

## Assessing the Diffusion and Impact of Grey Literature Published by International Intergovernmental Scientific Groups: The Case of the Gulf of Maine Council on the Marine Environment

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Published online: 15 August 2007  
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**Abstract** Although many governmental and intergovernmental organizations publish vast quantities of grey literature, the importance of the diffusion and impact of this literature are rarely studied. Evidence from an investigation of the grey literature output of GESAMP, the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (sponsored by the UN and several of the UN-family of organizations), indicated that the literature reached scientific readers and was cited. To determine whether that evidence was representative of international intergovernmental bodies, another intergovernmental organization devoted to marine environmental issues, namely, the Gulf of Maine Council on the Marine Environment (GOMC) was studied. GOMC, an American–Canadian partnership, has been working since 1989 to maintain and enhance environmental quality in the Gulf of Maine. Through its own publications and others resulting from studies conducted under contract or in cooperation with other organizations, GOMC provides a complex publishing history for investigation. Over 300 publications were identified and over 500 citations were located after extensive searching using several citation tools. Citation patterns for GOMC publications mirror the findings of the study of GESAMP; grey literature is cited over lengthy periods, but grey literature tends to be cited primarily by other grey literature. Although digital alerting and access tools are increasing in number and coverage, a reliance on grey literature as the primary means of publication continues to pose hurdles for influencing scientific research, public policy, and public opinion. While grey literature is common

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This paper is dedicated to the memory of Susan Snow-Cotter, who passed away December 2006. She was a long-term member of the Working Group of the GOMC, a member of Council, and a person devoted to wise environmental management of the Gulf of Maine.

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to organizations such as GOMC and GESAMP, the impact of this literature can be muted because of the limitations of its dissemination and perceptions of its quality.

**Keywords** Grey literature · Information use · Citation analysis · GOMC · GESAMP · Marine environmental studies · Public policy · Communication of science

## Introduction

It is widely recognized today that environmental issues “have expanded from local and regional problems...to complex, interactive, and persistent problems that threaten the planet as we know it” [1, p. 4]. Over the past quarter century governmental research units, university departments, and many other public and private sector organizations have devoted extensive resources to scientific and social science research on environmental subjects. These initiatives have prompted local, regional, national, and international governmental agencies to produce thousands of reports on environmental topics, most often published as grey literature. Major publications, such as the *Stern Review on the Economics of Climate Change* [2], released in the United Kingdom in October 2006, have received broad international attention [3–5]. The same occurred for the vitally important *Millennium Ecosystem Assessment Reports*, the first of which was published in March 2005 [6]. While those particular reports may in fact foster public policy debate and action (it is too early to tell, if that will be the case), what is the fate of many, many other documents that fall below the radar of national and international media? Even when the reports are of the stature of the *Stern Review*, do they reach readers when and where it matters or are they only noted for short periods of time?

It is clear that the production of grey literature is central to the publishing practices of many organizations [7, 8]. But is that literature found easily when needed and used to maximum efficiency? Are the extensive resources devoted to the production of such publications justified (in some instances upwards of \$1 million per title)? Are there better ways of ensuring the important scientific and technical assessments found in grey literature come to the attention of policymakers, stay in their view, and are used when appropriate to guide much needed environmental policies and other actions? Given the urgent nature of a number of environmental issues, such as climate change, these questions are not trivial, or easy to answer [9–12].

Such questions and others guided an investigation of the grey literature produced by GESAMP,<sup>1</sup> a significant international marine scientific advisory body [8]. That study demonstrated that marine environmental reports published as grey literature are used, often over lengthy periods, even though the publishing practices of GESAMP’s sponsoring agencies have often hindered widespread distribution of its publications, and resulting awareness of its reports was often low. To test whether

<sup>1</sup> GESAMP is formally titled IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.

those findings are representative of major governmental and intergovernmental agencies focused on environmental topics, an examination has been undertaken of the work of another intergovernmental body with multiple jurisdictional responsibilities, namely, the Gulf of Maine Council on the Marine Environment (GOMC) ([www.gulfofmaine.org](http://www.gulfofmaine.org)). The primary questions in this research are: (1) What has GOMC published, where and how? (2) What does citation analysis show regarding the distribution and use of GOMC publications? (3) What other approaches can be deployed to demonstrate the use and influence of GOMC publications? (4) What fundamental principles regarding the dissemination of grey literature from such organizations are emerging from this new study? and (5) Ultimately, is the Gulf of Maine better off environmentally from all this publication effort? Has the grey literature production had its intended effect on human behavior towards the environment?

### **Mandate and History of the Gulf of Maine Council on the Marine Environment**

The work of the Gulf of Maine Council on the Marine Environment began in 1988 with discussions on the need for a regional interagency organization, and initiation of a “State of the Gulf on Maine” report, which was released in December 1989 [13]. The Council was established formally by the Premiers of the Canadian provinces of Nova Scotia and New Brunswick and the Governors of the American states of Maine, New Hampshire, and Massachusetts in December 1989 at an inaugural conference held in Portland, Maine. According to Springer [14], “the Council’s creation responded both to the perceived need for increased institutionalization of patterns of cooperation in the North Atlantic region, and to the desire by state and provincial actors, both governmental and non-governmental, to play a more central role in that process.”

The Council focuses on the marine environment of the Gulf of Maine and the Bay of Fundy. This marine region has a very high biological productivity and diversity, abundant and very valuable fisheries, habitats for numerous endangered or threatened species, many threats to its health and ecological integrity, and established economies and lifestyles linked to the sea in its many coastal communities. This focus also includes consideration of the land–sea interface, and the watersheds and estuaries of the Gulf region. The underlying philosophy in the Council’s work is that activities on the land ultimately affect the sea, especially in more shallow coastal areas.

GOMC is an international intergovernmental body, with linkages to non-governmental organizations (NGOs), and the university research sector. Its focus is the marine environment of the Gulf of Maine, and environmental issues and their resolution, particularly ones of a cross boundary nature (e.g., air and water pollution, conservation of critical habitats and hemispheric migratory species, climate change, and introduced species). With the exception of a 2004 report, *Tides of Change across the Gulf* prepared by Pesch and Wells [15], fisheries issues have not received extensive attention of the Council. The Council has had limited direct relations with citizen-based NGOs, and at times works with unpredictable finances

received from its members. Some governmental agencies, particularly the U.S. National Oceanographic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA), have been the main fiscal supporters, although substantial financial and in-kind support comes from all members. GOMC's programs are financed with a budget normally in the \$0.5–1.0 million per year range, excluding extensive in-kind support; matching dollars are in a ratio of 3 or 4 to 1. The Council works with refreshed five-year Action Plans, and is currently operating under its fourth Plan which spans fiscal years 2007–2012. The current Plan has three primary goals: habitat conservation and restoration, human and ecosystem health, and environmental sustainability.

Among GOMC's several long-term, flagship initiatives are its quarterly newspaper *The Gulf of Maine Times*, the Gulfwatch contaminants monitoring program, a salt-marsh restoration program, the Council's website ([www.gulfof-maine.org](http://www.gulfof-maine.org)) which includes services such as a "People Finder" and an "Inventory of Monitoring Programs," and an active publishing agenda. In addition, the Council maintains several funding programs for studies conducted externally (e.g., its external action grants), and a distinguished awards program to recognize outstanding achievements.

The Council Secretariat rotates among the five states and provinces on an annual basis, and is chaired by an individual in the host jurisdiction. The Council itself convenes twice a year, in one- or two-day meetings held in the host state or province, and is attended by political Cabinet Ministers, Deputy Ministers, Commissioners, or their representatives. The Council's mandate is carried out primarily through its Working Group, which reports to the Council, and is also chaired by a representative of the host jurisdiction. The Working Group holds quarterly two-day meetings, which are attended by senior policy managers and scientists directly involved in the Council's programs, and the Council's Secretariat. Several committees and subcommittees, which meet at least once per year, report to the Council's Working Group. These committees, e.g., the Habitat, Monitoring, and Public Education and Participation committees, are co-chaired by American and Canadian members. The actual committee structures and agendas are steered by the action plans.

Overall, the GOMC's work entails research, ecosystem monitoring, communication and education, and public policy. Research is linked to and integrated through the Regional Association for Research on the Gulf of Maine (RARGOM), currently coordinated by the University of New Hampshire, Durham, New Hampshire, as well as through the facilities of the member institutions. Monitoring is conducted through habitat and contaminant subcommittees. The Council's significant communication agenda is pursued primarily through its website and publications, and many widely attended workshops on a variety of topics (e.g., monitoring programs, salt-marsh restorations, indicators of environmental change, and climate change). The Council also encourages public policy discussions, through both academic studies and public forums associated with Council meetings (e.g., wind farms, climate change, coastal zonation, and indicators for monitoring). The core work of GOMC is conducted with individual researchers and through the

work plans of the member agencies. As shown below, the Council's work has been extensive in scope and prolific.

### GOMC Publications

The Council has produced a large and diverse body of publications since it was established in 1989. The earliest items, an inventory of marine environmental quality monitoring programs in the Gulf of Maine and the first issues of the *Turning the Tide* newsletter, were published by the Gulf of Maine Working Group several months before the Council was officially created. The goal of many Council publications is to disseminate information to environmental managers and other decision-makers. As a result, visual appeal and clear language are prominent features of publications ranging from *The Gulf of Maine: Sustaining Our Common Heritage* [13], to the recent *Gulf of Maine Marine Habitat Primer* [16].

In the 17 years of its existence, the Council, working by itself or in collaboration with others, has published widely, including conference proceedings, technical reports, conference background documents, annual reports, action plans, newsletters, newspapers, magazines, fact sheets, brochures, maps in poster format, and a video. Other groups also have benefited from the Council's support for producing a similar array of publications. Moreover, individuals associated with the Council have given many workshop and conference presentations and written primary journal articles, resulting in another class of publications.

By the mid-1990s, the Internet had become a very important medium for communication and publishing. Many of the print publications that the Council had produced since 1997, along with a few from earlier years, are now available on the Council's website, most as easily printable PDF files (Table 1). The website is itself an evolving publication in its own right, presenting information in ways that are particularly adapted to the medium. For example, information from the GOMC's Gulfwatch monitoring program can be displayed with an interactive mapping tool, and the *Gulf of Maine Habitat Restoration Portal* offers information about the hows and whys of restoration projects. The new *KnowledgeBase* interface will soon allow searching for information in a variety of ways. The Council's website is taking on an increasingly important publication and communication role, but print publications remain an important part of the history and on-going work of the Council. Both print and digital publications currently have roles for information dissemination, but the Council's clear trend is to increasing emphasis on electronic media and its website.

Early in its history the Council recognized that "in order to effectively manage the Gulf of Maine as the ecosystem that it truly is, decision-makers must have access to data and information from sources throughout the entire Gulf of Maine system" [17, p. 4]. An "explicit priority in the [first] Action Plan was the design of a computer system to manage large amounts of information about the Gulf of Maine ecosystem and to organize and package it in a way that would be usable by many audiences: state, provincial and federal agencies; laboratories; universities; schools; and non-governmental organizations.... The long-term goal of the system is to allow

**Table 1** GOMC Publications<sup>a</sup> (Total 321)

Type of publication	# items	# online
<i>Council publications</i>		
Action plans, work plans, annual reports (incl. six drafts)	27	6
Brochures and posters	13	4
Conference background papers	32	29
Conference reports	26	13
Fact sheets	10	7
Reports (incl. six interim reports)	85	31
Serials	4	1
Miscellaneous	17	6
<i>Council-supported publications</i>		
Conference reports and background documents	25	8
Other reports	13	7
Miscellaneous items	12	5
<i>Reprints of Council authored documents</i>		
Mostly “Gulf of Maine Times” articles	14	13
<i>Publications based on Council work</i>		
Journal articles	4	2
Papers in conference proceedings	9	2
Abstracts of conference presentations or posters	30	18

<sup>a</sup> Identified as of December 1, 2006

people to exchange information, display graphics, search data and answer specific questions, and directly communicate with one another” [18, p. 11]. Publication and communication of information about the Gulf of Maine was a priority of the Council, and it has remained so.

## Documenting GOMC Publications

A number of valuable regional collections exist in New Hampshire, Maine, and Nova Scotia, but GOMC has not maintained a formal and comprehensive collection or list of its publications since it was established in 1989. Therefore, it was necessary to gather evidence of its publications from a variety of sources, including personal collections of GOMC publications and documents, the GOMC website, nearby libraries, other library catalogues, and web search engines. Evidence of GOMC-related journal articles and conference presentations were also found by searching article databases, electronic collections of proceedings, and print copies of other proceedings. These searches also led to the discovery of items published by other organizations with GOMC support. Some publications have effectively vanished, with electronic versions no longer available on the web and no print copies listed in library catalogues; only citations or mentions in other documents

remain. While a large number of GOMC publications has been identified (Table 1), probably some have been missed, particularly if they were published during the Council's early years of operation. Some information about a collection at the Maine State Planning Office in Augusta is found on the GOMC website; if all items in that extensive collection were examined, additional early GOMC publications might be identified.

A database of records of the GOMC publications was created using ProCite software. Some draft versions of documents were included in the database, if copies were held by libraries or if they were cited. No attempt was made to record the detailed contents of the *Gulf of Maine Times* and the Council's earlier periodicals in the database. Many articles were published in the *Times* (currently 38 issues, 1997–), *Our Common Heritage* (two issues, 1995–1996), *Program Highlights* (30 identified issues, 1990–1996), and *Turning the Tide* (16 identified issues, 1989–1993). Documents such as press releases, briefing documents linked to the Council "meetings" webpage, or the individual presentations (PDFs of slides) from the Northeast Coastal Indicators Workshop, held in January 2004, were also excluded from the database (although they are available on the GOMC website).

### Locating Citations to GOMC Publications

Since citations provide one indicator of the use of publications, searches of citation databases were undertaken to reveal which GOMC publications have been cited in the research literature. Environmental managers, who are the intended audience for many of GOMC's publications, are more likely to prepare technical reports than to write journal articles, so strategies were developed to locate citations in such reports published on the Web.

*Web of Science*, *Scopus*, *Google Scholar*, and *Google* were used for citation searching in this study. In the study of GESAMP, completed in 2001–2002, Thomson ISI's *Web of Science* citation databases, which index a broad interdisciplinary collection of research journals dating back several decades, were the only tools for systematically locating citations. Those citation databases use a compressed citation format which works well for citations of journal articles but makes it difficult to locate citations of report literature. Since 2002, additional tools for citation searching have become available. Elsevier's *Scopus* database, launched in 2004, indexes a broader range of periodicals than *Web of Science*, but the currently indexed citations primarily cover articles published since 1996 [19]. *Google Scholar* indexes journal articles and selected web-based resources, but a description of its coverage is not available. *Google Scholar* searches sometimes return relevant results from *Google Book Search*, so some citations in books were identified. Unlike *Web of Science*, both *Scopus* and *Google Scholar* provide the full text of each citation, making it possible to more accurately locate citations to technical reports.

Since web search engines such as *Google* and *Yahoo* now index PDF documents, *Google* was used to locate citations in reports published in that format, but such searching is not very efficient. In both *Google* and *Google Scholar*, each likely file

must be opened and searched to determine whether it contains a reference to a specific GOMC publication, or merely a mention of the Council and its work. When a large report has been broken into several files and a citation is found in one of them, additional time is needed to identify the citing document by locating its first section or the linking web page. Recording information about citing documents is much more time-consuming than importing information about citing journal articles from an article database directly into bibliographic management software. Notwithstanding difficulties in locating citations, the following discussion demonstrates characteristics of GOMC publications, and their use and influence.

## Discussion of Findings

### GOMC Publications

Since its creation in 1989, GOMC has produced over 300 publications, the majority of which were prepared by the Council itself (Table 1, [20]). GOMC provides financial support to related organizations, which have published at least 50 reports and documents with GOMC sponsorship. Furthermore, researchers, managers, and consultants associated with GOMC through its Working Group or committees have published conference papers and papers, which draw on the work of the Council. While early GOMC publications were produced only in print, most items produced since 1997 have been available in both print and electronic format. For example, the most recent report, *Cross Border Indicators of Climate Change over the Past Century: Northeastern United States and Canadian Maritime Region* [21] is available in both formats (with a limited print-run of the print version).

In contrast to the publishing pattern of GESAMP, which has produced about 115 publications, plus a similar number of translations or reprints in other report series, over almost four decades, GOMC has been more prolific. Whereas GESAMP publishes mostly major technical reports in its advisory capacity to its UN agency sponsors, GOMC's mandate includes responsibility for public education. Thus, GOMC places greater attention on design and readability. However, greater concern for accessibility has not translated into consistent attention to dissemination of publications, nor care in describing publications for identification and access. The multi-jurisdictional nature of GOMC and its rotating governance model has contributed to inequity in distribution of its publications. For example, when the *Gulf of Maine Marine Habitat Primer* was published [16], copies were mailed to a large list in the United States, but distribution was much less effective in New Brunswick and Nova Scotia [20]. Even when publication is in digital format, as in the recent report on the important topic of climate change (Wake et al. 2006), significant details such as the date of publication are not obvious. Like many other organizations that rely on grey publications (whether in print or online), GOMC's interest is often focused primarily on the content of documents rather than diffusion and accessibility matters. Once a work is published, attention moves rapidly to other projects rather than providing additional resources to ensure that the published work



is disseminated (in the case of print copies) and effectively designed and described for searchability and heightened awareness (in the case of digital copies).

While GOMC has a specific mandate to integrate and communicate findings for regional environmental management of the Gulf of Maine, the Council has not until now maintained a comprehensive list of its own publications to document its output and influence [20]. This inattention to recording its past output is not uncommon among organizations of multi-jurisdictional structure. Publishing to the web has the potential of reducing this oversight, since publications can be maintained in continuous existence, and development of digital discovery tools might overcome the lack of comprehensive publication records.

### Results of the Citation Analysis

Citation data confirm that GOMC publications are used worldwide, but primarily by authors within the region of the Gulf of Maine (Table 2). Over 500 citations—to publications in the first category of Table 1, and to four journal articles based on GOMC work, tracked through the citation search noted above—are related to GOMC's print and online publications. Within the Gulf region and in Canada outside of the Gulf region, authors show little difference in their preference for print or online publications, but beyond these two areas mostly digital copies of publications are cited. This citation pattern is explained in part by the distribution practices of the Council. Print copies are disseminated primarily within the two Canadian Maritime provinces and three American states in the Council's jurisdiction. Readers outside of the Gulf region, if they become aware of GOMC publications, are far more likely to discover the digital publications rather than printed reports, and journal articles are more easily located. The citation pattern also relates to the focus of GOMC's publications on coastal ecosystem and management issues, which may be sufficiently unique to the Gulf of Maine and northwest Atlantic that the publications are of lower relevance to other coastal regions of the world.

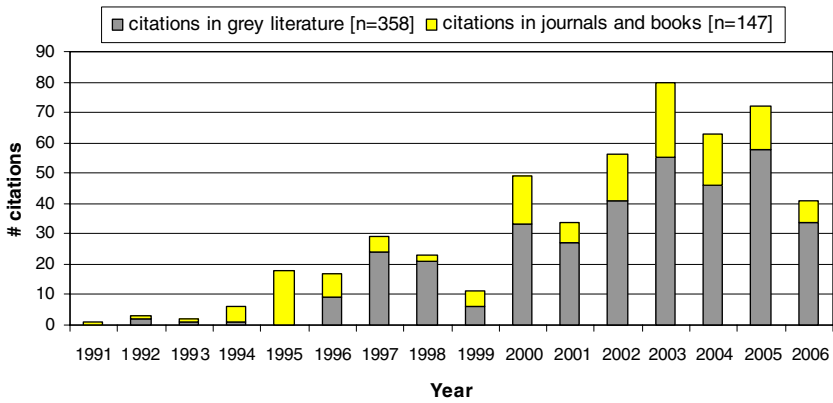
The usage patterns revealed by the citation data are informative in other respects. When citations are charted over time and the types of citing documents are noted

**Table 2** Citations to GOMC Publications<sup>a</sup> by region of the citing authors

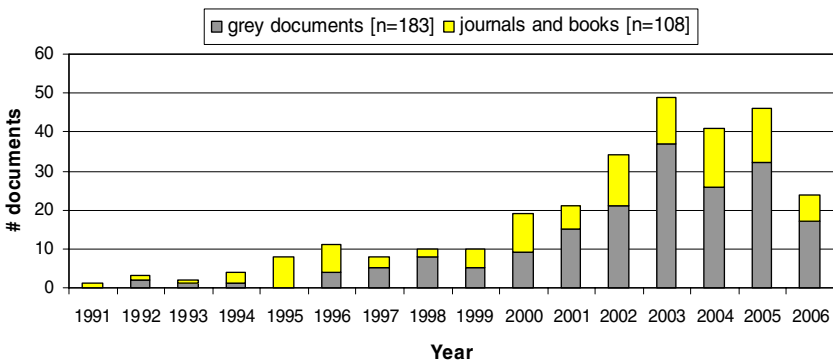
Region	Online GOMC publications <sup>b</sup>	Print only GOMC publications
Gulf of Maine Region	157	169
Canada (outside Gulf region)	24	34
USA (outside Gulf region)	58	18
Europe	24	2
Rest of world	14	5
Total	277	228

<sup>a</sup> Only "Council Publications" and journal articles noted in Table 1 were used as targets in the citation analysis reported in this paper

<sup>b</sup> Most online publications were also published in print editions



**Fig. 1** Total citations to GOMC Publications, 1991–2006 ( $n = 505$ )



**Fig. 2** Total documents citing GOMC Publications, 1991–2006 ( $n = 291$ )

(Fig. 1), it is apparent that GOMC publications are receiving increasing attention, but many of the citing publications are grey literature rather than peer-reviewed journals and books. In other words, GOMC’s grey literature is cited more by other grey literature, and this pattern holds up whether one considers total citations or total citing documents (Fig. 2). Very few reports from the early 1990s are available on the web, so citations in grey literature from that period are under-represented in our results.

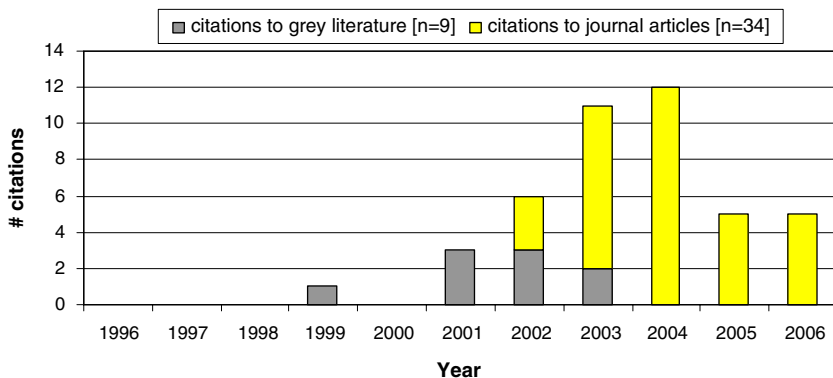
The nature of citations to GOMC publications can be probed further in an examination of reports generated by one the Council’s significant ongoing initiatives, the Gulfwatch program, noted above. The Council’s publications from this program consist of a mix of grey literature and papers published in peer reviewed journals. Detailed data reports are produced periodically, and syntheses of these reports have been published as scientific papers in the leading scientific journals, *Marine Pollution Bulletin* [22] and the *Journal of Shellfish Research* [23]. Scientists involved in the Gulfwatch program feel compelled to publish in both

genres. The grey literature reports provide a venue for detailed annual documentation of findings, whereas the credibility and accessibility of peer-reviewed periodicals offer heightened exposure for the research undertaken in and major results of this program. The journal article by Chase et al. [22] is available electronically, and is much more likely than the reports to be cited outside the region. It is cited in 16 articles from Europe, often providing a comparison for the findings of local monitoring programs [24, 25].

Figures 3 and 4 show clearly a bias in citation patterns. Papers in scientific journals are much more likely to cite the Gulfwatch journal articles than the grey literature on the same topic, which may provide more detailed data and analysis (Fig. 3). Similarly, authors of grey literature are more likely to cite other grey literature than journal publications (Fig. 4). This citation bias was also found in the study of citations to GESAMP publications (Fig. 5). In the GESAMP case, authors of scientific papers were far more likely to cite the version of *The Atmospheric Input of Trace Species to the World Ocean* published by Duce et al. as in a scientific paper [27], than the original report [26]. Since GESAMP reports are rigorously peer reviewed, the citation bias is not necessarily related to the perceived quality of a journal article versus a technical report.

The citation patterns uncovered in both the GOMC and GESAMP examples may be attributed to limited distribution of grey literature versus scientific periodicals, variations resulting from searching tendencies of researchers (i.e., the tendency to search databases of scientific periodicals rather than grey literature sources), and/or perceptions of the quality of grey literature versus peer-reviewed journals on the part of researchers and journal editors. In addition, citations serve to publicize the cited works. Cordes [28] examined citations to two GESAMP reports that were each published in three print versions: in two report series and as a journal article or a book. In both instances, the version cited by the authors of the report, in articles they wrote, was the most highly cited version overall. Other citing authors chose the version recommended to them in earlier citing papers.

Tracking usage of grey literature in public policy settings is a complex undertaking due largely to the policymaking process, which limits following



**Fig. 3** Citations in journal articles to Gulfwatch Publications ( $n = 43$ )

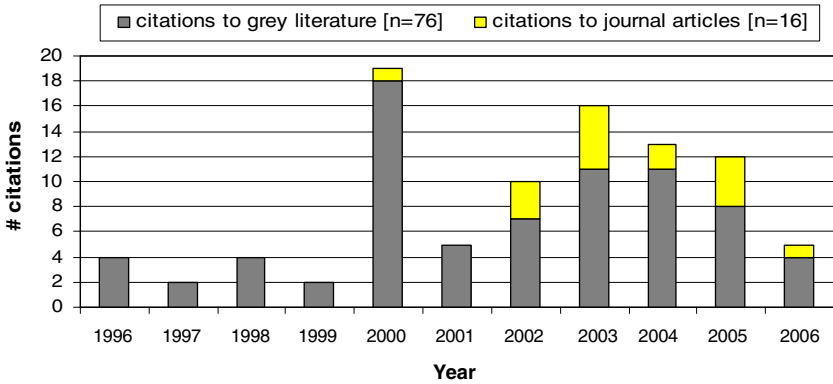


Fig. 4 Citations in grey literature to Gulfwatch Publications (n = 92)

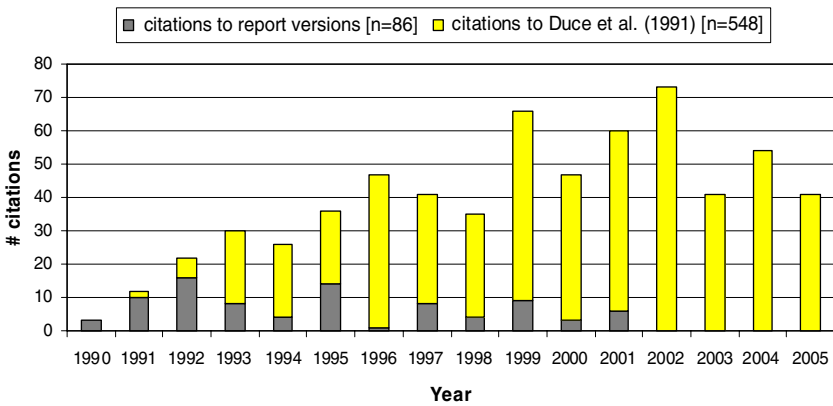


Fig. 5 Citations to versions of The Atmospheric Input of Trace Species to the World Ocean [8]. Citations to the report versions [26] were extracted from *Web of Science* to the end of 2001 only. Citations to Duce et al. [27] were extracted from *Web of Science*, *Scopus*, and *SciFinder Scholar*

connections (i.e., citations) within documentary evidence. Much of the policy documentation is internal to units of governments, is never published formally, and hence is not covered by citation databases. Nonetheless, citation evidence can uncover references to grey literature in policymaking settings. Given the mandate of GOMC, its publications are often relevant for policymaking at municipal, state or provincial, or federal levels, and citations confirm use at all three levels as well as in international contexts. For example, at the federal level, Peter Shelley (vice-president of the Conservation Law Foundation) cited a GOMC publication when he testified to the U.S. Commission on Ocean Policy on July 24, 2002 [29]. GOMC publications are noted within state and provincial policy documentation, such as the watershed assessment report for the Merrimack River in Massachusetts [30]. While international interest is limited, citations show that GOMC publications have been used in marine policy areas in Australia [31], and as background to decisions of the World Court related to the UN Convention on the Law of the Sea [32]. However,

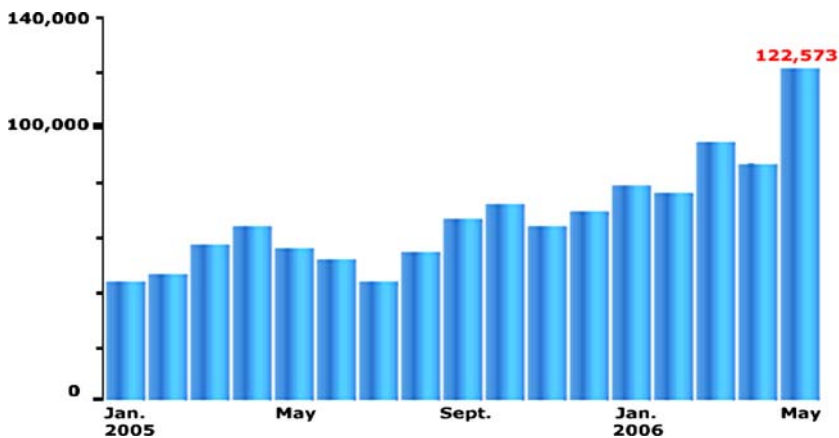
most public policy references to GOMC publications are regionally based, at municipal, state/provincial and federal government jurisdictions.

Since GOMC increasingly is publishing digital versions of documents, statistics captured from traffic on the Council's website are a further indicator of usage of grey literature. Data over a 17-month period from January 2005 through May 2006, in terms of "page views per month" (Fig. 6) and "user sessions per month" (Fig. 7), show a steady rise in website traffic (P.H. Taylor and J. Cradock, personal communication, July 15, 2006). These statistics emphasize the growing importance of web presence for organizations like GOMC. A further indicator of the significance of the web lies in interconnections of sites on the web. Tracing those interconnections via search engines in any definitive manner is problematic due to indexing and search engine vagaries, but a broad brush perspective about Internet links can be seen in the number of links to the GOMC website in comparison to the GESAMP site. On December 1, 2006, a search for links using the Yahoo search engine ("linkdomain:gulfofmaine.org-inurl:gulfofmaine.org") located 1,000 links to the GOMC website from other websites, and 486 to the GESAMP site ("linkdomain:gesamp.imo.org-inurl:gesamp.imo.org"). The number of links reflects the more extensive and sophisticated GOMC website, and indicates that GOMC publications may be receiving greater interest and use than GESAMP's.

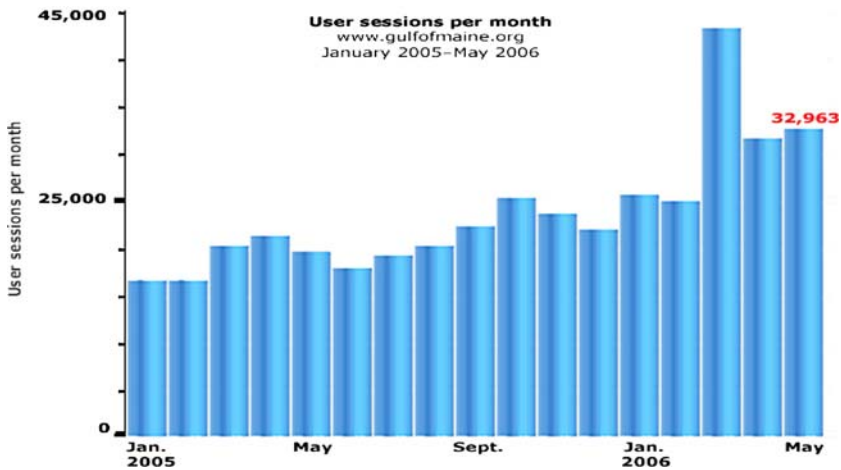
Evolving citation tools and searching services offer increasing means of locating data that indicate usage patterns. Such tools also promote use of grey literature, particularly when the literature is accessible via the web.

## Conclusions

In 2004, Peter Taylor, a science translation writer employed by the Gulf of Maine Council, wrote: "A core constraint for understanding and managing the oceans on a regional scale has been information: collection of data for research and monitoring;



**Fig. 6** Page views per month (<http://www.gulfofmaine.org>) January 2005–May 2006 (credit P. Taylor and J. Cradock)



**Fig. 7** User sessions per month (<http://www.gulfofmaine.org>) January 2005–May 2006 (credit P. Taylor and J. Cradock)

data sharing; integration and analysis; and regional exchange of findings and management solutions. These challenges are magnified by the geographic size and ecological complexity of a system like the Gulf of Maine” [33, p. 1]. Taylor’s assessment, which places information at the center of environmental management issues, brings the questions raised at the beginning of this paper back into focus. In recognition of the importance of information diffusion and use in environmental management decision making, the following points can be made:

- (1) Grey literature is the mainstay of the GOMC’s significant publication initiatives, which now number more than 300 titles. In this regard, GOMC and GESAMP are very similar. Both marine environmental intergovernmental organizations publish mostly grey literature.
- (2) In contrast to GESAMP, which primarily produces rigorously refereed reports (but still by definition grey literature), GOMC generates a variety of information products, not all of which are refereed.
- (3) For both GOMC and GESAMP, dissemination of print publications has been uneven. GOMC has been more aware than GESAMP of the value of effective information dissemination, but neither organization has achieved consistency in practice.
- (4) With continuing development of its website (which is itself a rich information source), GOMC may be overcoming dissemination problems. Further study of web access traffic and web links will confirm whether usage is wider spread than evidence drawn from citation data currently shows. In contrast to GOMC’s increasing web-based initiatives, GESAMP and the UN agency secretariat which supports its publication program have devoted very limited resources to website development and maintenance.
- (5) Evidence of usage of GOMC publications is manifested in the assembled citation data. Citation patterns for GOMC and GESAMP illustrate similarities

of publication use. Characteristics in citations to GOMC publications highlighted a dichotomy regarding the source of citations, which suggests that grey literature may be overlooked or its use discouraged in peer-reviewed scientific literature. Why this dichotomy exists warrants further study.

- (6) While evidence that GOMC publications are used in public-policy settings was uncovered, the evidence is not strong. However, even if more comprehensive searches for citations were undertaken, this investigative technique is unlikely to yield significantly greater understanding of usage patterns. Citation analysis has been informative, but it has limitations for tracking public policy and management documentation in contrast to research literature [34].
- (7) To complement our current findings, other methods of determining usage in policy decision making contexts are needed. GOMC was set up for direct transfer of scientific information to public sector managers. Senior policy personnel participate in the Council meetings and are provided with a sizeable volume of documentation. Tracking the life of information contained in a GOMC publication through the Council meeting documentation to other policy documents would provide additional insights on the impact of the Council's work.

Since finding solutions to the environmental problems that are threatening planetary health will rest in part on effective transfer of scientific findings and knowledge into public policy, grappling with the challenges that grey literature poses is vitally important. Will greater dependence on digital publications accessible on the web provide the solutions? The complexity of the phenomenon of information creation, distribution and incorporation into knowledge and action implies that the answer to this question will be elusive, and no single answer will be sufficient. That the problem deserves an answer is beyond question and will form the focus of future studies.

**Acknowledgments** Support for this study was received from the Gulf of Maine Council on the Marine Environment, Environment Canada, and the School of Information Management, Dalhousie University. Patricia Hinch (Nova Scotia Department of the Environment and Labour), Michele Tremblay, David Keeley, and Peter Taylor (Gulf of Maine Council on the Marine Environment), and numerous librarians in the Gulf of Maine region offered valued advice and assistance.

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