi-stakeholder meeting, 46% ($N=13$) agreed to be interviewed to provide further information on use and influence of the *Report*. Together the responses to the questionnaires and interviews measured initial awareness and use by six stakeholder groups: the general public, government, non-governmental organizations, industry, academic organizations, and First Nations communities.

3.1.1. Awareness

Overall, awareness of the *Report* resulted mainly from electronic means of promotion (email and Web-based). Of the combined responses from the open houses and the multi-stakeholder meeting ($N=280$), 38% received a notification email, 26% became aware of the *Report* through the news media, and 16% became aware of the *Report* from the Web site (Fig. 1a). While respondents became aware of the *Report* through a combination of these methods, 45% of respondents at the open houses ($N=256$) were introduced to the *Report* by an email message sent either through the government notification emails or through NGO email networks. Fifty percent of the multi-stakeholder workshop attendees ($N=24$) and interviewees ($N=13$) stated that they had received copies of the *Report* or a notification letter, and were previously aware of the *Report* as they were involved in its production in one or more ways including: peer-review of the *Report*, contribution of sources of information, attendance at relevant meetings with the Provincial Ocean's Secretariat, or attendance at the official release of the *Report*.

Awareness of the *Report* by the general public was low. Although 73 organizations with Web sites were notified of the release of the *Report*, only 24 web-links to the government's "*Our Coast*" Web page containing the *Report* were found. Of these, 33% belonged to non-governmental organizations, 30% belonged to university libraries, and 12.5% were industry Web sites. Of the 600 persons interviewed in the telephone survey, only 6.8% (41 respondents) were aware of the *Report*. The response from the telephone survey was insufficient to provide a statistically significant sample to determine awareness, use, and influence of the *Report*.

3.1.2. Use

Preferences for the different versions of the *Report* varied among the stakeholder groups. While 53% ($N=256$) of stakeholders at the open houses preferred the summary, each respondent from the

multi-stakeholder group ($N=24$) commented on the usefulness of each of the three versions of the *Report*.

Overall, respondents from the open houses and the multi-stakeholder meeting ($N=280$) stated that they will use the *Report* for education and awareness building (34%), support for public participation (17%), and monitoring the government and advocacy (13%) (Fig. 1b). Three percent of attendees stated that they will use it for policy development and decision making and these responses came from the stakeholders who had prior knowledge of coastal issues due to their employment. Evidence of direct use of the *Report* was limited and included use in university curriculum development and as supporting documentation for proposals seeking university research grants. In general, the *Report* is being used indirectly to build awareness of coastal issues among all stakeholders. Survey respondents commended the general nature in which the *Report* was written and formatted, which enabled almost all stakeholder groups to identify with the issues identified in the *Report*.

Two peaks occurred in the web usage of the *Report*. The average number of online hits per month increased by approximately three times at the time of the launch (December 2009–January 2010) and during the public consultations (May–June 2010), whereas usage was steady but lower in the interim periods with monthly averages of 660 page views and 561 downloads.

3.1.3. Influence

Evidence of indirect benefits was recorded, such as increased collaboration and networking within and among the governmental and other types of organizations. Approximately 88% ($N=24$) of individuals who completed the survey at the multi-stakeholder meeting took steps, primarily through electronic methods, to promote the *Report* within their internal professional and institutional networks. The effect of the *Report* on the development of coastal policy is seen mostly in increased awareness and knowledge about the state of the province's coasts by multiple stakeholders (Fig. 1b). Interviewees believed that enhanced awareness will increase public participation in the development of public policy in the future: "it is [the open houses and meetings] bringing it [the *Report*] to life, provoking discussion, engaging people with that information so that they can be involved in making decisions around the next piece of the development of the strategy" (NGO Stakeholder 2, Multi-stakeholder Interview).

3.2. Case study 2—The State of the Gulf of Maine Report

In the surveys, responses were received from 52% ($N=11$) of the current 21 Council members; 48% ($N=13$) of the 27 Working Group members; and 3% ($N=72$) of the 2400 readers of the *Gulf of Maine Times*, all of whom received an invitation to complete the survey.

Of the 72 responses to the survey of the *Times* readers, 51 were complete, i.e., respondents exited the survey after answering the last question. Respondents did not complete all of the questions as they progressed through the survey. Of the 38 who completed the demographic questions, most reside in the United States (77%), 18% reside in Canada, and 5% did not indicate their nationality (Table 1). The age of the survey population was skewed as 50% of the sample population was between 51 years and above and the median age range was 51–60 years; 16% were within the 41–50 age group and 23% were between 21 and 40 years old. Fifty-five percent of the respondents were male and 97% indicated that they had a university degree (Table 1). Among the readers of the *Times*, government representatives were the largest group of respondents in the survey (37%). Respondents also included consultants, teachers, and individuals working outside of GOMC but within the organizations/jurisdictions to which the GOMC representatives belong (Table 1).

Table 1
Descriptive statistics for the demographic variables for the *Gulf of Maine Times* readers: nationality, age, gender, education, and stakeholder group.

Demographic variables	Value
Nationality ($N=38$)[a]	
USA	77%
Canada	18%
Unknown	5%
Age ($N=38$)[a]	
Median age range	51–60
Std. Dev.	11.95
Kurtosis	1.965
Gender ($N=38$)[a]	
Male	55%
Female	45%
Education ($N=38$)[a]	
Persons with a university degree	97%
Stakeholder group ($N=38$)[a]	
Government agency	37%
Academic institution	18%
Industry	8%
Non-governmental agency	5%

[a] Number of responses to the questions on nationality, age, gender, education, and stakeholder group. Total number of complete responses was 51.

3.2.1. Awareness

All Council members ($N=11$) and Working Group members ($N=13$) who responded were aware of *The State of the Gulf of Maine Report* since the Council initiated and funded the project. They found the availability of digital forms of the *Report* on the Web site to be a suitable form of access. Sixty-four of the 72 readers of the *Gulf of Maine Times* responded to questions on awareness and 78% ($N=64$) were aware of the *Report* and had visited the GOMC Web site within the previous three months of the survey (June 2011). Twenty-two percent of readers of the *Times* were not aware of the release of the *Report* in June 2011 and had not visited the GOMC Web site within the previous year.

All of the Working Group members, 40% of Council Members, and 22% of the readers of the *Gulf of Maine Times* used mainly electronic networks (e.g., email, the *Gulf of Maine Times*, Web links to the GOMC Web site, and Facebook) to promote awareness of the theme papers. The theme papers were identified as the best source of available information specific for the region; as one reader stated "the papers bring together useful information that is normally scattered in various places, and the concise format is good, rather than reading a huge report…the papers present the latest thinking of the experts and get that thinking out to a broad audience" (Gulf of Maine Times Reader 3).

3.2.2. Use

All three survey groups favoured the availability of *The State of the Gulf of Maine Report* as a series of issue-based theme papers. Overall, respondents believed this format was useful for decision making since it facilitated dissemination, distribution, and updating of information about the Gulf of Maine/Bay of Fundy. On average, 37% of Working Group members and 34% of readers of the *Gulf of Maine Times* stated that the theme papers should be updated every 2–5 years.

The State of the Gulf of Maine Report was read overall by 70% of the Council members ($N=11$) and 83% Working Group members

($N=13$), and in general each member had read more than one of the theme papers (Fig. 2). Of the 72 readers of the *Gulf of Maine Times*, 44 answered the questions on use, of whom 80% ($N=44$) stated that they had read the *Report*. Use of the *Report* was varied in spite of the high readership of the theme papers by the three groups (Fig. 3). On average, respondents were twice as likely to read the *Report* for general information as to use it for a specific purpose; 48% of Working Group members and of Council members stated they read the theme papers while 24% of each of these two groups stated they used the information. Use was lowest for the readers of the *Gulf of Maine Times* as 39% stated they read the *Report* while 20% stated they used it for a specific purpose. The *Times* readers noted that others were using the *Report* for personal education and communication about the environmental issues in the region, and for developing similar publications and Web content.

All respondents noted the importance of the theme papers as a source of baseline information for public education to aid in increasing public awareness of the key threats to the region, and as a starting point for managers to inform the formulation of policy and for guiding work and discussion on the environmental management of the Gulf of Maine/Bay of Fundy region.

An analysis of responses by Council, Working Group, and readers of the *Gulf of Maine Times* to questions about awareness ($N=64$) and use ($N=63$) showed the preferences of the respondents about which of the theme papers had been read and used (Figs. 2 and 3). At this time, the evidence is insufficient to conclude that there is a significant difference in the overall readership and use of the six theme papers among all three survey groups. Differences are suggested but not confirmed as significant, likely due to the sample sizes in the surveys, particularly the low response rate of the readers of the *Gulf of Maine Times*.

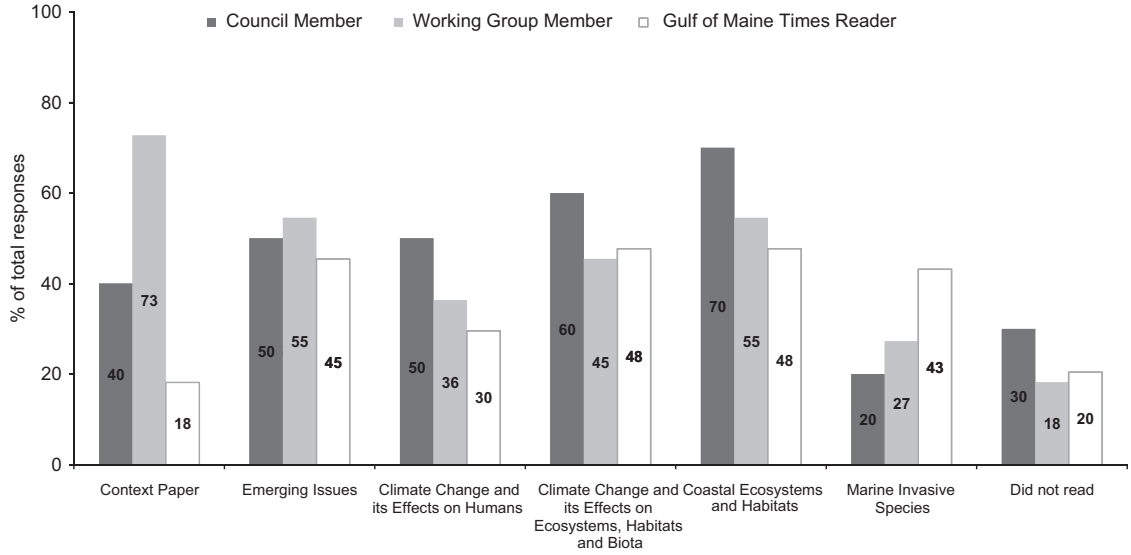

Fig. 2. Papers read by the three surveyed groups in the case study of *The State of the Gulf of Maine Report* (% of completed responses: Council members, $N=10$; Working Group members, $N=11$; readers of the *Times*, $N=44$; total $N=65$).

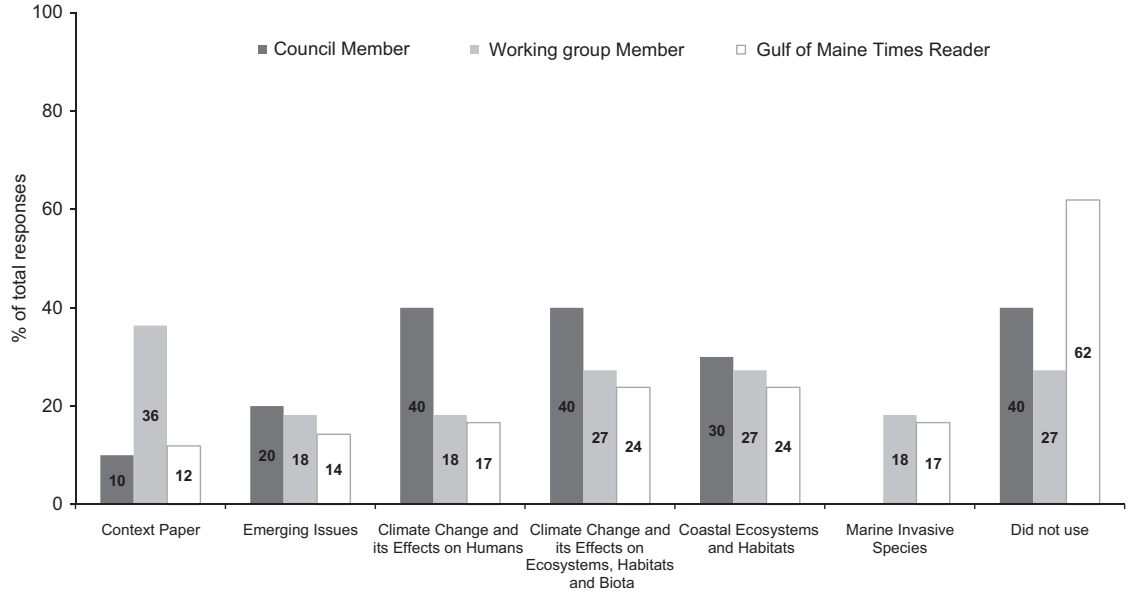

Fig. 3. Papers used by the three surveyed groups in the case study of The *State of the Gulf of Maine Report* (% of completed responses: Council members, $N=10$; Working Group members, $N=11$; readers of the *Times*, $N=42$; total $N=63$).

3.2.3. Influence

Overall, respondents believed it was "too soon to gauge" influence of *The State of the Gulf of Maine Report* due to the recent timing of its release (June 2010). However, it was believed that the information contained in the theme papers will be used more frequently in making decisions/providing information in the future as "the material can help [to] influence policy decisions as it provides them [decision-makers] with the best scientific information available" (Working Group Member 1). Respondents believed that the *Report* facilitated communication and understanding across institutional and geographical jurisdictions since it "represents a bi-national and multi-state/provincial position on the Gulf of Maine" (Working Group Member 7). The theme papers also presented a means to acquire new information from multiple jurisdictions. For the GOMC itself, *The State of the Gulf of Maine Report* theme papers informed the Working Group developing the next GOMC action plan (2012–2017) (P. Wells, personal observation).

4. Discussion

4.1. Methods of measuring awareness, use, and influence of environmental information

The methods used in the case studies involved qualitative and quantitative approaches producing complementary results; no single method was sufficient to measure awareness, use, and influence of the two state of the environment reports (Table 2). The survey responses and data from direct observations of the public consultations are informative indicators of initial (early) awareness of *The 2009 State of Nova Scotia's Coast Report* and *The State of the Gulf of Maine Report*. While citations are an indicator of awareness and use, interviews of key stakeholders at different levels of decision-making were more valuable by providing additional information and insights. Definitions of personal use and influence of the two reports on respondents were not pre-determined in the two case studies; rather the qualitative methods provided evidence of use and influence [27]. Direct observation at the open houses, web-tracking, and interviews gave a snapshot of the information-exchange networks. For continued tracking of usage of the reports, the combination of citation analysis, web-link searching, interviews, and questionnaires is needed. Other methods such as content analysis (e.g., of traditional media reports and social media) and network analysis could be included in future analyses.

Table 2
Methods used in the case studies of *The 2009 State of Nova Scotia's Coast Report* and *the State of the Gulf of Maine Report* and examples of the main output.

Method	What was measured
Bibliometrics	Number of citations to the state of environment reports.
Citation analysis	Who cites and the location and role of citing authors.
Webometrics (web-tracking)	
Web statistics	Frequency of web use of the reports.
Web link searches	Awareness of publications by diverse audiences.
Web content analysis	Evidence of networking within and outside the government bodies that produced the reports.
Surveys	
Questionnaires (open houses, online, telephone)	Nature of collaboration in the production of the reports. Information management actions of stakeholders.
Semi-structured interviews	Information pathways and usage. Use of the reports in policy contexts.
Media analysis	
Print and digital news	Awareness by the general public and stakeholder groups.
Direct observation	Awareness by the general public and stakeholder groups and the nature of their participation. Information seeking behavior of the public and stakeholder groups. Information pathways and usage.

The relatively small population sizes of the main stakeholder groups, for example, the numbers of Working Group and Council Members in the case study of the *State of the Gulf of Maine Report,* placed limitations on the range of appropriate statistical analyses; mostly descriptive statistics were utilized in this study. Given the recent release of *The 2009 State of Nova Scotia's Coast Report* and the 2010 *State of the Gulf of Maine Report*, data sources other than the methods used in both case studies were not available.

4.2. Communication of information

4.2.1. The 2009 State of Nova Scotia's Coast Report

The case study of *The 2009 State of Nova Scotia's Coast Report* showed that several communication methods and multiple mechanisms of report distribution are needed to reach diverse audiences. No single method is sufficient unless the information contained in a report is intended for a specific audience. *The 2009 State of Nova Scotia's Coast Report* was designed in the three versions intended to be read by a wide range of individuals to inform them about coastal issues and to encourage their participation in the development of coastal policy (the *Coastal Strategy*) in the province. Both direct communication (e.g., notification letters), and indirect (e.g., information transferred through government and NGO networks) were needed. Both print and digital means of distribution were shown to be necessary, as well as release of the *Report* in less technical versions (summary and fact sheets).

The role of "email-facilitated" social networks was important for increasing community awareness of the *Report*. Email networks of the non-governmental organizations as well as the government were instrumental in increasing awareness among their established networked groups. Non-governmental organizations that received copies of *The 2009 State of Nova Scotia's Coast Report* or notification letters forwarded this information to their membership. These notices alerted individuals associated with non-governmental organizations to attend the open houses. Few Web links to the *Our Coast* Web site were found, in spite of the large number of organizations that were notified of the *Report*. Most organizations may not have recognized the benefit of creating a link to the *Our Coast* Web site on their own Web sites.

In spite of being diverse, the methods used by the Nova Scotian government to promote awareness of and access to *The 2009 State of Nova Scotia's Coast Report*, in order to encourage public participation in coastal policy making, were more effective in reaching some individuals than others. For the most part, information about the *Report* reached the "interested public" rather than the "general public". Attendees at the public consultations and survey respondents were more apt to be part of the interested members of the public and as a consequence may be better able to inform policy development. Individuals who were previously aware of the *Report*, or who were part of existing social networks with links to coastal issues, or who were already active in coastal zone conservation and protection are included in this category. In contrast, the wider general public may include individuals who follow coastal issues but are not involved in a group, such as one of the non-governmental groups in this study, which would have

fostered awareness of the *Report*. Since many who participated in the open houses and multi-stakeholder meeting were the "interested public", it follows that the groups or individuals who were more likely to use the *Report* were those who had such awareness and a strong interest in coastal issues. Literature on policy networks and communities [53,54] describes a comparable but more established pressure group, the "attentive public", which can influence policy processes through the generation of ideas, publications, and occasional lobbying but does not participate in central decision-making processes. In the Nova Scotia case study, the "interested public" may very well be an emerging "attentive public". However, the full extent of the public's influence on Nova Scotia coastal policy decision-making awaits further research.

4.2.2. The State of the Gulf of Maine Report

Not surprisingly, awareness of *The State of the Gulf of Maine Report* was high among both Council members and Working Group members. As a proxy for the public, readers of the *Gulf of Maine Times* showed that, to date, neither the interested nor the general public have used the theme papers to any great extent. Government representatives, including individuals working outside of GOMC but within the organizations/jurisdictions to which the GOMC members belong, were the majority of the respondents and can be labeled the "interested public". The low number of responses from members of industrial communities in the region was unexpected, since industry (from aquaculture to the petroleum sector) is engaged in activities that affect the environment of the Gulf of Maine/Bay of Fundy region. As with *The 2009 State of Nova Scotia's Coast Report*, the methods used to distribute and increase awareness of *The State of the Gulf of Maine Report*, i.e., by placing digital versions of the theme papers on the GOMC Web site and a notice in the *Gulf of Maine Times*, were more effective in reaching the "interested public" than the general public.

The production of *The State of the Gulf of Maine Report* as individual theme papers, rather than a single large state of the environment document, provided respondents with choices. As a result, *The State of the Gulf of Maine Report* reached wide audiences since persons could simply access and read the theme paper of their interest. While survey respondents were supportive of the theme paper format of *The State of the Gulf of Maine Report*, its availability only in digital format on GOMC's Web site was considered to be a limiting factor in its distribution and awareness. Respondents recommended the production of print copies in addition to the digital version: "emails and downloads do not have the same impact although they are convenient. I read the *Gulf of Maine Times* much more closely when it was mailed to me" (*Gulf of Maine Times* Reader 16).

Working Group members believed in hindsight that additional summarized information related to *The State of the Gulf of Maine Report* was needed. Fact-sheets or "at a glance" summaries placed on the GOMC Web site were suggested as ways to promote awareness of this report and the issues and as an alternative to the pdf files of the theme papers which are relatively large and exceed the capacity for downloading on many current mobile devices. Adding digital links among the various theme papers was also suggested as an aid to facilitate a comprehensive understanding of the state of the Gulf of Maine, Bay of Fundy, and related watersheds. Recently, the Council has created such links now that seven of the 14 theme papers have been completed (P. Wells, personal observation).

Overall, respondents recommended the need to focus greater efforts on distribution of *The State of the Gulf of Maine Report* to increase awareness and education of wider and more diverse audiences. Respondents recommended increased use of the news media (print, radio, and television) and various forms of social media. They also suggested that organizations and policy- and decision-makers already focused on the Gulf of Maine/Bay of Fundy region must be included in these efforts.

4.3. The use and influence of information in coastal and marine policy and decision making

Current digital technologies, including email social networks, played a key role in promoting awareness of both reports among the established groups which historically respond to government surveys and interviews, namely, the "interested public". In spite of increasing application of information technologies as methods of distribution, challenges remain to ensure the most effective use of information in policy and decision making. The results of the two case studies are consistent with other inquiries that identified limited communication of scientific information to wide audiences (multiple stakeholders) as one of the main issues restricting increased public participation in decision making e.g., [25,37]. These stakeholders include policy and decision makers, resource users, as well as the general public who need to take scientific and technical information into account in making informed decisions.

Evidence of use and influence of *The 2009 State of Nova Scotia's Coast Report*, as determined by statistics of library holdings and citation analysis in August 2010 and January 2011, was low and is likely due to its recent release, its publication as gray literature, and its limited distribution both inside and outside of Nova Scotia. Citations to the *Report* will likely increase over time as copies already in libraries and online databases become more widely known. Since both *The 2009 State of Nova Scotia's Coast Report* and *The State of the Gulf of Maine Report* are gray literature, hence not commercially advertised and distributed, coverage by traditional citation databases such as *Web of Science* will be limited. Participants in both case studies confirmed that information about the coasts is very important for their own understanding of coastal matters, and for informing their work in policy making. It is, therefore, anticipated that awareness, use, and influence of the two reports will increase as time progresses. While citation analysis and library holdings showed little indication of scholarly use, the results from the qualitative methodologies revealed uses and benefits, including increased inter/intra agency cooperation, and the production of related information by non-governmental organizations which referred to one or other of the reports [55].

The producers of *The 2009 State of Nova Scotia's Coast Report* (technical report, summary document, and fact sheets) and *The State of the Gulf of Maine Report* (context and five theme papers) took the initiative to publish less technical versions and/or formats in order to reach diverse audiences and to facilitate understanding. The information contained in these reports covers broad topics, is multidisciplinary by nature, and is relevant to the many stakeholders who live and work in the respective coastal zones [45,56]. Respondents in the case studies stated the information in the reports was well presented, easy to read and to understand, and contained an appropriate level of detail. Overall, no comments on the reliability or the legitimacy of the information were made. Thus, understanding the information in the reports may encourage stakeholders to act upon it. Previous studies indicate that use and influence of the information contained in environmental reports depends as much on awareness of the reports as on the ability of audiences to understand the information contained in them e.g., [14]. Studies in science communication support the "framing" of communication in a manner that connects with diverse audiences [30].

The problem of how to better utilize existing information usually lies with its communication across the science-policy interface [14]. This communication may be subject to the cultural,

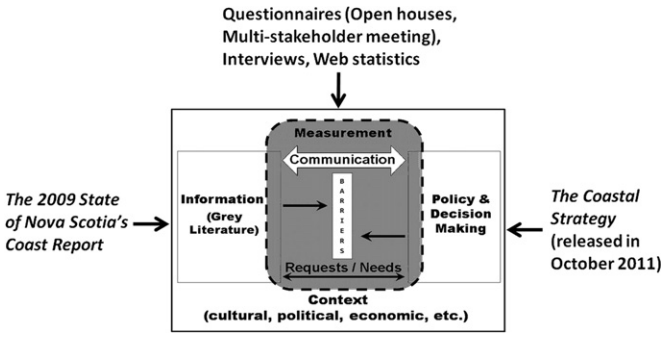

Fig. 4. Guiding framework of the Environmental Information: Use and Influence (EIUI) research initiative showing the communication flow between the production of *The 2009 State of Nova Scotia's Coast Report* and intended policy output.

political, and economic contexts, among others, in which the information was produced and released. Technical information may be created to guide policy making or it may be produced as a result of existing policy or decisions. The role of environmental information in public policy development was more explicit in the case study of *The 2009 State of Nova Scotia's Coast Report*. Since the release of the *Report*, efforts focused on raising public awareness of the *Report* so as to increase public participation in the review and completion of the draft *Coastal Strategy*, released in October 2011. This intended policy endpoint, the *Coastal Strategy*, was also the driving factor in the production of *The* 2009 *State of Nova Scotia's Coast Report* (J. Huston, personal communication). A two-way communication, across the science-policy interface, i.e., between production of information and policy and decision making, was clearly demonstrated in this case study (Fig. 4). Responses to the draft of the *Coastal Strategy* released in mid-October 2011 for public feedback and consultation [44] provides additional data to measure the influence of *The* 2009 *State of Nova Scotia's Coast Report*.

5. Conclusions and recommendations

By tracking the awareness of the reports, i.e., by determining how respondents were informing themselves after reading the material and the extent to which respondents were using the information to become involved in addressing coastal issues, the case studies sought to determine if the release of *The* 2009 *State of Nova Scotia's Coast Report* and *The State of the Gulf of Maine Report* had an influence on policy making. The research methods aimed at determining the role of the technical reports in policy and decision-making and in so doing identified opportunities and barriers to communication of the reports.

Both case studies were initiated by the groups responsible for producing the reports, which may signal a growing recognition that the critical role of information in the science-policy interface warrants greater attention by policy-makers. The results of the case studies provide evidence to support the hypothesis of the importance of marine environmental gray literature, in the form of government reports, in public policy settings. *The* 2009 *State of Nova Scotia's Coast Report* and *The State of the Gulf of Maine Report* are examples of state of the environment reports used to inform the public and to encourage participation in policy making. The findings from these two North American settings are consistent with other scholarly research that identified limited communication of scientific information to wide audiences as one of the main issues decreasing public participation in decision making (e.g., [29,30]).

Results of the two case studies contributed to increased understanding of the publication practices and use of scientific information produced by governmental and intergovernmental bodies. The two governmental reports are fulfilling their intended purpose as a first step in guiding decision making and increasing public participation in decision-making. However, several communication methods were needed to reach diverse audiences, including direct communication (e.g., notification letters, and print and digital means), and indirect (e.g., information about the reports transferred through government and NGO networks). Several versions, including less technical forms of the reports, were shown to be needed. These insights can be used by the two case study organizations to maximize the value of their publications to diverse audiences by exercising efficient transfer of information so that the public finds the "right" information and is encouraged to participate in policy making processes. Furthermore, the findings of the two case studies are informative and relevant since funding for environmental research is often limited and accountability of public expenditures is increasingly expected.

At the recent 2012 United Nations Conference on Sustainable Development (Rio+20) and its precursor meetings, the value of public involvement in policy making was recognized [6,7,11,12]. Furthermore, attention was drawn to the fundamental need to include numerous stakeholder groups in decision making efforts to strengthen the science-policy interface. In support of this continued global commitment for public involvement in policy making, recommendations for organizations to improve communication of scientific information, increase awareness and use of scientific reports, and overall to increase understanding of the science-policy interface arising from the two case studies include:

(1) Focus on engaging the "interested public" in order to build momentum for wider public awareness and education. The "interested public" represents a range of key stakeholder organizations and individuals who usually are already identified as important in the development of coastal policy. Apart from being involved in the production of environmental information, these individuals are often members of existing social networks with links to coastal issues, or who are already active in coastal zone conservation and protection. Efforts to increase awareness, use, and influence of information should emphasize maintaining relationships through existing partnerships, focusing on communication with the range of stakeholders, particularly within coastal industries and communities, and creating new means of continuous "interested public" participation in policy formulation.
(2) Implement ongoing communication initiatives aimed at the general public, including the development of long-term working relationships between government bodies and the public to continue to increase sensitization about coastal and marine issues. These working relationships should include mechanisms for public feedback on the usefulness of the methods used by government to disseminate information. Evaluation of such feedback by governmental bodies can identify additional stakeholder groups which can be encouraged to participate in the development of coastal and marine policy. Members of the general public who are not reached during traditional forms of public consultations, including individuals outside of established networks, may become engaged by alternate forms of communication, which can result in broadening the extent of the "interested public".
(3) Employ all forms of communication media (e.g., news in print, audio, and digital formats; and widely adopted social media tools) to promote awareness and use by all audiences for

reports such as those identified in the case studies. Implementing techniques to engage diverse audiences outside of traditional methods of communication will give rise to increased public awareness of coastal and marine issues and greater participation in policy-making. Globally, social media has become a major element of everyday life and business and are particularly important for delivering information and achieving public involvement. Social media are likely to engage younger audiences. Many governments are wary about using social media; however, widespread deployment of Facebook, Twitter, and other social media tools has increasingly prompted governments to develop guidelines for the use of social media among their communication strategies (e.g., [57–59]).

(4) Conduct detailed studies on the awareness, use, and influence of information in the processes of coastal and marine resource management to further understanding of the problems with communication at the science-policy interface. Due to the complexity of the science-policy interface, a suite of methodologies is needed to achieve comprehensive understanding of the awareness, use, and influence of information in public policy settings. An approach employing several information research methodologies, including citation analysis, web tracking, online surveys, and interviews, may lead to an appreciable increase in understanding of the use and influence of environmental gray literature. Additional methods, including content analysis (e.g., of traditional media reports and social media) and network analysis, can provide details on use and influence of technical reports. Furthermore, new and innovative methods may also emerge from this research field.

The findings of the two case studies are relevant to the fields of information management, coastal zone management, and public policy; they can also inform scientists in research settings or in public policy arenas, public sector managers, governmental and non-governmental bodies, and research funders. Moreover, these case study findings can be applied to other fields of study outside of the marine context (e.g., forest management and public health) where challenges to communicate information at the science-policy interface also exist (e.g., [60,61]). The increasing global attention on understanding the science-policy interface may usher in a new era of research collaborations with government and other organizations as they become more interested in understanding the role that information contained in their publications plays in policy- and decision-making.

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