Developing an Inclusive Measure of Influence for Marine Environmental Grey Literature

by

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DEDICATION

Heartfelt thanks to everyone who put up with me through the process of writing this thesis. Thank you for the dinners, the phone calls, and the support. I owe you!

Love to:

Robert Harris (Grandpa)
Mom & Dad
Auntie Carol
Brett & Alex
Ashley
David

Data collection and analysis was aided by repeated listens to the following albums:

Art Brut – *Bang Bang Rock & Roll*
The Fall – *The Real New Fall LP (Formerly Country on the Click)*
Jim Guthrie – *Now, More Than Ever*
Hot Snakes – *Audit in Progress*
Hüsker Dü – *Zen Arcade*
Josef K – *Entomology*
Chad VanGaalen – *Soft Airplane*
Neil Young – *After the Goldrush*

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ABSTRACT

Today's seriously deteriorating global environmental conditions are focusing increased attention on the urgent need for effective public policy use of scientific information. Much scientific information which could inform public policy responses is published as grey literature but its use and influence is largely unknown. Using a case study of a UN-based intergovernmental advisory body that produces significant reports on the state of marine environments, this thesis establishes methodologies to improve understanding of the influence of scientific grey literature in print and digital formats. Whereas citation analysis, based on Web of Science data, has been used for several decades to measure the influence of scientific literature, this thesis demonstrated the limitations of relying solely on Web of Science data. Based on analysis of citation data drawn from Google, Google Scholar, monographs, as well as Web of Science, a more comprehensive metric of the use and influence of grey literature was developed.

LIST OF ABBREVIATIONS USED

FAO	Food and Agriculture Organization
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
IAEA	International Atomic Energy Agency
IMO	International Maritime Organization
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO-IOC	United Nations Educational, Scientific, and Cultural Organization - Intergovernmental Oceanographic Commission
UNIDO	United Nations Industrial Development Organization
WMO	World Meteorological Organization

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CHAPTER 1 INTRODUCTION

1.1 Background

Today's seriously deteriorating global environmental conditions are directing increased attention on the urgent need for the use of scientific information in support of effective policy responses. Unequivocal evidence shows that climate change, the most pressing environmental concern, is affecting natural systems (Intergovernmental Panel on Climate Change [IPCC], 2007). Stress on the health of marine environments is one of the consequences of climate change. For example, studies have shown that global sea levels will rise steadily as air temperatures rise and ice sheets and caps melt ("Troubled Waters," 2009). In addition to problems caused by warming climates, marine systems also suffer from human-made pollution and unsustainable policies and practices, including fertilizer runoff causing excessive eutrophication, pollutants such as oils and plastics entering the seas, and overfishing ("Troubled Waters," 2009). Action arising from scientifically informed individual and public policy responses could combat the effects of climate change and marine pollution before irrevocable damage has occurred.

Large bodies of scientific information that should enlighten policy decisions currently exist and accessibility is increasing in a rapidly-changing dissemination milieu due to the evolution of the Web. Agencies and individual researchers now have greater opportunities to publish and locate scientific information in a wide variety of forms besides traditional, peer-reviewed journals, and especially in grey literature formats. Briefly defined, grey literature is scientific information published outside of peer-reviewed journals and includes "material in print and electronic formats, such as reports, preprints, internal documents (memoranda, newsletters, market surveys, etc.), theses and dissertations, conference proceedings, technical specifications and standards, trade literature, etc." (Reitz, 2007). Grey literature is often produced to address specific scientific concerns, making its findings the most salient and timely sources available for many topics. Therefore, grey literature could provide the solid scientific foundation on which many policy and decision making settings are based.

Even though grey literature can be an important source of scientific insight, several barriers may prevent it from being used. For example, questions about the editorial standards of grey literature occur because of the perception that the publications are not subjected to the same rigorous peer review processes as articles published in peer-reviewed journals (Conn, Valentine, Cooper, and Rantz, 2003). Additionally, even though grey literature is often available from the Web sites of governments, non-governmental organizations, and many other publishing groups, greater accessibility to such scientific information due to emerging publication and dissemination methods may not lead to improved policy initiatives (de Alwis, 2006; Mitchell, Clark, and Cash, 2006). Relevant scientific publications may be overlooked if potential information users are not aware of their existence. Similarly, sources of information may simply be ignored or disregarded because of negative assumptions regarding the reliability or authority of the content.

Much of the scientific information published as grey literature could and should be used as a relevant source in a variety of contexts. Potential uses range from applications in other scientific research through to informing policy responses to environmental concerns. However, since comprehensive evidence of the use of grey literature has not previously been assembled, current understanding of the influence of this genre of publication is limited. As grey literature's role in communication and decision making may increase, it is important to determine which indicators demonstrate that this literature is being used, especially in today's milieu largely categorized by an overabundance of potential sources. This thesis aims to address this gap in understanding by showing how evidence can be assembled and analyzed to ascertain if grey literature is being used or whether it is overlooked, ignored, or otherwise unused.

Evidence of the influence of grey literature can be found in references or citations to such publications in other sources. Bibliometric techniques, especially analyses of citation data, have been applied in many studies to determine the impact of scholars and publications (Bar-Ilan, 2008a). Analysis of citation data collected from Thomson

Reuters' Web of Science has been used extensively as a means of quantifying the influence of peer-reviewed scientific literature (Bar-Ilan, 2008b). While Web of Science is a very large database of citation data, it primarily indexes peer-reviewed (mostly commercially-published) journals, thereby limiting its ability to measure the influence of grey literature. Web of Science is not designed to include citations to grey literature, nor does the database index many of the potential sources of citations relevant in a study of grey literature's influence. As a result, citation analysis methodologies must be adapted or created for assembling a more comprehensive set of citation data to evaluate grey literature's influence more effectively. This thesis illustrates how a more inclusive analysis can be achieved.

A case study of important grey literature produced by an intergovernmental body was undertaken to address the limitations of traditional citation analysis. Citation data was collected for the publications of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), an international advisory body sponsored by the UN and seven UN-based agencies, and a group which itself is interested in evaluating the value of its technical advice. These citation data were used to propose a multi-faceted metric of the influence of grey literature. GESAMP was established in 1969 to "provide authoritative, independent, interdisciplinary scientific advice to organizations and member governments to support the protection and sustainable use of the marine environment" (GESAMP, 2008). Many of its publications were produced as grey literature in a "Reports and Studies" series (Pravdić, 1981; Windom, 1991). Historically, GESAMP published its reports in print format, and since 2007 all reports have been made available as free, full-text files on the organization's Web site. GESAMP's technical reports are arguably more rigorously reviewed than typically occurs in peer-reviewed scientific journals because of thorough internal vetting and the requirement that all supporting agencies approve its publications. Thus, GESAMP's reports, which contain important findings, syntheses, and recommendations of global concern, are relevant and applicable to a wide range of marine environmental policy and management initiatives.

Several sources of citation data were consulted in this study because, as noted above, current methodologies are insufficient in determining grey literature's use and influence. Insights drawn from analyses of citations to GESAMP's publications will, in turn, form the basis of a more comprehensive understanding of the influence of grey literature more generally. The metric proposed in this study includes Web of Science citation data, and also citation data from sources including Google Scholar, Google, monographs (printed books and government publications), and hyperlinks between Web sites. A novel metric encompassing these sources of citations provides new insights into the nature, use, and influence of grey literature.

1.2 Sources of Citation Data Beyond Web of Science

Citation data available on the Web are not incorporated in traditional citation analysis, which is a weakness in studies of grey literature's influence. Grey literature is currently more accessible than it has ever been, thanks to greater opportunities for its dissemination through the Web. As early as 1997, authors predicted a new era of relevance and accessibility for grey literature, ushered-in by the proliferation of Web technologies and their widespread use (Farace, 1997; Gelfand, 1997; Weintraub, 2000). There is no indication that the rate of production and dissemination of grey literature will soon plateau or decrease. For example, Gelfand (2000) has noted that grey literature is "being created in digital formats at *alarming speed* [italics added], in all subject areas, around the globe" (Gelfand, 2000, p. 147). The online availability of grey literature and evolution of the Web, a source relied on by most information seekers, makes an investigation of Web data a logical extension of citation studies. Researchers such as Vaughan and Shaw (2005; 2008) and Kousha and Thelwall (2007a) have made progress in developing methodologies for effectively searching the Web for citation data. In all cases, the authors looked for citations to the titles of a sample of publications in Google Scholar and Google. Similar methodologies were employed in this study to identify the benefits and limitations of including Google Scholar and Google citation data in a comprehensive metric of the influence of grey literature.

Studies of hyperlinks between Web sites suggest that they are similar to traditional citations (Vaughan & Shaw, 2003). Links between Web sources show connections, whether as recommendations for further information or as a reference for the sources used to construct the citing Web site. Links to GESAMP's Web site could arguably be viewed as a recommendation of its publications. While recommendations do not necessarily indicate direct use of publications, they do represent influence to some degree. In order for a Web link to be created, an individual or agency has to consider GESAMP's mandate and recognize how its publications are relevant to marine environmental matters. Online visibility associated with Web links to GESAMP's Web site highlights the importance of including such data in a metric of grey literature's influence.

Citations from monographs (printed books and government publications) are the final source of citation data that was examined. Studies of citation data from monographs are few in number, especially with regard to grey literature (Kousha and Thelwall, 2009). To exclude citation data from monographs overlooks an otherwise untapped indicator of grey literature's influence. A methodology was designed to locate monographs that could potentially include citations to GESAMP publications, and the subsequent analyses contributed an additional component to the proposed metric of the influence of grey literature.

1.3 BUILDING A METRIC OF INFLUENCE

Figure 1 outlines the approach that this study followed to assemble citation data for GESAMP reports from Web of Science, Google Scholar, Google, and monographs. The data were analyzed in order to show how multiple sources of citation data enhance understanding of the influence of GESAMP's publications. The information contained in many grey literature publications should be actively used by relevant communities, be they scientific or policy-related; otherwise, the time and resources required for their production would be better directed to more effective publication and dissemination methods. The findings of this thesis demonstrate that the framework shown in Figure 1

allows for the collection and analysis of evidence of grey literature's use, which can then be drawn on to understand if the publication genre is relevant and influential. The insights generated by this thesis constitute the first steps in the establishment of a metric of influence for all publishers of grey literature.

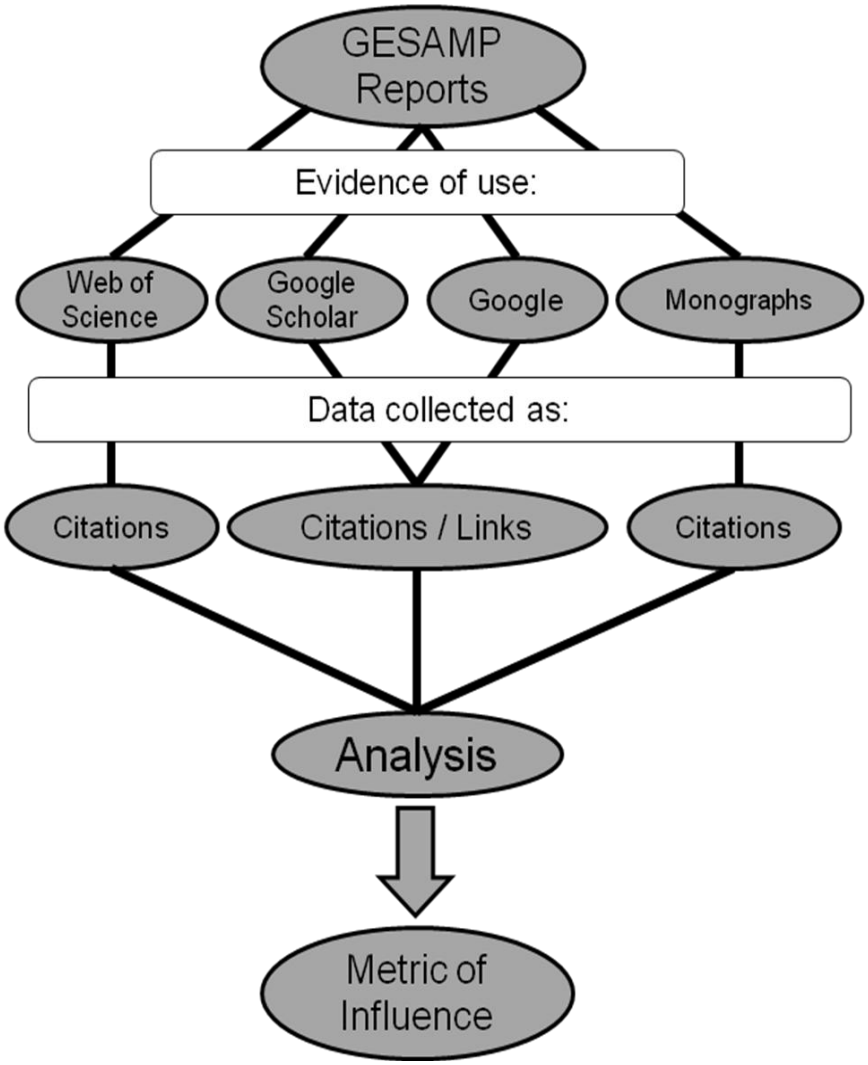

Figure 1. Model of a Metric for Measuring the Influence of Grey Literature

1.4 RESEARCH QUESTIONS

The following questions guided this case study of grey literature:

a. Where and how is influence of GESAMP's publications measurable?

b. What do traditional citation analysis techniques reveal about GESAMP's influence?
c. Given changes in publishing and scientific communication practices, what techniques are needed to complement traditional citation analysis?
d. Based on findings from the case study, what elements will make up a comprehensive metric of use of grey literature?
e. Based on findings from the case study, what suggestions can be made about alternative methods for promotion and dissemination of grey literature so that its influence is more pronounced?
f. What insights might the case study suggest about grey literature as a whole? Will the study yield insights into potential methodologies for understanding the "value" of other producers of grey literature?

Answering the research questions posed by this study in the context of GESAMP's publications produces an understanding of how evidence of grey literature's use can be collected and analyzed. The processes of data collection and analysis give important initial insights into a comprehensive metric of grey literature's influence. Chapter Two provides a review of the literature regarding characteristics of grey literature and details how citation analysis techniques can be applied in order to understand the use and influence of scientific information. Chapter Three outlines the methodologies employed for locating and analyzing citation data from Web of Science, Google Scholar, Google, and monographs. Chapter Four contains analyses of the citation data gathered from each source and demonstrates that each provides unique, relevant insights into grey literature's overall influence. Chapter Five discusses and summarizes the importance of collecting citations from multiple sources and sets out recommendations for future grey literature studies.

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

Research documentation relevant to the determination of methods for tracking and measuring the influence of grey literature was consulted for this thesis. A straightforward definition of scientific grey literature was posited by the GreyNet group, originally in 1997 and revised in 2004, which states that grey literature as "information produced by all levels of government, academics, business and industry in electronic and print formats not controlled by commercial publishing, i.e., where publishing is not the primary activity of the producing body" (GreyNet, 2004). As noted in Chapter 1, the Online Dictionary for Library and Information Science (ODLIS) provides a more detailed definition, which states that grey literature is "not readily available through regular market channels because it was never commercially published/listed or was not widely distributed" (Reitz, 2007). This definition also points out the potential lack of editorial control, which may call into question the authenticity or reliability of a publication. Whereas the Grey Net definition tries to encompass all domains of grey literature, the ODLIS definition is rooted more closely within scientific information. For the purposes of this thesis, only rigorously reviewed grey literature associated with a reputable publisher was considered.

The editorial practices and standards that the UN-based Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) applies in its reports published by the various sponsoring agencies meet or exceed those of traditional peer-reviewed journals, and as a result, it can be assumed that they meet the requirements necessary to be considered scientifically authoritative. This reputability coupled with the pertinent information contained in its reports strongly suggests that GESAMP's publications can justifiably be used in public policy and decision making contexts. This assertion has informed this study of whether GESAMP's publications are cited in both science and public policy, with the ultimate goal of gaining a better understanding of the organization's influence.

A seemingly obvious starting point in determining the influence of GESAMP's publications is to identify who is citing its grey literature and ascertain what these citations mean. The literature on citation studies provides detailed accounts of what it means for an author to cite a scientist's or working group's publications, and is useful in interpreting GESAMP's influence.

The changing face of scientific publishing must be considered in conjunction with the nature of scientific citation studies. Most new and original scientific knowledge has traditionally been conveyed in peer-reviewed journals, which remain among the most visible and prestigious venues available to scientists. However, over the past two decades considerable shifts have occurred in publishing practices that are based primarily in evolving Web technologies, such as free accessibility of grey literature and open access materials, institutional repositories, pre-print archives, and publications placed directly online by scientists (Borgman, 2007). Citation studies similar to those that attempt to measure the influence of scientific papers published in peer-reviewed journals have been conducted for these emerging technologies, typically under the over-arching title of webometrics (Thelwall, 2008, 2009). The research literature details shifts in publishing techniques and new forms of citation tracking, and has suggested that the traditional peer-reviewed journal is losing its once untouchable position as the primary publishing venue for scientists and work groups. While it remains to be seen what impact open access to information will ultimately have on commercial publishers, it cannot be assumed that only scientific knowledge published in journals is relevant to scientists, policy makers, the general public, and other potential stakeholders. Instead, the publishing shift and the rise of webometrics makes it not only possible, but necessary to look beyond traditional citation analysis methods to better understand how grey literature influences other scientific studies and public policy. A focus on online citations sources will highlight the emerging role of Web-based technologies in disseminating alternative sources of information.

2.2 Distribution and Use of Grey Literature

As noted above, grey literature is loosely assumed to be any scientific information that conforms to generally accepted scientific principles, but which is published outside of traditional, peer-reviewed, mostly commercially-published scientific journals. Over the past decade several authors expressed very positive outlooks about the impact grey literature would have on public policy and in the general communication of science. At the end of the 1990s Farace wrote that grey literature "in the coming century will be perceived and judged by the contributions it makes in resolving scientific and technical, as well as social problems facing the public and private sectors" (Farace, 1997, p. 73). He cited developments in electronic dissemination technologies and the "breakthrough of network publishing" as factors that will contribute to these developments (Farace, 1997, p. 73). Non-standardized collection practices and cataloguing techniques applied to grey literature were also emphasized as a major factor in preventing the effective dissemination of the information contained in that genre (Farace, 1997). By the late 1990s Farace was able to show that internet technology had advanced to allow scientific information to be shared and published more quickly than in printed forms. This theme was picked up a few years later by Weintraub who pointed out the "relatively long period to effect change in a world that communicates mainly in print" (Weintraub, 2000, p. 55) and then suggested that the increase in dissemination speeds allowed by internet technologies would "have implications for the formation of science policy and public attitudes in a more profound way than in the past" (Weintraub, 2000, p. 57). While Weintraub was no doubt correct in stating that increased speed of scientific communication has occurred because of the development of internet technologies, it still remains unknown if the impact on scientific and public policy communities has truly been as profound as he once suggested. As a counterpoint, the speed of communication allowed by the internet has created a glut of information that has decreased users' abilities to discover relevant, timely information in the manner Weintraub envisioned, as well as creating information overload on the user's desk. While the true impact of Web-based scientific publishing probably falls somewhere in between the two extremes, it is

important to note that the potential benefits of speed and accessibility offered online may be confused with the unproven assumption that these factors have contributed to greater use of grey literature.

While increased speed of communication was welcomed by authors such as Farace and Weintraub after the emergence of internet technologies, collection and distribution policies of institutions such as academic libraries and health sciences practitioners had to incorporate appropriate strategies for grey literature to keep up. In discussing grey literature collection policies for academic libraries, Gelfand expressed an optimistic attitude about the positive effects of speedier information diffusion similar to Farace and Weintraub. Although she was "increasingly convinced that grey literature is in a new heyday" (Gelfand, 1997, p. 16), her outlook and recommendations were slightly more cautious. She predicted that grey literature will prove to be a useful resource for libraries to obtain, but that the rapid proliferation of the material would remain a "thorn with which libraries must deal" (Gelfand, 1997, p. 22). Three years later, Gelfand identified a series of fears of adopting grey literature in libraries, such as a need to "organize information in new ways," a requirement for "greater reference and curatorial support," and a loss of "control and seeing new relationships emerge between library staffs and their methods of obtaining and using their collections" (Gelfand, 2000, p. 140). This perspective represents a significant shift away from the optimism of statements made in 1997. Gelfand concluded that grey literature is "being created in digital formats at *alarming speed* [italics added], in all subject areas, around the globe, and it is often defied by adequate bibliographic description" (Gelfand, 2000, p. 147). What was heralded only a couple years earlier as an excellent opportunity for increased scientific ability to solve problems due to swifter communication systems is regarded here with significantly more reserve, especially within the academic library community.

Strategies for organizing grey literature have continued to advance as attitudes and approaches have become more focused on how to handle available grey literature and as collection policies have become more sophisticated. A number of grey literature compendiums deal with information available on the internet; these include resources

such as the Grey Literature Report hosted by the New York Academy of Medicine. This bimonthly publication alerts "readers to new grey literature publications in health services research and selected public health topics" and catalogues "all resources" in an Online Index available to over 800 subscribers (New York Academy of Medicine, n.d.). The site represents a well-organized, accessible (subscriptions are free) approach to disseminating health information that falls into the grey category. Similarly, science.gov acts as a "gateway to more than 50 million pages of American government scientific information," the majority of which can be considered grey literature (http://www.science.gov). While this large number of pages represents an intimidating breadth of information, the site is search-enabled, and at the very least represents an attempt to categorize and legitimize information being produced by the American government. These sources represent efforts to consolidate all the grey literature in a given field, but it is also worth noting that organizations such as GESAMP have taken steps to ensure the information they produce is available easily. Historically, the Group's influence may have suffered from limited print runs and dissemination, as well as inconsistencies with cataloguing techniques (Cordes, 2004). Even though print versions of GESAMP reports are still being published, most users now likely turn to the Web site http://gesamp.net/ as the primary source for the reports. Overall, while the New York Academy of Medicine's Report, Science.gov and GESAMP's Web site do not represent a complete list of the resources that catalogue and disseminate grey literature in an organized way, they serve as excellent examples of the steps being taken to overcome the problems of standardization and availability that have been a concern of academic librarians for years. Grey literature is being produced on a large scale, with stakeholders expressing interest in both the medium as well as individual producers taking steps to disseminate knowledge. These Web resources represent important initiatives in the effective collection and distribution of grey literature.

2.3 Historical Use and Significance of Scientific Citations

Before discussing some of the techniques and theories entailed in traditional citation analysis, it is important to outline the historical context from which the practice emerged.

An understanding of how citations have traditionally been regarded within scientific communities is the logical starting point for an overview of citation analysis. Citations serve as a way to acknowledge sources that informed a study, thus alerting a reader about preceding work. This concept has been explained more eloquently in terms of scientific tradition which "requires that scientists, when documenting their own research, refer to earlier works that relate to the subject matter of their reported work. These bibliographic references are supposed to identify those earlier researchers whose concepts, theories, methods, equipment, and so on, inspired or were used by the author in the process of conducting and presenting his or her own research" (Nicolaisen, 2007, p. 610). The process of citing is not a new procedure, as one author, in describing the evolution of the practice from the Middle Ages to modern sciences, states that "authors have always made references" (Leydesdorff, 1998, p. 9-10). Cronin metaphorically envisioned citations as "frozen footprints on the landscape of scholarly achievement; footprints which bear witness to the passage of ideas" (Cronin, 1984, p. 25). While Cronin expressed doubts as to the validity of reading too much into what citations actually "mean" with regard to influence or use, he agreed that it should be possible to follow the footprints and "construct a picture of those who have passed by, whilst the distribution and variety furnish clues as to whether the advance was orderly and purposive" (Cronin, 1984, p. 25). Regardless of whether or not citation analysis allows researchers to determine a definite definition of relationships between citing and cited papers, it is impossible to deny, as Cronin has recently written, that "the citing of one author by another is treated as a significant event in communication terms, and the more significant events recorded in favor of a particular author, the greater that author's presumed influence or prestige" (Cronin, 2005, p. 95). The view that citations are an indicator of communication among authors and a measure of some, albeit possibly limited, impact or influence from one article to another will be adopted in this study. It is important to note that the basic idea of citation studies lies with the traditional view that citations represent a form of connectivity between authors even though all citations do not have equal value.

The literature agrees that the organized study of scientific citations directly coincided with Garfield's introduction of a unified Scientific Citation Index (SCI) in 1955 (Cronin,

2001; 2005). The system works by indexing rigorously selected journals and captures the citation data available in each paper. The SCI uses this citation data to list all citations made in a paper, as well as to indicate publications that cited the paper itself. Thelwall clearly explains that the "SCI was created as a database of the references made by authors, to earlier articles, in their articles published in the top scientific journals" and argues that the "underlying idea, [which is] still highly relevant today, is that if a scientist reads an article, then s/he would benefit from knowing which articles cited it, since they may cover a similar topic and might update or correct the original article" (Thelwall, 2008, p. 606). Even though some of the practices of citation and bibliometric analysis were already well established by the time the SCI was envisioned and introduced, the tool gave scholars access to a volume of information that had to that point been unrealized.

A wide range of scholars attribute the subsequent development of citation analysis techniques to the creation of the SCI. Writing in 1984, Cronin suggested that "citation would not have emerged as a serious 'academic' issue for sociologists and historians of science had not the commercial development of citation indexing proved so successful" (Cronin, 1984, p. 6). It should be noted, however, that although bibliometric analyses took place before the advent of the SCI, its presence along with the "availability of electronic access (online, CD-ROM, and Web-based) to the [SCI's] massive datasets, has had a catalytic effect on the popularity, scope, and ambition of bibliometric research" (Cronin, 2005, p. 175). Similarly, authors agree that the tools that were developed to realize Garfield's notion have set the standard for scientific citation analysis, (Bar-Ilan, 2008b; Cronin, 2001; MacRoberts and MacRoberts, 1989; Meho, 2007; Nicolaisen, 2007; Rowlands, 2002; Thelwall, 2008). These authors present a wide range of approaches that ground themselves in the culture of citation analysis first proposed by Garfield. Although they may propose alternatives to traditional citation analysis practices and assumptions of influence, the authors place their studies in an established historical context. These papers show that citation analysis is deeply rooted in Garfield's contributions.

Traditional citation analysis has not completely accounted for recent developments in publishing practices and dissemination techniques, a point that will be discussed at more

length below. Cronin wrote in 1984 that "scientists may be less than totally satisfied with the scholarly journal as a dissemination mechanism… they are deeply attached to it as a means of preserving a faithful and reliable account of scientific progress; as a repository of accepted ideas and beliefs" (Cronin, 1984, p. 12); however, the literature has shown that this is no longer as applicable as it once was. Although grey literature has typically played a role in disseminating scientific knowledge, it is now more widely available and accessible than ever before. Whereas scholarly journal articles may have traditionally been regarded as the pinnacle of scientific communication, recent developments in publishing and attitudes about communication are turning more to open-access and grey literature thanks in large measure to developments in accessibility. As will be shown below, shifts in publication practices have led to necessary changes in the theories surrounding citation analysis.

Several criticisms of citation analysis should be kept in mind in any study employing the techniques. One question that has been raised is whether instances of scientific citation can be said to be a direct representation of influence. Considered simplistically, the natural answer is affirmative, as the citing author is assumed to have read, interpreted, and applied previous scientific studies to his or her work in a responsible manner. But science does not exist or operate entirely in a vacuum free from "non-scientific" pressures, such as increasing personal or institutional status, or conforming to political agendas. Arguments abound about instances of self or institutional citation for purposes of self promotion, or overloading an otherwise weak paper with citations to help increase its visibility (Cronin, 1984, 2005; MacRoberts and MacRoberts, 1989). These arguments suggest that visibility and acknowledgement of published works by peers and colleagues can be a goal of scientists that may supersede the tenets of doing science for the sake of increasing knowledge and understanding. The negative effects that such practices may have on the larger scientific community as well as any stakeholders affected by policy decisions could be damaging. The potentially negative applications of citation analysis techniques noted in the literature helped to inform the methodologies used in this study, which were designed to minimize misuse of citations.

Journal Impact Factor (JIF) is one of the most important developments to emerge out of Garfield's theories. JIF determines how many times papers appearing in a journal have been cited over a given period of time and subsequently journals are ranked according to their scores on this scale. In a 2006 paper on the history of the JIF, Garfield stated that: "A journal's impact factor is based on 2 elements: the numerator, which is the number of citations in the current year to items published in the previous 2 years, and the denominator, which is the number of substantive articles and reviews published in the same 2 years" (p. 90). "Substantive articles and reviews" excludes aspects of journals such as letters and book reviews. The underlying notion is that journals with higher impact factors are more prestigious and scientists will strive to publish their work there even though being published in those journals may prove to be difficult because acceptance rates are low. Hoeffel pointed out that "experience has shown that in each specialty the best journals are those in which it is most difficult to have an article accepted, and these are the journals that have a high impact factor" (quoted in Garfield, 2006, p. 92). While the validity of this statement has been questioned (counter-arguments will be discussed below), historically, the JIF has been held in considerable esteem in the world of citation-analysis and is used widely in performance assessments.

2.4 Changes in Scientific Publishing Patterns

The milieu of scientific communication and publication has changed significantly in recent years. Two main developments explain the shift in publishing practices: "the computerization of the printing process, reducing costs significantly and allowing more journals and books to appear in print; and the conversion of the entire publishing cycle (submission of articles, refereeing and publication) to the internet, allowing faster and possibly cheaper communication throughout" (Thelwall, 2008, p. 605). The latter development may be the most interesting to consider in connection with grey literature, which as has been noted above, has had its worth reevaluated since its potential visibility has significantly increased thanks to online availability. In his explanation of how bibliometrics has also had to respond to publishing shifts, Thelwall stated that "Web

publishing of an increasingly broad range of research-related documents, from articles to email discussion lists, [necessitates] the creation of a range of new metrics relating to their access and use" (Thelwall, 2008, p. 605). Although he did not explicitly name grey literature in his discussion, Thelwall described many of the forms in which grey literature now appears. Borgman offered a very similar interpretation which imagines the evolution of scholarly publishing as partly attributable to the "'pull' of new technologies and partly to the 'push' of institutional restructuring" (Borgman, 2007, p. 76). Cronin questioned whether "the move to online and open-access publishing provide[s] new measures of authorial salience and intellectual impact?" (Cronin, 2005, p. 5). While not suggesting any specific answers, Cronin's question serves as recognition of the important impact developments in publishing methods may have on the scientific process. Perhaps most importantly, Cronin questioned "what exactly does it mean to publish in the digital age?" (Cronin, 2005, p. 16). This question will be addressed indirectly in this thesis, as current technology allows anyone with Internet access to "publish" to the Web. In such a system, what differentiates grey literature from any other source purporting to be scientifically authoritative? Future definitions of grey literature may need to account for increased public access to information, and the controls needed to ensure its quality.

Although it is easy to cite the development of the Web as the major advancement in electronic access to information, actual publishing practices and research initiatives can be investigated which more concretely describe how these technologies are being used. In a chapter in her book dealing with scholarship in a digital age, Borgman stated that the "production of more digital content is pushing the development of scholarly information infrastructure technologies to manage it, and the availability of more digital content, tools, and services is pulling more scholars toward using them" (Borgman, 2007, p. 31). In her explanation of emerging tools, Borgman very informatively went beyond simply attributing the change to access to the Web, and instead discussed the impact of digital libraries, international initiatives in scholarly infrastructure, as well as e-research initiatives (Borgman, 2007). These technologies, along with others such as online institutional repositories, have created a system where "more people can discover, retrieve, and read more scholarly content than was ever before possible" (Borgman, 2007,

p. 77). While several authors address developments in electronic access to information in relatively vague terms relating to electronic access to information, Borgman clearly grounds actual developments in concrete terms, which is especially helpful in determining why scholarly communicative practices have been and are being subjected to considerable change.

Changes in publishing practices have also had an illuminating effect on the differences by which scientific information is communicated among disciplines. A notable example occurs in the area of high-energy physics, where a large body of information is conveyed through electronic pre-print archives (Brown, 2001; Cronin, 2005). According to Brown, a preprint is the "precursor to an article that may eventually be published in a peer-reviewed journal" (Brown, 2001, p. 187). These pre-prints allow physicists to remain at the cutting edge of recent developments in the field and have been used "for over 3 decades to facilitate large international collaborations, to avoid duplication of effort, and to bypass lengthy journal publication schedules" (Brown, 2001, p. 187). The concept of the pre-print conforms well with Borgman's suggestion of a system which, if properly adopted, "could make data and documents permanently accessible throughout the life cycle of research and learning" (Borgman, 2007, p. 77). While the vast amount of information available to scientific communities can, in some cases, be problematic in terms of sheer volume, swift communication benefits disciplines such as high-energy physics greatly. Resources such as the Los Alamos E-Print Archive (arXiv.org) allow high energy physicists to disseminate information at a rate that significantly exceeds the ability of traditional printed journals.

2.5 Beyond Traditional Citation Analysis

The literature has shown considerable progress in areas of study outside the territory of traditional citation analysis. It has been established that traditional approaches to citation analysis need to be reevaluated in order to better understand influence and new methods are proposed for collecting citation data. To this end, the ways in which Web-based searching have been employed to try to replicate Web of Science citation searching, as

well as attempts to prove the validity of these methods, are of particular interest. As Thelwall insightfully surmises, "mainstream bibliometrics has evolved rather than undergone revolutionary change in response to the Web and Web-related developments" (Thelwall, 2008, p. 607). This development is shown by studies that have found a direct correlation between citation searches completed within Google and Google Scholar to the results available via the traditional source of citation collection in Web of Science (Charbonneau, 2006; Kousha and Thelwall, 2007a; Vaughan and Shaw, 2005). Much like the attempts to re-evaluate and critique citation analysis techniques noted above, those studying webometrics validate their findings by comparing them to the old standards. Opinions expressed about citation analysis do not suggest that the long-standing system should be torn down and recreated from scratch, but instead pay respect to previously established norms.

Studies comparing the old guard of citation analysis to the emerging technologies have concluded that a correlation exists between citation counts found in Thomson Reuters's Web of Science and those in Google / Google Scholar. An article in the March 2006 issue of *University News* details a study performed by Daniel Pauly of the University of British Columbia and Konstantinos Stergiou of Aristotle University of Thessaloniki in Greece, which concluded that "you can use Google essentially for the same purpose as you use Thomson ISI [the former name of Thomson Reuters]" (Charbonneau, 2006). Interestingly, the article suggests that the reason for the correlation may be a direct result of grey literature's availability on the Web, because even though Google Scholar cannot access the same breadth of commercially published literature, it makes up in its total counts by accessing grey literature not indexed by Web of Science (Charbonneau, 2006). Pauly and Stergiou's study may be criticized for having a narrow focus, as it covered "114 papers from 11 disciplines published between 1925 and 1990" (Charbonneau, 2006). The conclusions drawn in the article must be taken with some caution, as even other studies that attempt to show a similar correlation are more reserved about declaring outright a direct correlation between Web of Science and Google Scholar (Kousha and Thelwall, 2007a; Vaughan and Shaw, 2008).

While Pauly and Stergiou stated direct correlations exist between quantitative citation data located in Google Scholar and Web of Science (Charbonneau, 2006), it is important to note studies that reach similar conclusions with qualifications or more reserved conclusions. For example, Kousha and Thelwall (2007a) found "a significant correlation between Google Scholar citations and ISI citations in all disciplines" which serves as "strong evidence that Google Scholar has a widely applicable value in citation counting" (Kousha and Thelwall, 2007a, p. 1063). However, the authors also note discrepancies in disciplinary counts between Web of Science and Google Scholar; higher counts were returned in the results of searches for biology, chemistry, and physics in Web of Science. Conversely, a larger number of results were available from the social science disciplines of sociology, economics, psychology, and education for Google Scholar (Kousha and Thelwall, 2007a). Similarly, Vaughan and Shaw found that "on the individual article level, there is a significant correlation between ISI and Web citations. Articles receiving more ISI citations also received higher numbers of Web citations and vice versa" (Vaughan and Shaw, 2005, p. 1081). However, the authors offered these results with caution, calling the disciplinary differences in citation counts "reasonably consistent" and warning that the results of Google Scholar searches could be unduly influenced by instances of self-publishing and self-citing (Vaughan and Shaw, 2005). In a study conducted two years later, Vaughan and Shaw found that with regard to publications by faculty members working in library and information studies there was a higher correlation between the citation results for Google Scholar and Web of Science than there was for citations retrieved from Google (Vaughan and Shaw, 2008). They suggested that if Google Scholar can eliminate some of its problems (which will be elaborated below), the overall higher citation counts representing intellectual impact could make the search engine "the primary source for measuring research impact" (Vaughan and Shaw, 2008, p. 328). While all of these studies have shown that there are positive correlations between citation patterns found via Google Scholar and Web of Science, none are so bold as to suggest that one can be substituted for the other. It is clear that the increasing recognition that Google Scholar is emerging as a legitimate source of citation data deserves attention, as locating citations to grey literature is ultimately best suited to a Web-based environment that is free from the restrictive indexing practices of Web of Science.

Despite its limitations, Google Scholar has emerged recently as a search tool that can be used legitimately in the tracking and compilation of citation data.

An important question arising from the conclusions of studies showing correlations between Web of Science and Google Scholar is whether the online availability of open access and grey literature materials actually increases its use over printed versions. In order to properly determine use, underlying assumptions about the correlation between information readily available for free and actually being accessed and used must be questioned, much like the assumption that each instance of citation uniformly represents influence. A number of studies attempt to show that free online access does indeed increase the use of the source. Vaughan and Shaw (2008) mentioned "mounting evidence that publications available on the Web are cited more frequently than those that are less readily available" (p. 319). Vaughan and Shaw (and other authors who wish to establish that online availability increases the impact of a paper) cite a study that showed "the ability to locate relevant research quickly will dramatically improve communication and scientific progress" (Lawrence, 2001, p. 521). Working with conference articles in computer science, his study showed a considerably higher rate of citation for those articles available online than those that were not (Lawrence, 2001). However, in a somewhat confusing move, the one-page paper did not discuss its methodologies at length. More recently, researchers have shown that there is a distinct citation advantage for open access articles, although they are uncertain as to why this is the case (Norris, Oppenheim, and Rowland, 2008). Even though the authors were able to establish that there were differences among the ways in which different subjects operate, they recommended more work be done to explain the underlying causes of the open-access advantage. While there is evidence that online availability of articles does increase their use and impact, careful consideration of how and why these documents are being cited needs to be carried out to ensure that a consistently applied definition of citation influence is maintained. Thus, we are left with the tenuous assumption that online availability does increase use which will need to be proven through direct analysis of individual incidents of citation.

Once Web citations have been found, other studies have been conducted to evaluate and categorize the motivations behind the citations. Kousha and Thelwall (2007b) provide an excellent example of expressing webometric data through qualitative contexts in their study "How Is Science Cited on the Web? A Classification of Google Unique Web Citations." After a lengthy literature review, the authors present their method for searching for and subsequently classifying the citations they found online (Kousha and Thelwall, 2007b). This research attempts to uncover how the internet is used to increase scientific communication, most notably the informal scholarly communication or exchange of information within "invisible colleges," as well as investigate the "types of citation to open-access journal articles in science" available via Google (Kousha and Thelwall, 2007b, p. 1633). The authors used a classification scheme that categorizes some citations into informal scholarly sources, which consist of citations that are the "by-product of any kind of scholarly communication," in the form of a "class reading list, presentation file, or a discussion board or forum message" (Kousha and Thelwall, 2007b, p. 1634). As well, Vaughan and Shaw proposed a classification scheme based on a 2003 pilot project that categorizes citation instances in a similar way, grouping citations into research / other intellectual impact as compared to perfunctory or nonintellectual impact (Vaughan and Shaw, 2005). In their system, research and intellectual impact is represented by papers that are posted on the Web, or materials that are listed in a bibliography or reading list for a course or other teaching related sources (Vaughan and Shaw, 2005). In their estimation, nonintellectual impact is represented by bibliographic lists on journal or author Web sites, Medline, conference announcements or descriptions, and items such as message boards and newsletters (Vaughan and Shaw, 2005). The authors were confident enough with their classification scheme to retain it in a study published in 2008, although they expanded their classification of Web content due to continuing evolution of the Web; to accomplish this, they added categories that accounted for Web-based developments such as blogs (Vaughan and Shaw, 2008, p. 321). These studies indicate significant thought has gone into developing categories that will be useful for classifying the influence that GESAMP has when its publications are cited in instances found through Web searches as well as those located in Web of Science.

While previous studies offer useful strategies for citation classification systems, some authors mention the difficulty of choosing a system that can be applied consistently and accurately as being a major hurdle (Kousha and Thelwall, 2007b). This observation emphasizes that in order to establish a classification system of use for both Web citations and those found through Web of Science, careful attention will need to be paid to forming a scheme that can be applied with equal accuracy to citations from both sources. Simplicity of classification may prove to be the most effective strategy, as Kousha and Thelwall suggest that broad categories should be the goal. This approach is reflected in the classification system employed by Vaughan and Shaw, since 2003, which uses rather broad descriptive terms. In order to determine a classification system appropriate to the study of GESAMP's publications, it is likely that the searching methodologies may need to be repeated and an appropriate set of classification guidelines drawn from the results.

While much has been written about approaches to webometric searching, an underlying question remains – what do Google and Google Scholar actually index? Whereas Web of Science clearly outlines which publications are indexed, Google has not yet released its indexing policies or algorithms used for searching. Several authors highlight this unknown variable (Bar-Ilan, 2008b; Kousha and Thelwall, 2007a; Kousha and Thelwall, 2007b). Bar-Ilan notes that "Google, probably on purpose, does not provide any explicit information either about the number of records or about its time coverage" (Bar-Ilan, 2008b, p. 258), but quite unfortunately does not suggest reasons for why this secrecy is maintained. Ultimately, the unknown nature of Google's indexing measures means that a direct comparison with Web of Science is difficult. Although studies have shown how the citation counts correspond between Web of Science and webometric research, the underlying unknown leads to a situation where a direct comparison is not valid. While this situation does not necessarily invalidate the results of these and future webometric studies, it is important to recognize as a potential area of contention. Since Google is very unlikely to reveal its indexing practices, this unknown will remain a factor to be noted and for which precise methodologies must be followed to account for the differences in the two search tools.

Other potential problems and considerations of the difficulties behind using Google and Google Scholar as tools for Web-searching are identified by authors that go beyond not knowing how the search engines index content. For example, Kousha and Thelwall draw attention to the fact that "Google often displays two hits per site" even though steps may have been taken to try to limit search results to unique Web URLs (Kousha and Thelwall, 2007b, p. 1634). Similarly, Vaughan and Shaw mention the difficulties in distinguishing between citing and cited papers in the results of searches, as well as the fact that "a single citation act may be represented multiple times when one citing work appears on several Web pages" (Vaughn and Shaw, 2008, p. 328). This state of affairs for the Web does not imply that Web of Science is problem free; however, researchers have had several decades to become accustomed to its limitations. Since citation analysis has been built largely around the Web of Science, it becomes increasingly difficult to separate traditional understanding of what should be expected of Web of Science and the total picture now available.

2.6 SUMMARY

Considerable work has gone into describing appropriate methodologies to approach citation analysis from new angles. While some of these methodologies call into question the very foundation of citation analysis – the Scientific Citation Index – an underlying respect and attention is paid to what can be learned from this index. While both traditional and webometric approaches to citation analysis have intrinsic benefits as well as limitations, various studies have suggested methods that can be used to effectively address the basic question of how to measure the influence scientific grey literature has on both scientific and public policy communities. As Nicolaisen stated in an overview of citation analysis, "ignoring the reference (i.e., ignoring the history of the citation) in order to understand the citation is logically impossible" (Nicolaisen, 2007, p. 633). The literature reviewed above has shown that in building an understanding of how GESAMP's publications are cited and what these citations may mean in terms of determining influence, one must be aware of both historical applications of citation

analysis as well as proposed methodologies that have evolved along with new publishing practices. This is particularly important as GESAMP has been producing publications during the societal transition to desktop computing, the Web, and to extensive use of search engines. Moreover, its publications in total have only recently become available on the Web.

CHAPTER 3 METHODOLOGY

Various citation analysis techniques were used in this study to investigate the influence of GESAMP's grey literature publications. Citations served as a proxy for measuring influence following the argument posited by numerous scholars that "citation counts are reasonable indicators for the impact of research" (Kousha and Thelwall, 2009, p. 1537). Data from four sources – Web of Science, Google Scholar, Google, and monographs – were collected and analyzed to account for where and how GESAMP was cited. This analysis enabled a more thorough understanding of GESAMP's influence than traditional practices. Whereas previous citation analysis relied entirely on data collected from Web of Science, studying data from other citation sources identified other important indicators of influence that are not tracked in traditional studies.

Each source of citation data was selected for its unique contribution to an understanding of the use of GESAMP's publications. Web of Science contains a large volume of citation data extracted from articles appearing in about 10,000 scientific journals chosen by Web of Science. The selective nature of Web of Science's indexing practices and ranking of journals have historically imbued those periodicals with prestige or respect in scientific communities. Papers published in these journals have long been considered sources of reliable, authoritative scientific information. Conversely, through citation data obtained from Google and Google Scholar, trends in Web publishing can be tracked in information sources not indexed by Web of Science. Searches in Google and Google Scholar can provide insights regarding the influence of GESAMP's publications in the open Web in areas such as law and public policy. Finally, monographs on a variety of subjects were read for citations, as they represent a source of data not addressed in previous studies of grey literature, nor covered by Web of Science, Google, or Google Scholar. A methodology for selecting relevant monographs and interpreting citations contained in those volumes provided heretofore unrealized insights. While the aggregate data generated by citation analysis cannot by itself confirm influence entirely, understanding of the influence of GESAMP publications in scientific, public policy, and decision-making contexts can be increased through examination of where and how they

were cited. Citation data were assembled and analyzed from each of the sources in the following order:

i) Web of Science
ii) Google Scholar
iii) Google
iv) Monographs

The steps employed to gather data were adopted from previous studies and customized for use in this thesis.

3.1 Web of Science

Locating citations to GESAMP's technical reports in Web of Science required a large variety of search strings in order to account for the number of ways the publications have been cited (Cordes, 2004). Because of a large number of indexing irregularities, the searching methods developed by Cordes were followed to ensure complete data collection. The majority of search results were located with the search string "*GESAMP*"* in the cited author field. However, numerous other search strings were required to accommodate the citation deviations. Citing authors sometimes mistakenly identified the sponsoring agencies as publishers of the reports or attributed authorship to a sponsoring agency, or in some cases misspelled GESAMP's acronym. All of these variations are indexed differently in Web of Science necessitating separate search strategies to locate citations. Accounting for all variables required an assortment of "Cited Author" and "Cited Work" strategies in Web of Science (see Appendix 2). Difficulties in searching were compounded by GESAMP's publication history, as the agency has published 77 items in its *Reports and Studies* series. Titles of each report were also used as search strings in order to account for misattributed citations, and specific search strings were needed to locate citations to documents co-published in the *Regional Seas* series of the United Nations Environment Programme.

Additional search strategies were required to locate citations to books and journal articles based on selected GESAMP reports. For example, citations to *The Sea Surface and Global Change*, based on GESAMP report #59, were retrieved through searches on the title of the book as well as the editor, P.S. Liss, as a cited author. To ensure that no citations were missed, searches for the 14 individual authors who contributed chapters to the volume were also conducted. In a similar manner, searches for citations to journal articles based on GESAMP reports #38, #40, #45, and #62 were also carried out. To update citation data Cordes assembled to 2002 (Cordes, 2004), searches were conducted in Web of Science through February 2009. The resulting dataset contained citations covering GESAMP's entire publication history to the end of 2008.

Each citing article located in Web of Science was examined to confirm citations to GESAMP reports. Once citations were confirmed, information from the citing articles was entered into a ProCite database and coded according to the GESAMP publications they cited. Coding facilitated analysis in both the Procite database and a Microsoft Access database, where the information was exported to allow queries to specific questions. Each record in the Procite database contained the following bibliographic information: the author(s) of a citing document and the geographic location of the first listed author, article title, publishing journal, volume, issue, and year of publication, and the abstract of the article. The coding system was based on the number of the title of reports in GESAMP's "Reports and Studies" series. For example, *Estimates of Oil Entering the Marine Environment from Sea-based Activities* is number 75 in the "Reports and Studies" series. Documents citing this report were assigned the code "#75." Coding was also used to distinguish documents that cited the books and journal originally published as GESAMP reports. For example, documents citing the book published by Blackwell (GESAMP, 1991b), based on GESAMP report number 39, *The State of the Marine Environment* were coded "39B" to distinguish citations to the book from citations to the original technical report which were given the code "#39." When an article cited more than one GESAMP report, a code for each report was included in the database record.

To determine whether the authors of citing documents, already familiar with GESAMP through a relationship with the organization, cited GESAMP reports more or less than authors without a relationship, a database of the names of individuals with some direct involvement was compiled from names listed in each of the technical reports, meeting documents, published histories of the organization, and the organization's Web site. Names were entered into the database if an individual was a scientific member of GESAMP, a member of a working group that contributed to the production of a report, an observer of a meeting, a reviewer of a technical document, or a member of the secretariat staff of one of the UN agencies that sponsor GESAMP.

Data analysis was conducted with the Procite database and a custom-made Access database. Selected fields were exported from records in the Procite database to the Access database. The latter database facilitated analysis, as it allowed for queries to be written for specific questions of the study as they arose from examination of the data. Procite was particularly helpful for initial assembly of citation data, but does not support customizable query formulation in the manner available in Access.

3.2 Google Scholar and Google Methodology

In order to track usage of GESAMP's publications beyond evidence obtained from Web of Science, the methodologies developed by two teams of researchers – Vaughan and Shaw (2005; 2008) and Kousha and Thelwall (2007a) – were followed. These authors located Web citations via the Google and Google Scholar search engines. In their initial study Vaughan and Shaw claimed that Google is both the "largest Web search engine" as well as the most stable (Vaughan and Shaw, 2005, p. 1078). Kousha and Thelwall give the same reason for using Google (Kousha and Thelwall, 2007). Both sets of authors used phrase searching of article titles (and added other indentifying information as necessary) to find Web citations.

Citation data collected from Web of Science was used as a benchmark for Web search strategies. The Web of Science data was used to rank GESAMP's grey literature reports in terms of the number of citations each had received and the ten most frequently cited reports and ten least-cited in GESAMP's publication history were identified. The title of each report was then entered within quotation marks in Google and Google Scholar searches along with the acronym GESAMP to ensure accuracy of results. The search results for each report title were examined individually to confirm that each represented a valid instance of a citation to a GESAMP report, thus preventing the collection of false-positive hits. A citation was accepted if the title of the report was present somewhere in the resulting hit and was obviously related to GESAMP. For example, one GESAMP report is entitled *The State of the Marine Environment*, which is a phrase prevalent throughout marine environmental literature and is not specific to GESAMP. Results that included this phrase but had no obvious reference to a GESAMP report were discarded. Pertinent bibliographic data for each valid result was entered in a ProCite database, including author, title of document or Web site, publisher, date of publication, and stable URL where available for each category. Since standard bibliographic data, such as author and date of publication, are often not available from sources available on the Web, many records do not contain such data.

Among the GESAMP reports searched in Google and Google Scholar were instances of reports which had been republished as a book or journal article and the latter sharing the title of the original report. Only the results that specifically cited the GESAMP report were chosen in these instances. Sources containing citations to books or journal articles were ignored, unless the original GESAMP report was also cited. Since GESAMP reports, as grey literature, were the focus of this study, citations to published books and journal articles were excluded.

Search preferences in Google and Google Scholar were set to maximize the efficiency of data collection. English was set as the preferred language in the "Search only for pages written in these language(s)" option and ten results were listed per page. If a hit did not

include a hyperlink for investigation of a source, the hit was omitted. The second result in Figure 2 shows a search result that cannot be accessed from Google Scholar.

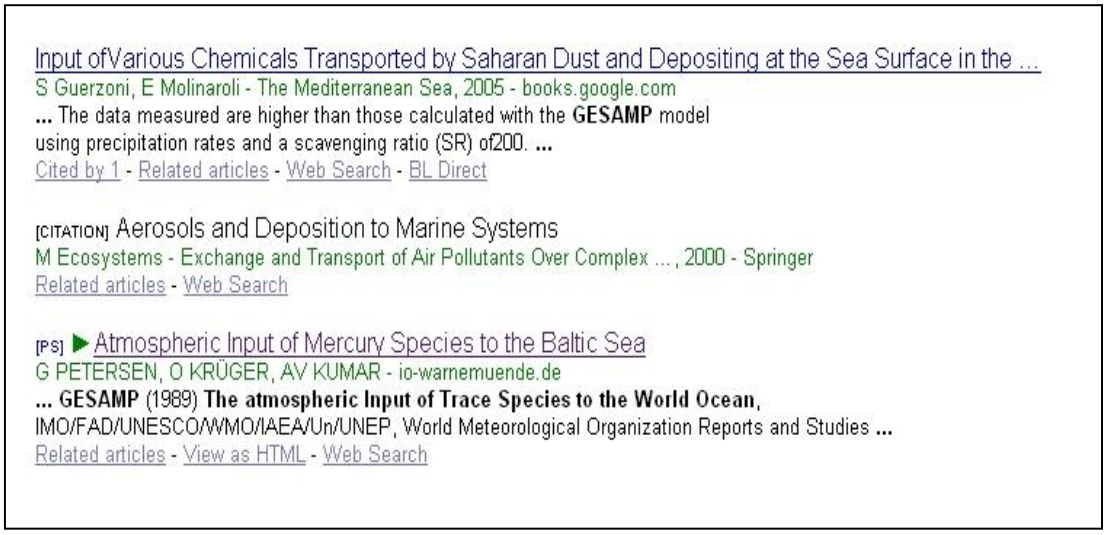

Figure 2. Example of a Google Scholar "[CITATION]" Search Results

While steps were taken to verify results lacking hyperlinks, in many cases verification proved impossible. Thus, as noted above, further investigation was deemed an inefficient use of time and pursued no further. Other pages which could not be readily opened, such as in instances of dead links or security warnings stating that the page about to be opened was not safe, were similarly disregarded. Inoperative result links were rare; thus, the exclusion of these results was deemed to have little impact on the overall trends of the collected data.

To avoid collecting false-positives as valid data, confirmation of citations to GESAMP publications in each result returned by Google and Google Scholar was required. Each link was opened and the GESAMP reference was located in the source (or, in cases where no GESAMP reference was located the result was considered a false positive and disregarded). For each valid hit, data from the document or Web site was gathered and entered into a ProCite database. Since a variety of results were returned ranging from online technical reports and papers to educational Web sites, identifying information was more commonly available in some sources than others. For example, the author(s) of an online paper was often more apparent than the persons or group responsible for the

creation of a Web site. The following types of information were entered in the Procite database whenever possible: the author or group responsible for the Web site or document and their geographic location, the journal or book containing the GESAMP reference, the stable URL for future reference to the result, date of publication, and the series number of GESAMP reports identified in the source. Since similar information had been extracted from Web of Science, a comparison of citation sources was feasible.

Google and Google Scholar – Understanding Search Results

All the results collected from Google and Google Scholar were classified in order to identify characteristics of the citing sources. This coding was necessary since the Web is host to large quantities of superfluous information which may not indicate use of GESAMP's publications. For example, a search result that was simply a Web site generated by GESAMP which listed the title of a report gives no clear indication that the report has been used; instead, the result simply indicates the existence of a GESAMP report.

The classification of Web hits was based on a scheme developed by Vaughan and Shaw (2005; 2007). They viewed Web citations as "text mentions of an article in a source on the Web" and classified these instances in terms of research / intellectual impact and perfunctory / non-intellectual impact (Vaughan and Shaw, 2005, p. 1076). Impact was defined as being "cited in a paper that is posted on the Web (the vast majority [being] papers from conference proceedings or online versions of articles published in journals)" (Vaughan and Shaw, 2005, p.1078). In a 2008 article, Vaughan and Shaw suggested a classification system that included seven types of Web citations that represent intellectual impact: "journal paper, conference paper, full paper, report, book chapter, thesis/student paper, [and] class reading list. Bibliographic services and 'others' represent non-intellectual impact" (324). It is important to note that full papers are meant to represent papers found on Web sites but it is not clear whether they are journal papers, draft papers, or papers presented at a conference (324). The authors used this classification system for both Google and Google Scholar.

In this thesis, each result from the Google and Google Scholar searches results was examined and coded using a classification system based on the Vaughan and Shaw system which identified each type of citing source. The nature of the sources that cited GESAMP publications required some modification of the classification system developed by Vaughan and Shaw. For example, a distinction was made between a Web site that simply provided a list of documents (coded as Bibliography) and a Web site that actively directed viewers to GESAMP reports based on topics of interest (coded as Subject Bibliography). The following list of codes was used:

1. Codes attributed to Web results that indicated active use of GESAMP reports

- Book – Assigned when one citing author or group of authors was responsible for an entire book available online. The list of references in these books related to the entire work.
- Book Chapter – Used when specific chapters of a book were individually authored, for example, a collection of essays. Each chapter had its own list of references.
- Conference – Used for accounts of a conference or workshop as well as a paper or presentation at a conference when they referred to a GESAMP report.
- Subject Bibliography – Differentiated from Bibliography (see below) because results directed readers to a GESAMP report based on subject areas. For example, a Web site may provide a bibliography of documents regarding oil pollution of the sea, and list the GESAMP report titles applicable to this area of study. This list indicated that the author of a citing Web site was familiar with the contents of each GESAMP report, rather than simply listing all of the reports in GESAMP's publication history.
- Dissertation – Used for masters or doctoral theses or dissertations.
- Journal – Identified a citation in an article in an online journal not indexed by Web of Science.
- Meeting – Used to identify meeting proceedings that cited GESAMP reports or included them as discussion documents.

- Online Paper – Used for citations in documents that appear to be journal articles, but do not indicate whether they are an online journal, conference, etc. (identified as "full papers" by Vaughan and Shaw).
- Other – Some citing documents did not fit into any other category. Examples include blogs, debate notes, news stories, educational Web sites, and concept notes.
- Proposal – Used to indicate proposal documents (e.g., grant proposals) that cited GESAMP reports.
- Report – Used to indicate technical reports, reports prepared for governments or interest groups, as well as briefing papers.
- Web of Science – Used to indicate hits that duplicated data that had already been collected during Web of Science searching.

2. Codes attributed to Web results that were considered perfunctory use of GESAMP reports.

- Bibliography – Used to indicate lists of publications (such as those given on Web sites hosted by GESAMP or FAO), or library catalogue search results.
- Commercial – Used for commercial Web sites that sold GESAMP reports as either PDF file downloads or paper reports.

As will be noted in Chapter 4, the search results from Google searches encompassed a wider variety of categories in the classification system than results of Google Scholar searches. Google Scholar results tended to include duplicates of Web of Science results, or citing documents present in online journals or in digitized books. Google results, on the other hand, required all of the aforementioned codes to account for the various ways citing documents were made available on the Web.

3.3 Acronym Searches and Google Web Links

The term "GESAMP" was entered in both search engines to locate connections between information producers and GESAMP's publications not revealed by searches for citations

to titles of its technical reports. Searching for the acronym GESAMP returned a large number of results in both cases. A search performed in Google on December 22, 2008 returned 36,700 results. Of these results, 445 were considered by Google to be "unique." While the algorithm Google uses to determine duplicate results is unknown, this study assumed that sampling from the unique results would suffice to offer insights into GESAMP's Web presence. A Google Scholar search for the acronym GESAMP completed on January 4, 2009 revealed "about 2,440" English language results. In this case, it was not possible to determine the total number of unique hits, as Google Scholar would not display results beyond page 10. Even with the number of results per page set to 100, it was not possible to go beyond the 988th result.

A sample of 100 results from each search engine was selected in each case. Systematic samples were chosen from the total number of results the two search engines identified as unique hits (445 in Google and 988 in Google Scholar). A sampling interval was identified that would achieve a sample size of 100 in each case and which ensured Web sites were selected throughout the full list of unique results, rather than focusing on the top hits ranked by the Google and Google Scholar algorithms. A sample size of 100 was considered sufficient for purposes of illustrating GESAMP's Web presence represented by notation of its acronym. A brief summary of how GESAMP was referred to in each source was included in a Procite database in addition to bibliographic information The total set of 200 records was analyzed to gain a broad overview of how GESAMP is cited or referred to on the Web.

A Google "link search" was performed on January 18, 2009 to gain further understanding of GESAMP's online profile. The link search was activated by entering "link:" into the Google search bar, followed by the full URLs for GESAMP's Web page. These "link searches" identify Web pages that link to the specific URLs. GESAMP has three URLs that Web sites could potentially be linked to: http://www.gesamp.net, http://www.gesamp.imo.org, and http://www.gesamp.org. However, the same set of linked pages was located using the search for each of the three URLs.

3.4 MONOGRAPH METHODOLOGY

Citations to GESAMP publications in monographs (books and printed government publications) represent uses which are largely overlooked in sources indexed by either Web of Science or Google. Therefore, separate searches for citations within a sample of monographs were conducted to identify uses of GESAMP's publications available in printed formats. Searching for citations in monographs is decidedly more time consuming than online searches, as the data must be collected manually. Since such searches have not been previously conducted, a method for selecting monographs was developed. Two factors were kept in mind when determining a strategy to efficiently locate citations in monographs: an appropriate sample to search and a method to determine which monographs would be sampled from available resources.

A sample size was determined with the awareness that searching through every available potentially citing monograph was neither a realistic goal nor necessary for this study. A sample size of 500 was set as a manageable number of monographs to scan for citations, and from which to obtain insights regarding patterns of citations to GESAMP reports. Further, it was assumed that this sample size was sufficient for assessing the effectiveness of the method followed to locate citations in monographs. The following steps detail the monograph search process:

1. Location and collections of monographs.

In order to select monographs covering subject areas where GESAMP reports might be cited, the broad ranging collections of Dalhousie University Libraries were chosen. These collections based in the W.K. Kellogg Health Sciences Library, Killam Memorial Library (science, social science and humanities), Sir James Dunn Law Library, Pharmacy Library, and the Sexton Design & Technology Library ensured the sample of monographs was not restricted to one subject area to the exclusion of others. For example, whereas the Killam Memorial Library includes monographs on the science of marine pollution, the Sir James Dunn Law Library holds publications pertaining to public

policy and law. In addition, since most monographs are only available in print format, access to readily available collections was needed for individual examination of each volume. The wider range of subjects available in the Dalhousie University Libraries as opposed to the more focused collection in the nearby library of the Bedford Institute of Oceanography was deemed more suitable for gaining insights about citations to GESAMP publications found in monographs.

2. Set of monographs to sample.

The sample was drawn from monographs located in Dalhousie University Libraries with subject headings corresponding to those of GESAMP reports. This approach was followed as it was assumed that publications on the same subjects as GESAMP reports would more likely cite GESAMP reports than monographs on other subjects. Identification of the pool of monographs was achieved in the following manner:

- Citation data from Web of Science was used to rank the number of times each GESAMP report was cited. From this ranked list, the five reports most-cited, the five least-cited, and the five reports that comprised the median of the list were identified and recorded (see Appendix 3 for a list of the reports).
- An entry for each report was located in the Novanet catalogue for holdings of Dalhousie University Libraries. The title of each GESAMP report and associated Library of Congress Subject Headings found in each catalogue record were entered into an Excel spreadsheet.
- The subject headings extracted from the Novanet catalogue records were used to search for monographs on each subject held by Dalhousie University Libraries. Advanced searches were completed in NovaNet for each subject heading as a phrase (for example, “Marine Pollution” was sought specifically; instances of subdivisions such as “Marine Pollution – Gulf of Mexico” were not be returned by these searches).
- The number of monographs for each subject heading was recorded in the Excel spreadsheet for a total number of 1114 potential monographs to search.
- The search results for monographs for each subject heading were exported in their entirety to the Refworks online bibliographic software. This step ensured that the

sample would not be affected by any changes in the catalogue of holdings of Dalhousie Libraries after the searches were performed. A stable set of search results was thereby established which could be consulted at any point as the study continued.

- Subject headings applicable to more than one GESAMP report were only searched once. For example, "Marine Pollution" was entered as a subject heading search in NovaNet only once, even though it was associated with several GESAMP reports.
- In a few cases where a search returned a single hit for a subject heading, the result was excluded as it simply was the GESAMP report from which the heading had been originally drawn. No steps were taken to exclude GESAMP reports from the results of subject heading searches that returned titles of multiple monographs.
- The total number of monographs located for each subject heading (other than searches that returned one title) were used to determine the corresponding percentage of the total population of 1114. For example, the search for monographs on "Marine Pollution" returned 130 results, which represents 11.7% of the total pool of potential monographs. Since the target sample size for this study was 500 monographs, 500 was multiplied by 0.117 to determine that 58 number of monographs needed to be consulted on the subject of "Marine Pollution." The same calculation was performed for the number of monographs on each subject to establish the sample.
- Restrictions were not placed on the types of monographs identified in the searches of the Novanet catalogue. Government publications, technical reports, and other monograph forms of grey literature were located and included in the sample as valid examples of monographs.
- The ratio of the total number of relevant monographs and the sample of 500 titles was approximately 2:1. Every second book was selected from the list of monographs in each subject exported to the Refworks file. Monographs in the Refworks file were sorted by publication date in reverse chronicle order.

3. Monographs were located and scanned for citations.

After the list of monographs was generated for each subject category, the monographs were retrieved from the stacks of Dalhousie University Libraries. Approximately 400 were readily available and correctly shelved, leading to unobstructed retrieval. Retrieval of the remaining 100 entries was complicated by several factors, including instances where other library users had checked out materials, items were lost or improperly shelved, and when GESAMP reports had mistakenly been selected in the monograph sample. Several approaches were used to overcome these obstacles. For example, materials that had been checked out by other users were recalled. In the cases of lost, missing, or mistakenly included items, the RefWorks' list of subject headings was consulted to select the next valid entry for the sample.

The reference lists and bibliographies of monographs that comprised the sample were scanned for certain terms indicating a GESAMP citation. These terms were made up of the four terms or phrases most likely to be included in a citation: GESAMP, Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, UNEP, and IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP. It was necessary to limit the number of potential citation formats since manual scanning of monographs is a very time-consuming process; GESAMP has been cited in such a variety of ways since its inception that looking for every potential permutation of the acronym would greatly increase the time spent scanning each monograph. This strategy should still have located the vast majority of citations.

When citations were located in a monograph, both the page number of the citation as well as the GESAMP report being cited were noted. If a reference list or bibliography indicated that one of the GESAMP's reports had been cited but did not direct readers to the specific citing pages, each page of the monograph was scanned for citations. In this latter scanning process, it is possible that citations were overlooked. In total, approximately one tenth of the monographs cited a GESAMP report at least once. Additional instances where GESAMP was included in a list of important acronyms or

mentioned in the index were also noted, even though GESAMP reports may not have been included in reference lists or bibliographies.

The text surrounding citations in the monographs was scanned using a scanner capable of performing Optical Character Recognition (OCR). Pages were scanned as OCR to allow the text to be manipulated, i.e., copied and pasted as Word documents in a file created for each citing monograph. The title of each Word document indicated the page number of the citing page, and sections of text around citations were highlighted for quick reference. In addition to page numbers where citations were located in the citing monograph, additional information was noted, including the chapter where a citation appeared, along with descriptive sections or subsections in order to give further context to the citations themselves.

3.5 DATA ANALYSIS

Data from each source were subjected to several analyses to illustrate methods by which unique insights into grey literature's influence can be revealed. Data analyses were used to answer the research questions posed by the thesis about the influence of GESAMP publications as well as the impact of grey literature as a whole. Chapter Four outlines the specific analyses performed on each dataset. Uniform analyses could not be performed for each set of data due to inconsistencies in publication information provided by some sources. For example, Web of Science includes the date of publication of the journal of every citing article, making it possible to track citations to GESAMP publications by year. In contrast, sources retrieved on the open Web using Google were significantly less likely to have an identifiable publication date, thereby making it impossible to perform accurate yearly analysis of citations to GESAMP publications.

CHAPTER 4 RESULTS & ANALYSIS

This chapter presents analyses of the data collected from each source of citations consulted in this study. Discussion of Web of Science data is given first, followed by data from Google Scholar, Google, searches for the acronym "GESAMP" on the open Web, Web link search results, and monographs. For each dataset, analytical techniques clearly illustrate why such data are important for an overall understanding of the influence of grey literature. Methods of analysis will differ between data sources based on the availability of bibliographic information. As the following sections show, the variety of analyses that can be conducted on data collected from each source of citation data emphasizes the importance of including data from multiple sources in a measure of grey literature's influence.

4.1 WEB OF SCIENCE ANALYSIS

This section begins with a brief recapitulation of the search processes used to locate citations to GESAMP's reports and related publications in Web of Science. Several analytical techniques are then applied to the citation data to promote better understanding of the citation trends. The analysis takes two broad perspectives. First, descriptive statistics evaluate GESAMP's influence determined from the total number of citations to the group's publications and the journals that cite GESAMP's publications most frequently. This analysis also identifies GESAMP's publications most frequently cited throughout the publication history of the group. Second, more focused examination establishes additional understanding drawn from the citation data. All of the analyses together help to build a multi-faceted metric of grey literature's influence since they depict evidence of use and clarify information use trends.

Search Strategies

The search methods developed by Cordes (2004) for locating citations to GESAMP publications in Web of Science were followed. Cordes collected citation data from the

inception of GESAMP through to the middle of 2002. Since her search techniques were comprehensive, the same methods were applied to update Web of Science citation data. Searches were undertaken to obtain all of the citations for the year 2002 and data collection continued to the end of February 2009 to ensure that citations for 2008 had time to be indexed in Web of Science. Thus, the final dataset included 2631citations from 1971 to 2008 inclusive.

Aggregate Data

In the first line of analysis, the 2631 citations to GESAMP reports and related publications can be examined in aggregate to begin to understand the influence of this grey literature. Figure 3 shows the distribution of these citations over time, beginning with 1971, the first year that citations to GESAMP publications appeared in sources indexed by Web of Science.

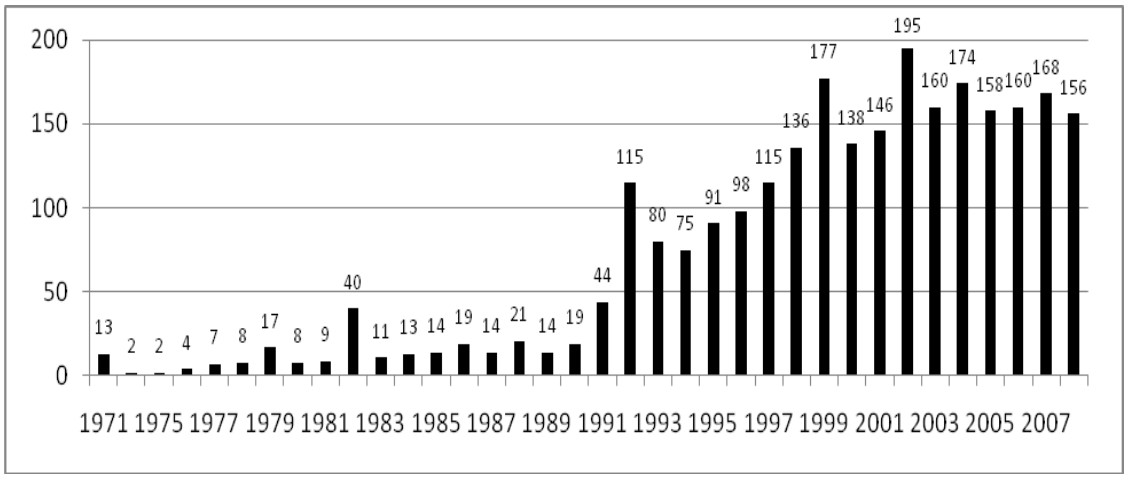

Figure 3. Aggregate GESAMP Citation Data

Figure 3 shows a generally level trend in yearly citations from 1971 to 1991, when an increase occurs through to 1999 and then plateaus through to 2008. The trend in the 2000s indicates that GESAMP publications have generally received a higher level of citations per year than at any other point during the group's publication history.

Further Analysis by Year – 1991 and 1992

Outliers in the annual citation frequencies to GESAMP publications, notably citation spikes seen in 1992, 1999, and 2002, are shown in Figure 3. An early spike in citation trends occurred in 1992, and the highest number of citations in GESAMP's history were indexed in 2002. Closer examination of the data for these two years identifies the most frequently cited reports or related publications. Figure 4 shows the 1992 citations, with the horizontal axis indicating the series number of the GESAMP report. The coding differentiates GESAMP technical reports from other publication formats such as books or journal articles, and also indicates co-publication in UNEP's *Regional Seas* series.

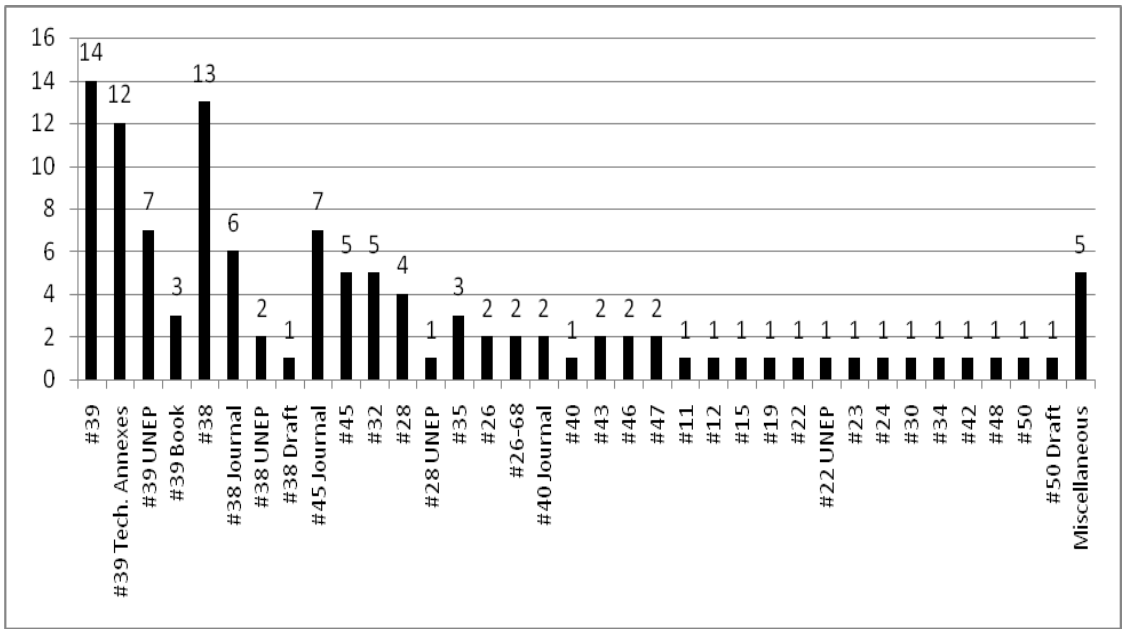

Figure 4. GESAMP Citations by Year - 1992

A small number of publications contribute an especially high number of citations to the yearly total. Many citations refer to the various versions of report 39, *The State of the Marine Environment* (GESAMP, 1990). This report was widely recognized as an internationally relevant, authoritative assessment of the health of the world's oceans, and it is also the document with which GESAMP is most often associated. The version GESAMP published as a report received the most citations (14) during 1992. A version of the report published by Fowler in *Marine Environmental Research* in 1990 (coded in Figure 4 as #39 Tech. Annexes) received ten citations (Fowler, 1990). Report 39 was also

republished by UNEP in its *Regional Seas* series (#39 UNEP), which was cited seven times in 1992. The book version published by Blackwell (#39 Book) was cited three times. The citation data for 1992 for Report 39 and all its versions, published during or after 1990, shows evidence of rapid use. The number of citations in 1992 to the report version was not surpassed in any subsequent year, suggesting the information in *The State of the Marine Environment* had an immediacy that is reflected in the relatively high citation counts. All of the versions of report 39 were cited 36 a total of times, representing 31.3% of the 115 citations in 1992 or nearly a third of the citation spike in that year.

Report 38 (GESAMP, 1989a) was also cited more frequently than most of GESAMP's reports in 1992, receiving 13 citations. These citations can be historically contextualized to provide possible explanations for the report's popularity. For example, in 1992 the report was about three years old, which allowed time for it to be read and incorporated as a reference in a journal article, and also time for the citing journal itself to be published and indexed by Web of Science. Furthermore, report 38 never received more than 13 citations in any year previous or since, which suggests that it may have been especially relevant in 1992. Additional context can be established by looking at an article based on the report published in *Global Biogeochemical Cycles* in 1991, which would go on to be the single most-cited document in GESAMP's publication history (see Figure 6 below, for example). In 1992, when it was cited six times (#38 Journal in Figure 4), the article was less than two years old and its full citation history had not emerged. Report 38 was also republished in UNEP's *Regional Seas* series (#38 UNEP in Figure 4), which received 2 citations in 1992. Finally, a draft version of the report (#38 Draft) received one citation. Altogether, report 38 was cited 22 times in 1992, or 19.1% of the total citations in that year.

Together, reports 38 and 39 and their related publications account for 50.4% of citations in 1992. The remaining citations relate to a wide variety of GESAMP publications; seven citations refer to a journal article based on report 45, five citations to report number 45 itself, report number 32 was cited five times, and report 28 received four citations. Other

citations relate to thematic reports or reports of sessions. Five citations were classified as miscellaneous, as they referred to initial reports of GESAMP sessions (not numbered in a GESAMP publication series) or related historical accounts written about the agency. In total, 22 publications each received one citation. By 1992, 77 GESAMP thematic reports, reports of sessions, and related publications had been published. During the year itself, 36 of these 77 publications were cited. Even though the majority of citations were to reports 38 and 39 and their related publications, the observation that 36 GESAMP publications were cited shows wide use. The citation distribution for 1992 suggests that GESAMP's work was influential in a number of different studies. The extent of use may also suggest increased awareness of GESAMP and a higher profile in the early 1990s. For example, during this period, GESAMP was acting as an advisor to the United Nations on Environment and Development (UNCED) Earth Summit '92 (MacDonald, Cordes, and Wells, 2004). One possible explanation for this trend is the salience of reports 38 and 39 and their related publications.

A comparison of citations for 1991 and 1992 reinforces the importance of certain publications that contributed to the 1992 spike. Figure 5 shows the publications cited in 1991. Reports 38 and 39 and their related publications are the most-cited publications, although the frequency of citation for both reports is less than in 1992. In 1991 fewer GESAMP reports and related publications are cited, with only 16 different publications as opposed to over 40 in 1992. Five publications each received a single citation, which is much lower than the 22 publications cited only once in 1992. The data in Figure 5 hints that reports 38 and 39 and their related publications will be cited more frequently as time passes. The low number of reports that received only one citation each in this dataset supports the hypothesis that GESAMP's profile was raised as reports 38 and 39 gained greater recognition through increased use. In other words, overall awareness of GESAMP may have increased largely due to the publication of the highly cited reports. These reports may have prompted citing authors to look at the agency's other publications, which could in turn explain why a higher number of reports were cited at least once in 1992. The 1991 dataset also points to a growing awareness of GESAMP reports in the

early nineties, which suggests that the reports published at that time were closely relevant to the issues of the day.

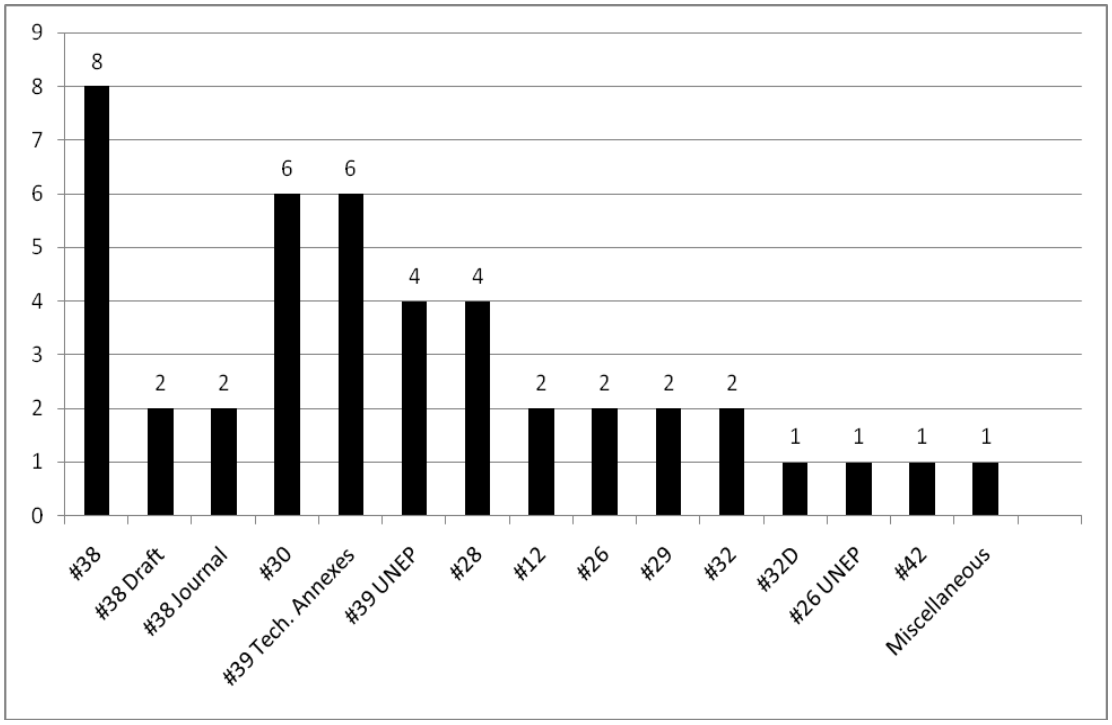

Figure 5. GESAMP Citations by Year - 1991

Further Analysis by Year – 2002

Figure 6 shows that 195 citations were retrieved from Web of Science for 2002, the highest yearly total in GESAMP's publication history. The highest number of citations refer to a journal article based on report 38. A sizeable number of citations refer to other non-grey publications, with the book version of report 59 and journal article based on report 62 receiving over 30 citations (19 and 13 citations respectively) in total. The majority of citations relate to only a few GESAMP publications, and the overall total is bolstered by a low number of citations to many additional publications. This pattern is similar to the tendency noted in 1992, where more than 35 GESAMP publications were cited, with a small number of publications standing out as the most frequently cited.

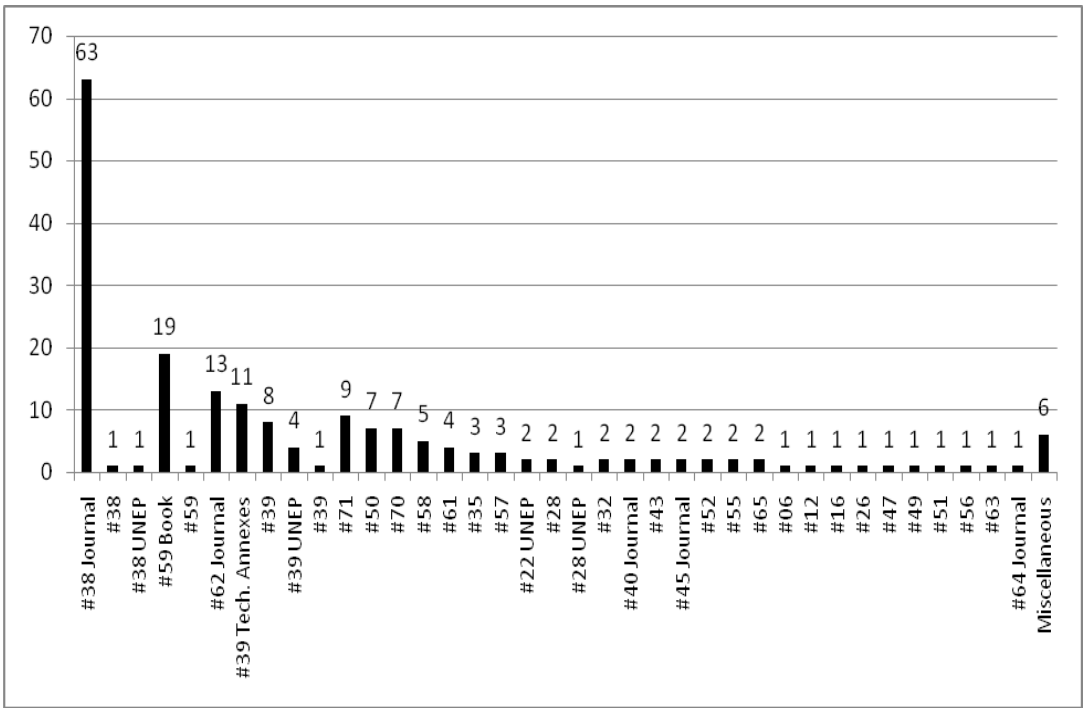

Figure 6. GESAMP Citations by Year - 2002

Citations to GESAMP Documents by Type

GESAMP's technical reports are primarily published as grey literature and are now available both in print and online (all reports were available online as of 2007). However, some of the agency's reports have been republished in various other formats and citations to these additional documents were collected. The publication type of the cited document was noted for each citation.

The primary purpose of this study is to determine the elements of a metric for measuring the influence of grey literature. Identifying citation trends in terms of publication type is, therefore, required in order to understand the influence of the reports published as grey literature. The majority of citations were to two distinct types of GESAMP publications: the grey literature reports published in the *Reports and Studies* series and non-grey titles such as books and journal articles. Table 1 shows the number of citations to each publication type, which totals the 2631 citations located during the study. There are about 200 more citations to grey literature publications (1416) than primary literature (1215).

Grey Literature	**# of Citations**
GESAMP Thematic Reports	1110
GESAMP Reports of Session	52
UNEP Thematic Reports (Co-publications)	194
Draft Documents	47
Miscellaneous	13
Total	**1416**
Primary Literature	
Books / Journal Articles	1201
Histories	14
Total	**1215**

Table 1. Types of Cited GESAMP Documents

Two types of publications stand out in each of these categories: the "GESAMP Thematic Reports" in the grey literature category with 1110 citations and the "Books / Journal Articles" in the primary literature category with 1201 citations.

Citations to Thematic Reports (Grey Literature)

GESAMP's thematic reports are the most frequently cited type in the grey literature category (1110 citations, or 42.2%). Figure 7 shows the citation distribution to the end of 2008 for the 30 most frequently cited thematic reports, which account for 92% (1021 out of 1110 citations). Citation data for all technical reports in the GESAMP *Reports and Studies* series are shown in Appendix 3.[1]

[1] For this thesis, total citation frequencies per report were used rather than being normalized to account for the various periods over which each report could have been cited since each report has a different period since publication.

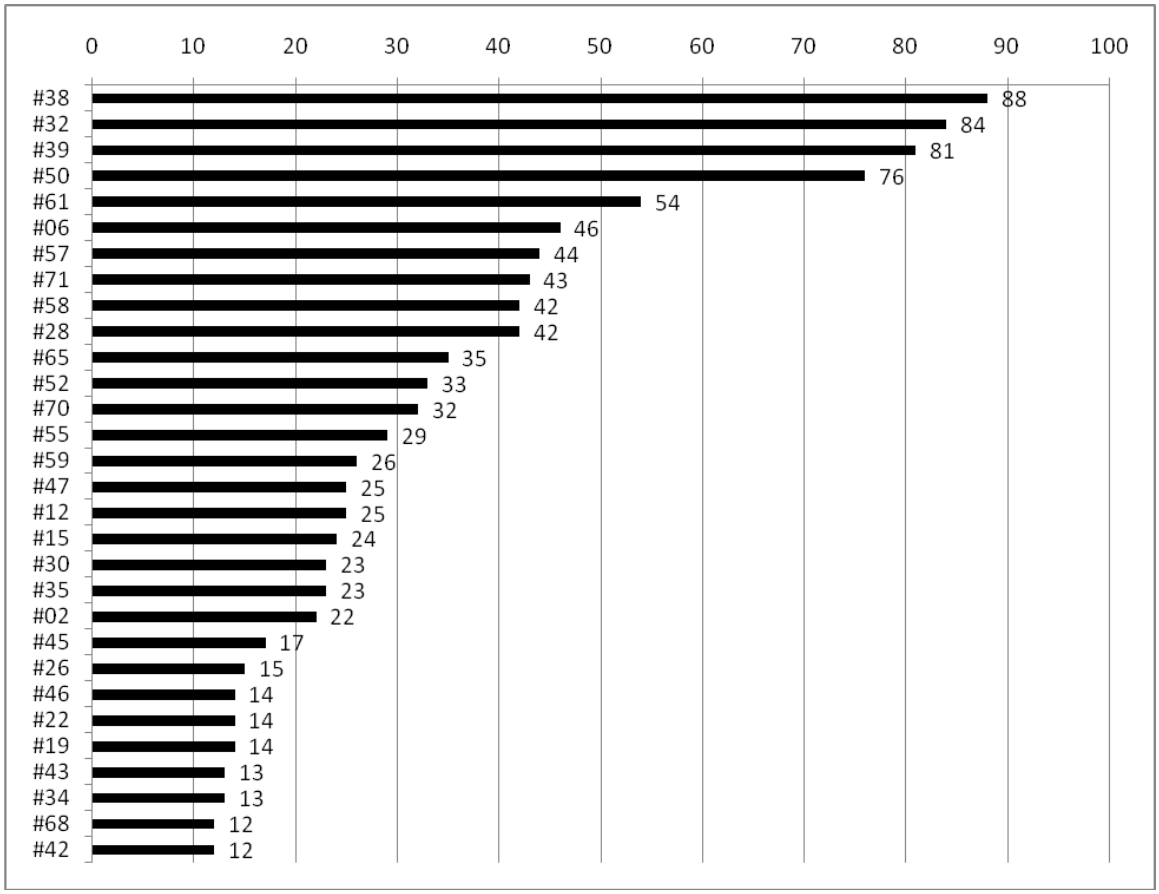

Figure 7. Citations to GESAMP's Most-Cited Thematic Reports to the End of 2008

Once GESAMP's most-cited thematic reports had been identified, further analysis could be conducted. For example, the citation history through 2008 for the five most-cited GESAMP reports is outlined in Figure 8. These reports, published between 1987 and 1996, are: Report 38, *The Atmospheric Input of Trace Species to the World Ocean*; Report 32, *Land/Sea Boundary Flux of Contaminants: Contributions from Rivers;* Report 39, *The State of the Marine Environment*; Report 50, *Impact of Oil and Related Chemicals and Wastes on the Marine Environment*; and Report 61, *The Contributions of Science to Integrated Coastal Management.*

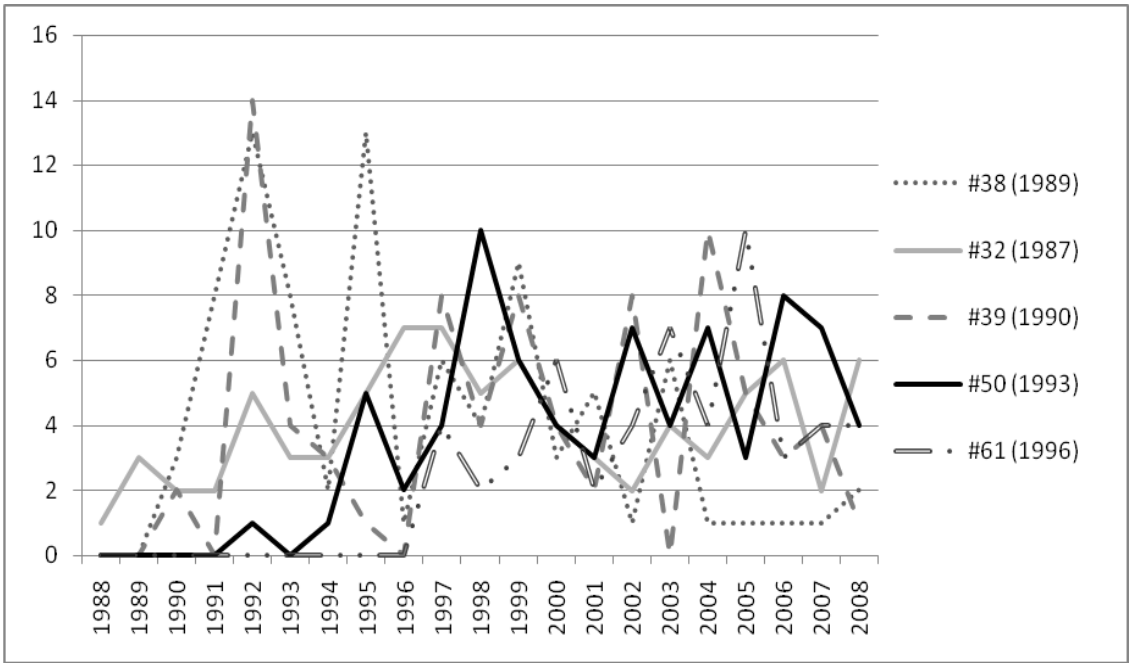

Figure 8. Citation History of the Five Most-Cited GESAMP Reports

While this figure does not show repeating patterns among the reports, two observations can be noted. Reports 38 and 39 reach citation peaks soon after their publication, whereas other reports, such as 50, take longer to achieve their highest level of citation. Citation patterns can be complicated as in the fluctuating citation peaks for report 38. Figure 8 shows that in most cases citation frequency peaks a few years after the publication of a report, followed by a low but steady citation rate.

Explanations for why the five reports have been more frequently cited than others require looking beyond temporal trends such those shown in Figure 8. Alternative theories may help explain the relative popularity of these reports. For example, two of GESAMP's most frequently cited reports, numbers 38 and 39, were republished in non-grey forms. Duce et. al (1991) published a journal article based on report 38. Similarly, a book version of report 39 published by Blackwell (GESAMP, 1991b) and the technical annexes to the report published as a journal article (Fowler, 1990) have been cited extensively. The variety of publication formats of the information in both reports may have prompted citing authors to revisit the original source reports. Conversely, the reports

may have been deemed important enough to warrant republication in other forms. Furthermore, the authors of the original grey literature reports may have been driven to republish their findings in additional forms. These potential explanations may only be verifiable by direct discussion with members of GESAMP. Explanations for why particular reports have higher citation frequencies than others can prove enlightening in determining appropriate elements to include in a metric of influence of information published as grey literature.

The theory that multiple publication formats encourages higher citations is tested in Figures 9 and 10 where trends in citation frequencies for report 38 and 39 are shown. The downward trend over time for both reports indicates reduced use of the reports as they age. This could be attributed to the tendency to prefer new information in science. Another explanation is that citing authors focused less on the original grey literature reports and chose to cite the primary literature formats instead when a choice existed. However, as both Figures 9 and 10 show, there is no consensus in the trend lines (which were determined by Microsoft Excel) for citation frequencies to the primary literature formats (book and journal article versions) over time. There is a relatively steep incline in the trend line for citations to the journal article version of report 38 (shown in Figure 9). In contrast, the trend line for the book based on report 39 shown in Figure 10 is nearly horizontal, suggesting more or less constant citation frequency. Furthermore, the trend line shows a decline for the primary journal version of the technical annexes to report 39 and there seems to be no rise in the use of the book publication, coupled with reduced use of the grey literature report. The peaks in citation frequency for both the technical annexes and the report generally coincide with one another. Figure 9 clearly shows increased use of the primary literature publication type coinciding with reduced use of the grey literature report, to which very few citations have occurred since 2004. This finding is not mirrored in Figure 10, and, instead, suggests reduced use over time of all forms of report 39 (report 39 was superseded by reports 70 and 71 in 2001). Thus, it is difficult to conclude that publication in multiple forms necessarily leads to increased awareness of a grey literature report, given the lack of a definitive pattern in these examples.

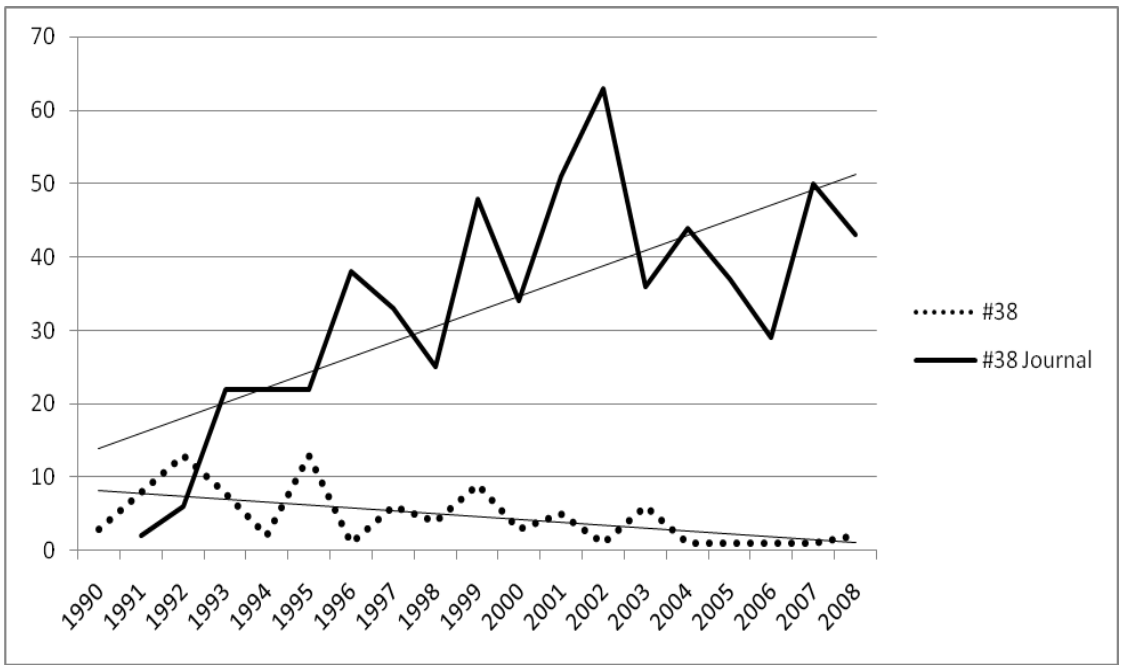

Figure 9. Report 38 – Citations to Grey Literature Report and Journal Article (trend lines determined by Microsoft Excel)

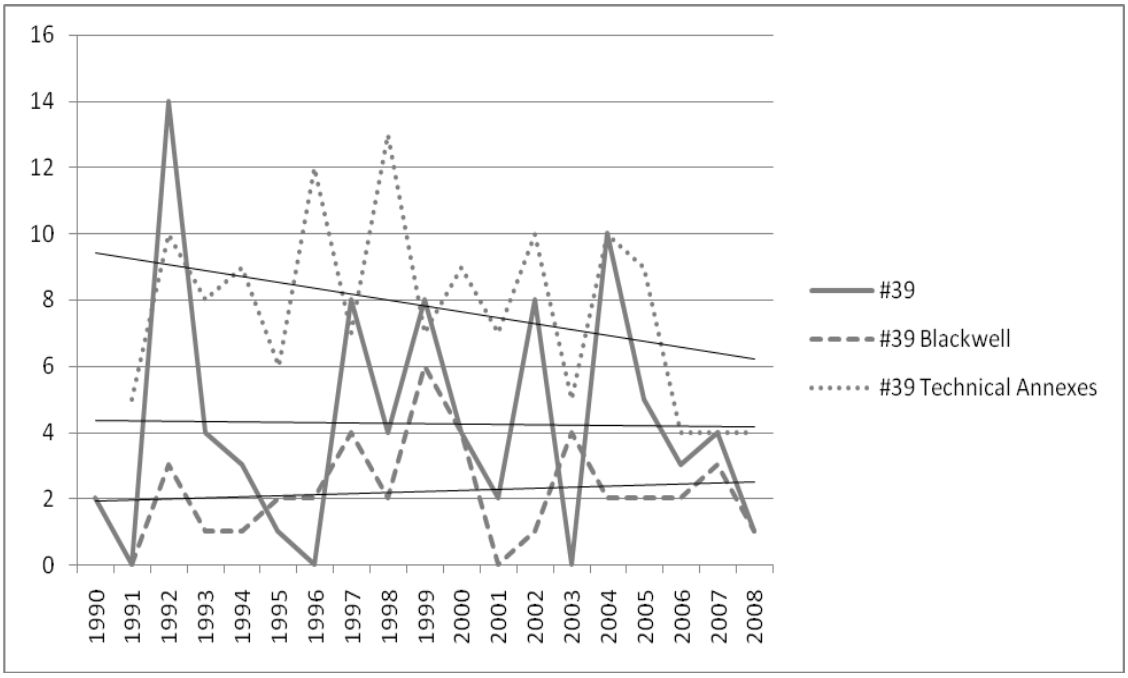

Figure 10. Report 39 – Citations to Grey Literature Report, Book, and Technical Annexes (trend lines determined by Microsoft Excel)

Co-Publications With UNEP's Regional Seas Series (Grey Literature)

GESAMP reports co-published in UNEP's *Regional Seas* series were cited 194 times. These citations are distinguishable from those to GESAMP publications either because UNEP is credited in the statement of responsibility in reference lists, or because the *Regional Seas* series number is referenced. The search strategies used to locate citations in Web of Science anticipated that some authors would attribute the publication of these reports to one agency over another, and steps were taken to ensure that citations to reports co-published by UNEP were gathered. Although these citations do not directly refer to reports published by GESAMP, the information is exactly the same. Collecting citations to co-publications was, therefore, determined to be appropriate for gaining an understanding GESAMP's influence. Additionally, the UNEP reports are published as grey literature, making the citation data also relevant to the study.

Figure 11 shows the frequency of citations to the UNEP *Regional Seas* publications that correspond to a GESAMP report, and the percentage of the total of 194 citations in this dataset. In this figure, GESAMP's series numbers are used to avoid any confusion by introducing UNEP's series numbers. "#39" represents the UNEP co-publication of GESAMP's *The State of the Marine Environment* (which was also published as a book and a journal article, see Figure 10). This report is the most frequently cited co-publication, receiving 104 citations (or 54% of the total citations to the UNEP series). A version of the technical annexes to the same report (#39 Tech. Annexes) was also cited. In this case, the publication received 14 citations, or 7% of the UNEP total. The co-publications of reports 15 and 22 also received relatively high citation counts, with 34 and 17 citations, respectively. Approximately 75% of citations to the *Regional Seas* reports were received by the UNEP versions of reports 39, 15, and 22. The remaining 25% of citations were to the technical annexes of report 39 as well as five other publications. This distribution of citations seems to mirror the pattern seen in the analysis of yearly citations to GESAMP reports outlined above. In 1992 and 2002 the citation counts consisted of a relatively high number of citations to a few reports and one or two citations to a higher number of publications. The same pattern is replicated in the UNEP

citation data. Describing such patterns is important in establishing the influence of particular titles in a body of grey literature.

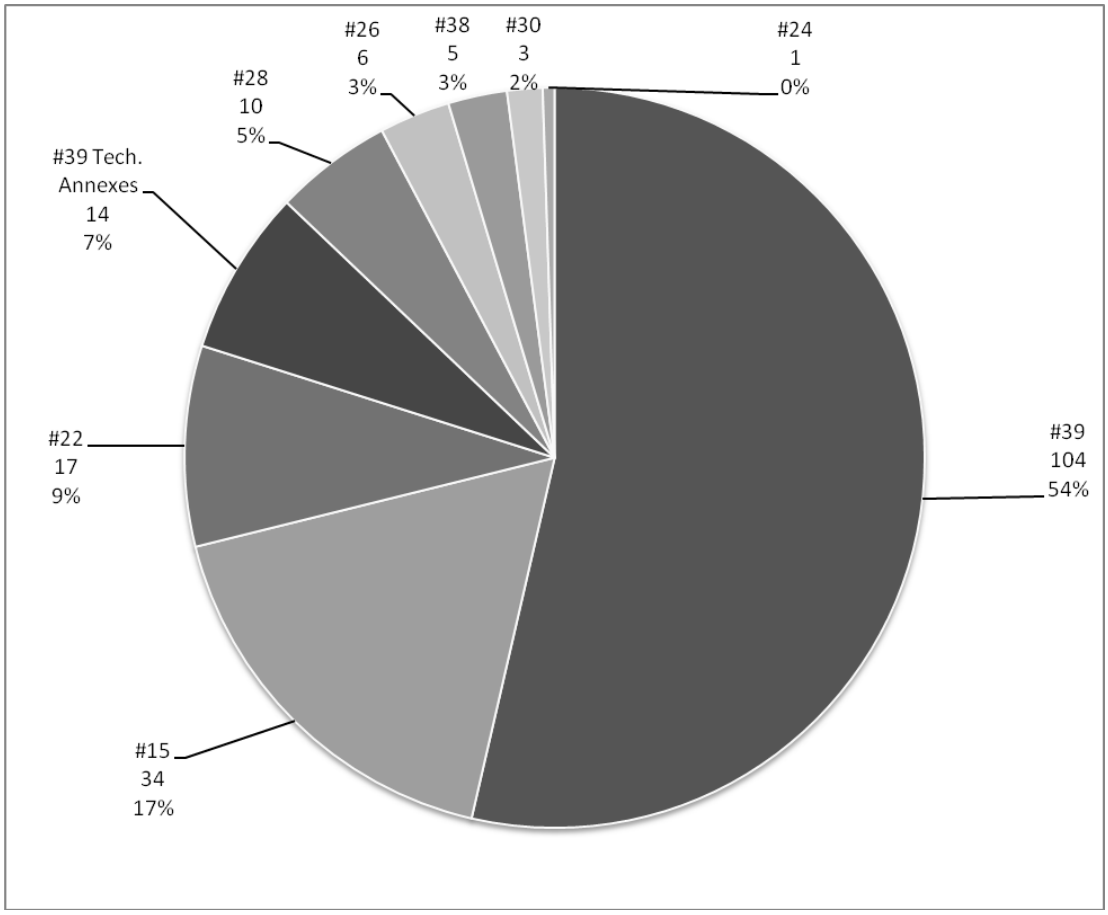

Figure 11. Citations to UNEP Regional Seas Publications (Co-Published GESAMP Reports)

Citations to Other Documents

Citations to an assortment of additional document types round out the total number of citations to GESAMP's reports and its related publications (see Table 1, page 48). These types include sessions of GESAMP meetings (52 citations), draft versions of thematic reports (47 citations), GESAMP histories (14 citations), and instances where the citation did not clearly identify a GESAMP report (13 citations). Citations to these documents confirm awareness of GESAMP as an advisory group, and comprise a diversity of document formats that are indexed by Web of Science.

Citations to Primary Literature

The "Books / Journal Articles" category in Table 1 is made up of eight articles and books based on GESAMP reports (see list in Table 2).

Author(s)	Title	Original Report Number	Format
Duce, R.A., Liss, P.S., and Merrill, J.T. et al.	The Atmospheric Input of Trace Species to the World Ocean	#38	Journal Article
GESAMP	The State of the Marine Environment	#39	Book
Fowler, S.	Technical Annexes to the Report of the State of the Marine Environment	#39	Journal Article
Howells, G., Calamari, D., Gray, J., et al.	An Analytical Approach to Assessment of Long-Term Effects of Low-Levels of Contaminants in the Marine-Environment	#40	Journal Article
Gray, J.S., Calamari, D., Duce, R., et al.	Scientifically Based Strategies for Marine Environmental Protection and Management	#45	Journal Article
Liss, P.S., and Duce, R.A.	The Sea-Surface and Global Change	#59	Book
Gray, J.S.	Marine Biodiversity: Patterns, Threats and Conservation Needs	#62	Journal Article
Wells, P.G., Hofer, T., and Nauke, M.	Evaluating the Hazards of Harmful Substances Carried by Ships: The Role of GESAMP and its EHS Working GROUP	#64	Journal Article

Table 2. Republished Versions of GESAMP Reports

Figure 12 shows the distribution of citations to each of these publications. Citations to GESAMP grey literature reports republished in book and journal forms total 1201, which represents 45.6% of the total number of citations located in Web of Science. As Figure 12 shows, the journal article version of GESAMP report 38 contributed 50% of the citations in the primary literature category. The book by Liss and Duce, based on GESAMP report 59, is the second most frequently cited, receiving 19% of the citations. The journal article versions of reports 39 and 62 both received 12% of the citations.

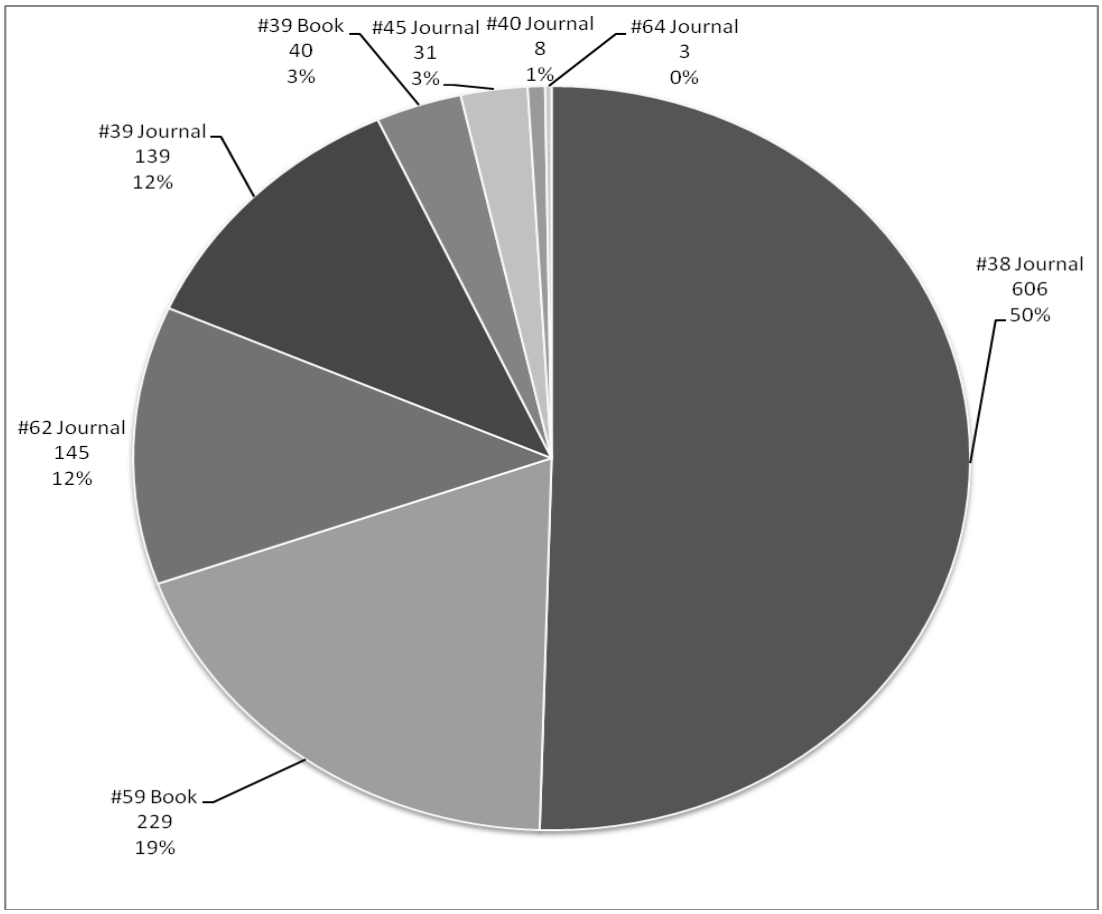

Figure 12. Citations to GESAMP Related Books and Journal Articles

The high percentage of citations received by primary literature versions of the grey literature reports (46.2%) suggests that citations in books and journal articles are an important indicator of GESAMP's overall influence. These citations suggest citing authors are aware of the group, even though the grey literature reports are not cited directly. This awareness and use of related documents contributes to GESAMP's profile as an organization focused on marine environmental subjects. Consideration of the type of citing publications is essential when studying the influence of grey literature. As this case has shown, a sizeable number of the total citations were contributed by non-grey sources.

Descriptive Analysis of Web of Science Citations

In addition to analyses that focus on aggregate statistics, the Web of Science citations can be studied in other ways to describe how grey literature is used. In the discussion below, the citation data are examined to determine citing characteristics of authors who have had some involvement with GESAMP, and characteristics of journals in which the citations have appeared. This data analysis provides further insights regarding the influence of grey literature and additional features for an overall metric that describes how its influence can be measured.

Informed Citation

Since its creation in 1969, a long roster of individuals has been involved with GESAMP. Some of citations located in Web of Science were made by authors who were involved with GESAMP throughout its history. A database of all of the individuals associated with GESAMP's thematic reports and reports of session was compiled from the names listed in each of the publications. For each individual, the first year he or she became involved with GESAMP as well as the role he or she played within the group was recorded. Roles were classified as: working group member, chairperson, technical secretariats, observer of meetings, or reviewer of thematic reports. In total, 744 people were identified as having been involved with GESAMP. Participation data for the report of the 32nd session of GESAMP were not published, preventing inclusion of names of those who took part in that session.

The list of individuals involved with GESAMP was compared to the authors responsible for the citations obtained from Web of Science. Names were matched on surname and given initials. Close matches were isolated and manually verified, such as in instances where the middle initials of an author were not printed in a GESAMP session report but were part of the author's name in a citing article. An individual's first year of GESAMP involvement was compared to the date a citing paper was published. If a citing paper was published before the first year an author was involved with GESAMP it was not considered a match since the citing document predated the author's involvement. Citing articles written by authors connected to GESAMP exhibit instances of informed citation.

Table 3 shows the authors involved with GESAMP who have contributed ten or more citations. Articles co-authored by several individuals with GESAMP affiliation were counted once for each contributing author. For example, if P. G. Wells, R. A. Duce, and T. D. Jickells co-wrote an article that cited a GESAMP publication, it was counted as one citation instance for each author.

Name	# of Citations
P. G. Wells	67
R. A. Duce	43
T. D. Jickells	43
T. Hofer	41
J. S. Gray	28
J. M. Bewers	25
R. Arimoto	24
M. E. Huber	20
J. M. Martin	18
R. Wu	16
M. K. Nauke	16
J. M. Prospero	15
T. M. Church	13
A. D. McIntyre	13
S. W. Fowler	12
A. J. Underwood	12
H. L. Windom	11
P. S. Liss	10

Table 3. Citations from GESAMP Affiliated Authors

The list of citing authors includes members who were also chairpersons (Wells, Duce, Gray, McIntyre, Windom, and Liss), working group members (Hofer, Bewers, Jickells, Arimoto, Huber, Martin, Prospero, Church, Fowler, and Underwood), a reviewer (Wu), and a technical secretary (Nauke). The number of authors with some involvement with GESAMP who cited GESAMP publications was 174. Approximately 5,410 individuals authored or co-authored articles that cite GESAMP publications. The latter number is approximate, as it does not account for differences in authors' given initials (e.g., S. V. Alyomov and S. Alyomov were counted as two authors even though the articles were probably written by the same person). Authors with some involvement with GESAMP, therefore, comprise 3.2% of the total pool of citing authors (174 out of 5,410). All other

authors (96.8%) had no known involvement with GESAMP, which suggests that awareness of GESAMP publications extends far beyond individuals who had "inside" knowledge of the publications.

The citation data suggests that authors involved with GESAMP cite its publications more frequently than other authors. Of the 2,631 citations, 627 were located in articles with at least one author who had some involvement with GESAMP, or 23.8% of all the citations. In other words, about three percent of the citing authors contribute nearly one quarter of all citations. Further study is required to determine the full meaning of these informed citations. However, the sizeable percentage of citations contributed by authors who have direct experience with GESAMP suggests that informed awareness of grey literature leads to greater use.

Citing Journals

Journal Names and Descriptions

Citations to GESAMP publications are located in a variety of journals. Table 4 lists the ten journals that cite GESAMP publications most frequently from 1969 to the end of 2008.

Journal Name	# of Citations
Marine Pollution Bulletin	275
Journal of Geophysical Research-Atmospheres	82
Marine Chemistry	78
Marine Ecology-Progress Series	74
Science of the Total Environment	70
Atmospheric Environment	59
Ocean & Coastal Management	59
Global Biogeochemical Cycles	57
Marine Policy	53
Geophysical Research Letters	45

Table 4. Citations to GESAMP Publications by Journal

Marine Pollution Bulletin leads the list with 275 citations. The breadth of subjects covered in this journal is highlighted in the description posted on the publisher's Web site:

> *Marine Pollution Bulletin* is concerned with the rational use of maritime and marine resources in estuaries, the seas and oceans, as well as with documenting marine pollution and introducing new forms of measurement and analysis. A wide range of topics are discussed as news, comment, reviews and research reports, not only on effluent disposal and pollution control, but also on the management, economic aspects and protection of the marine environment in general (Elsevier, 2009c).

While marine sciences are the primary focus of the journal, marine management and policy considerations are also included. Papers that take the latter perspective are illustrated by "Long-Term Marine Litter Monitoring in the Remote Great Australian Bight, South Australia" (Edyvane, Dalgetty, Hone, Higham, and Wace, 2004), which discusses the lack of marine litter management programs in Australia and in the larger, southern ocean region. Similarly, the 2003 article "Cost/Benefit Analysis of a Benthic Monitoring Programme of Organic Benthic Enrichment Using Different Sampling and Analysis Methods" explicitly suggests management implications (Lampadariou, Karakassis, and Pearson, 2005). Citations to GESAMP publications in papers such as these could and probably do inform management or policy decisions. Such examples underscore the importance of using citation data from Web of Science as a component of the metric of influence of grey literature. In this case, one journal, *Marine Pollution Bulletin*, stands out in the number of citations to GESAMP publications.

The *Journal of Geophysical Research – Atmospheres* published the second highest number of citations (83). The scope of this journal includes "physics and chemistry of the atmosphere, as well as the atmospheric-biospheric, lithospheric, and hydrospheric interface" (American Geophysical Union, 2009). *Marine Chemistry*, the third ranked citing journals (78 citations), is described as "an international medium for the publication of original studies and occasional reviews in the field of chemistry in the marine environment, with emphasis on the dynamic approach" (Elsevier, 2009a). *Marine Ecology – Progress Series* is also among the top ranked citing journals (with 74

citations). This journal is described as covering "all aspects of marine ecology, fundamental and applied" (Inter-Research, n.d.). Each of these three journals has a scientific perspective (reflecting the indexing practices of Web of Science). Unlike *Marine Pollution Bulletin*, however, they typically do not present policy implications of the scientific findings that they publish.

Studying citations from scientific journals is important for determining the use of grey literature, but use in these contexts does not completely describe the use and influence of such literature. Use outside of scientific contexts is highlighted by journals such as *Marine Policy*, which contributed 53 citations, and puts the journal among the top ten sources of citations. Use of GESAMP publications in policy and decision making contexts may be apparent from citations appearing in this journal as its title and description imply:

> *Marine Policy* is the leading journal of ocean policy studies. It offers researchers, analysts and policy makers a unique combination of analyses in the principal social science disciplines relevant to the formulation of marine policy. Major articles are contributed by specialists in marine affairs, including marine economists and marine resource managers, political scientists, marine scientists, international lawyers, geographers and anthropologists. Drawing on their expertise and research, the journal covers: international, regional and national marine policies; institutional arrangements for the management and regulation of marine activities, including fisheries and shipping; conflict resolution; marine pollution and environment; conservation and use of marine resources (Elsevier, 2009b).

Marine Policy's publication mandate highlights fields of activity in which GESAMP publications may prove useful. The 53 citations in this journal are many fewer than the nearly 300 in the *Marine Pollution Bulletin*, but as the descriptions of both journals suggest, use of GESAMP publications evidently extends beyond scientific purposes. For example, papers which include citations to GESAMP's grey literature, such as "Examination of Policies and MEAs [multilateral environmental agreements] Commitment by SIDs [small island developing states] for Sustainable Management of the Caribbean Sea," illustrate a policy directed focus (Singh and Mee, 2008). In this case, the paper provides a review of regional responses to policy decisions that affect tourism and the economy of the Caribbean Sea. "A Large Marine Ecosystem Governance

Framework," which also highlights environmental issues in the Caribbean Sea, provides recommendations for the formation of management initiatives to protect marine ecosystems that take into account understanding of policy cycles (Fanning, Mahon, McConney, Angulo, and Burrows et al., 2007). Both of the papers support the premise that in building a metric that measures the use of grey literature, searches for citation data should extend beyond sources that predominantly index scientific journals.

Published descriptions of the mandates of journals do not fully explain the contexts in which GESAMP publications are cited. Nonetheless, since Web of Science primarily indexes research journals, it can be reasonably assumed that the majority of citations to GESAMP publications identified in sources indexed by Web of Science are based on the scientific findings and recommendations in the publications and less on the policy and decision making implications of that information.

Subject

Web of Science assigns subject categories for every indexed journal. Thus, citation trends can be shown in terms of the subjects of the journals in which they appear (see Table 5). Since many journals have more than one assigned subject category, citing articles can fall into more than one category. For example, *Comparative Biochemistry and Physiology C-Pharmacology Toxicology & Endocrinology* was assigned five subject categories, and journals such as *Australian Journal of Marine and Freshwater Research*, *Journal of Agricultural & Environmental Ethics*, and *Nuclear Instruments & Methods in Physics Research Section B-Beam Interactions with Materials and Atoms* were put into four categories. In other words, an article containing one GESAMP reference published in a journal with three subject categories was counted three times. Thus, the number of citations in this figure is higher than the actual number of citations collected from Web of Science.

Table 5 shows the top 20 broad subject areas of citing journals, the general category these subjects fall into, and the corresponding number of citations. Journals that focus on scientific subjects account for 17 of the top 20. Journals on "Environmental Sciences"

with 1004 citations ranked first, followed by "Marine and Freshwater Biology" (690 citations), "Oceanography" (398 citations), and "Interdisciplinary Geosciences" (325 citations). Journals in the social sciences category include "International Relations" (83 citations), "Environmental Studies," (63 citations), and "Law" (34 citations). This ranking of subjects clearly shows that citations to GESAMP's publications come predominantly from sources on scientific subjects.

Subject	Subject Category	# of Citations*
Environmental Sciences	science	1004
Marine & Freshwater Biology	science	690
Oceanography	science	398
Geosciences, Interdisciplinary	science	325
Meteorology & Atmospheric Sciences	science	192
Ecology	science	187
Toxicology	science	142
Water Resources	science	137
Engineering, Environmental	science	109
Chemistry, Multidisciplinary	science	91
Fisheries	science	88
International Relations	social science	83
Geochemistry & Geophysics	science	79
Environmental Studies	social science	63
Limnology	science	48
Multidisciplinary Sciences	science	37
Biodiversity Conservation	science	34
Law	social science	34
Biology	science	27
Chemistry, Analytical	science	26

* Relates to number of subject categories, and thus exceeds the actual number of citations.

Table 5. Citations to GESAMP Reports and Related Publications by Subject

Journal Impact Factors

Traditional citation analysis often includes consideration of Journal Impact Factors (JIF). In a 2006 paper on the history of the JIF, Garfield stated that:

> A journal's impact factor is based on 2 elements: the numerator, which is the number of citations in the current year to items published in the previous 2 years, and the denominator, which is the number of substantive articles and reviews published in the same 2 years (Garfield, 2006, p. 90).

"Substantive articles and reviews" excludes aspects of journals such as letters and book reviews. More specifically, the factor is calculated by taking the total number of citations to the articles published in a journal over a two year period, and dividing that sum by the number of articles published in that journal during that time. For example, a journal with articles cited 1000 times in 2007 and 2008 from 500 published articles would earn a JIF score of 2 (1000 divided by 500). Journals with higher JIF scores are considered to be more prestigious than other journals with similar subject matter but lower scores. Therefore, publishing research findings in journals with higher JIF scores is a major consideration for most scientists. Citations to GESAMP's publications can be analyzed in terms of the JIF scores of the sources in which they appear. This step can be helpful in establishing whether citations to grey literature appear in high impact journals. Publishers of grey literature could be interested in the assumed quality of citing journals.

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Journal Impact Factors for Most Frequently Citing Journals

Table 6 shows the respective Journal Impact Factors for the journals that cite GESAMP publications most frequently. *Global Biogeochemical Cycles* and *Marine Chemistry*, with impact factors of 4.335 and 3.085 respectively, have the highest JIF scores. *Marine Pollution Bulletin*, the journal containing the most citations to GESAMP publications (see Table 4 above), has a lower impact factor (2.334). The journal with the lowest impact factor (0.972) is *Ocean & Coastal Management*. The journal impact factor score for *Marine Policy* was unavailable as of April 2009. The average journal impact factor for the ten journals that most frequently cite GESAMP publications is 2.633.

While further information is needed to more fully understand the relationship of Journal Impact Factor to use of GESAMP's publications, this factor can provide evidence of the caliber of publications which cite its literature. Thus, including this type of analysis of

citation data should be an important component of a metric of the influence of grey literature.

Journal	Impact Factor
Global Biogeochemical Cycles	4.335
Marine Chemistry	3.085
Journal of Geophysical Research-Atmospheres	2.953
Geophysical Research Letters	2.744
Atmospheric Environment	2.549
Marine Ecology-Progress Series	2.546
Marine Pollution Bulletin	2.334
Science of the Total Environment	2.182
Ocean & Coastal Management	0.972
Marine Policy	Unavailable
Average	2.633

Table 6. Citations by Journal Impact Factor

4.2 GOOGLE SCHOLAR CITATION DATA

This section provides an analysis of the citation data collected from Google Scholar. Aggregate citation data for the ten most frequently cited and ten least-cited GESAMP reports (based on Web of Science citation ranking shown in Appendix 3) were analyzed first. Citation trends were determined from citation counts for each dataset and characteristics of how the individual reports were cited in Google Scholar sources were compared to those indexed by Web of Science. Then, descriptive techniques were applied to the two Google Scholar datasets with regard to the publication type of citing documents. Specific examples of how GESAMP publications were cited are included in the discussion of types to highlight use of grey literature.

Clarification of the terminology used to describe citation counts for Google Scholar searches is needed because of differences between the data collected with this search engine and from Web of Science. Only one citation was counted for each Google

Scholar search result when a search on the title of a GESAMP report was successfully done. Even though that source may have cited other GESAMP publications, only a single count was recorded for the report title used in the search. This method of counting citations allowed an accurate comparison of Google Scholar data with the citation frequencies for individual GESAMP reports located in Web of Science. However, to avoid confusion about the concept of citation during discussion of publication types of citing documents, the number of citing documents is used rather than total citations to GESAMP publications.

Ten Most Frequently Cited GESAMP Reports (Web of Science)

Aggregate Citation Data

Aggregate citation data collected by Google Scholar searches for the titles of the ten GESAMP reports most cited in Web of Science and the ten least-cited reports are presented in Tables 7 and 8. The data for the ten most-cited reports (Table 7) show the total number of citations to the reports in sources indexed by Web of Science (601) and Google Scholar (587). These aggregate figures suggest that highly ranked reports, based on Web of Science citations, will also rank highly in citations obtained via Google Scholar. A considerable overlap occurred between the citing documents located by both tools; 327 of the results located in Google Scholar were duplicates of articles located in Web of Science. Google Scholar's indexing practices are undisclosed proprietary information, but the commonality of citations suggests that Google Scholar covers many of the "top" scientific journals. The remaining 260 citations obtained via Google Scholar show how GESAMP reports are cited outside of the peer-reviewed journals indexed by Web of Science. Discussion of these citations in terms of type of citing publication is set out below.

					Categories Showing Influence			
Report #	WoS (Total)	G.S. Exports	WoS (from G.S.) *	G.S. Unique**	Report	Journal	Book Chapter	Book
38	88	47	38	9	1	3	3	0
32	84	47	38	9	0	5	2	1
39	81	139	84	55	10	11	12	10
50	76	57	30	27	7	7	8	1
61	54	62	23	39	14	4	5	2
6	47	28	12	16	2	7	3	2
57	44	50	32	18	7	0	2	2
71	43	85	33	52	20	7	12	2
28	42	19	10	9	4	2	1	1
58	42	53	27	26	4	12	4	0
Total	601	587	327	260	69	58	52	21
				% Unique	26.5	22.3	20.0	8.1

	Categories Showing Influence						Non-Influential Category
Report #	Conference	Online Papers	Meetings	Dissertations	Proposals	Other	Bibliographies
38	2	0	0	0	0	0	0
32	1	0	0	0	0	0	0
39	4	3	3	2	0	0	0
50	0	4	0	0	0	0	0
61	5	6	1	0	2	0	0
6	0	0	0	0	0	1	1
57	3	2	1	0	0	0	1
71	5	1	3	1	0	0	1
28	0	0	1	0	0	0	0
58	1	4	0	0	0	1	0
Total	21	20	9	3	2	2	3
% Unique	8.1	7.7	3.5	1.2	0.8	0.8	1.2

* Citations that duplicate Web of Science citations

**`Citations not found in Web of Science. These unique citations are further categorized as influential or non-influential.

Table 7. Google Scholar - Ten Most Frequently Cited GESAMP Reports

					Categories Showing Influence			
Report #	WoS (Total)	G.S. Exports	WoS (from G.S) *	G.S. Unique **	Journal	Report	Conference	Book
23	3	2	1	1	0	0	0	0
16	3	8	1	7	0	1	0	2
29	3	0	0	0	0	0	0	0
11	3	1	0	1	1	0	0	0
7	3	2	0	2	1	0	0	0
5	2	3	2	1	0	1	0	0
75	2	6	2	4	1	1	1	0
20	0	1	0	1	1	0	0	0
36	0	2	0	2	0	0	0	0
76	0	13	0	13	0	0	2	0
Total	19	38	6	32	4	3	3	2
				% Unique	12.5	9.4	9.4	6.3

	Categories Showing Influence				Non-Influential Categories	
Report #	Meeting	Book Chapter	Subject Bibliography	Other	Bibliography	Commercial
23	1	0	0	0	0	0
16	1	1	0	2	0	0
29	0	0	0	0	0	0
11	0	0	0	0	0	0
7	0	0	0	0	0	1
5	0	0	0	0	0	0
75	0	0	0	0	0	1
20	0	0	0	0	0	0
36	0	0	1	0	1	0
76	0	0	0	1	10	0
Total	2	1	1	3	11	2
% Unique	6.3	3.1	3.1	9.4	34.4	6.3

* Citations that duplicate Web of Science citations

**`Citations not found in Web of Science. These unique citations are further categorized as influential or non-influential.

Table 8. Google Scholar - Ten Least Frequently Cited GESAMP Reports

Although the total citation frequencies for the ten most-cited GESAMP reports are similarly reported in Web of Science and Google Scholar, the number of citations each report receives can vary substantially between the two sources. For example, reports 38 and 32 each received 40 more citations from sources indexed by Web of Science than in Google Scholar. There are several potential explanations for these differences. For example, a version of report 38 was republished as a journal article in 1991. The journal article received 606 citations (Web of Science search), making it by far the most frequently cited GESAMP-related publication. Due to this level of citation, readers may have become aware of the journal article and then sought the GESAMP report itself to strengthen arguments, provide further background, or for other reasons. Many authors cite both the report and the book versions in the same article, which increased the citation frequency for the report in Web of Science sources. Report 32's title ─ *Land/Sea Boundary Flux of Contaminants: Contributions from Rivers* ─ may have complicated retrieval of citations from Google Scholar. Unless citing authors referred to the title of the report exactly as written, searches on the exact title, which included the "/" and ":", may not have been identified by the search engine. If this occurred, the number of citations available via Google Scholar may be higher than reported in Table 7. Finally, the relative ages of the reports may contribute to their increased visibility in Web of Science over Google Scholar, as it has been shown that newer materials are more likely to be cited on the Internet (Vaughan and Shaw, 2003). The opposite might occur as citations for older publications may be more prevalent in the Web of Science database. Web of Science could provide more complete citation data for older publications since the chronological period of its index is clearly stated whereas Google Scholar's indexing practices are largely unknown. Google Scholar may not index as many older sources, which could explain the differences in citations. This point may explain higher citation counts in Web of Science vs. Google Scholar for reports 38 and 32 published in 1989 and 1987, respectively.

The conclusion that newer information is cited more often on the Web than is reported in Web of Science is supported by looking at the citation totals for GESAMP's more recent publications. For example, report 71 (GESAMP, 2001), was cited in 42 more sources

indexed by Google Scholar (85 citations) than in Web of Science (43 citations). This observation not only supports Vaughan and Shaw's finding, but may also suggest that the theory that Google Scholar indexing is focused on contemporary Web sources is accurate. This conclusion is given further support by the citations for reports 61, 57, and 58, which, following report 71, are the three most recently published reports in the set of the ten most cited in Web of Science. In all four cases the citation totals for these reports, published between 1996 and 2001, is higher in Google Scholar than Web of Science. GESAMP reports published since the mid-1990s, which are ranked higher in citations counts in Web of Science sources are also cited more frequently in sources indexed by Google Scholar. Web technologies began to proliferate after the mid-1990s, which may explain the increased evidence of use of the reports. Although all of GESAMP's reports were not available online until 2007, higher citation counts from online sources coincide with the increased use of the Web. The four reports published since 1996 received higher Google Scholar citation totals than the earlier reports 38 and 32, which both have 47 citations. Trends in scientific issues in relation to the topics of the GESAMP reports could provide an alternate explanation of the citation pattern. Continued tracking of citations for GESAMP's newest reports via Google Scholar will be necessary to determine which of the explanations can be supported. However, the aggregate citation data regarding GESAMP's most frequently cited reports currently lends support to Vaughan and Shaw's conclusion about newer information being cited more often. This finding is especially relevant to publishers of grey literature who wish to assess use of their publications since the widespread proliferation of Web technologies.

GESAMP report 39, like the recent GESAMP reports, received more citations from Google Scholar sources than Web of Science. However, report 39 represents an anomaly as it was released in a number of forms including as a book published by Blackwell and as a co-publication in UNEP's *Regional Seas* series. The technical annexes of the report were also published and cited. GESAMP report 39 and its offshoots are the second most commonly cited documents in GESAMP's publication history according to Web of Science data (see Table 7 or Appendix 3). Google Scholar search results for citations to either the original GESAMP report or the UNEP co-publication were considered valid as

they are both grey literature.[2] The number of citations to both GESAMP report 39 and its UNEP *Regional Seas* version total 184 (81 to the GESAMP version and 103 to the UNEP version), which can then be compared to the 139 citations located via Google Scholar. Published in 1990, report 39 falls into the category of older reports that are expected to be cited more frequently in Web of Science than in Google Scholar.

This initial examination of the aggregate citation data from Google Scholar in comparison to similar data from Web of Science shows distinct differences in the record of use reported by the two research tools. In contrast to Web of Science data, the aggregate citation data from Google Scholar suggests increased use of GESAMP's reports published since 1996. Thus, in assessing use of grey literature, data from both tools should be consulted. While the patterns seen in the citation data to GESAMP reports may not be exactly present in the aggregate citation data for other grey literature publications, the influence of grey literature will be better understood after considering citation data from both Web of Science and Google Scholar.

Google Scholar Citation Data by Publication Type

Determining the publication type of each citing publication located in Google Scholar reveals further characteristics of the data. Whereas each citing document indexed in Web of Science is assumed to be an article published in a peer-reviewed journal, the same assumption concerning authority and reliability of the information published on the Web does not necessarily apply. Google Scholar purports to locate scholarly sources of information, but its proprietary indexing practices make this claim unverifiable. Therefore, it could not be assumed that each search result in Google Scholar automatically represented scholarly or influential use of a GESAMP report. Instead, each

[2] As noted in Chapter 3, only citations to GESAMP's grey literature reports were located in Google Scholar searches. Citations to the book version of report 39 published by Blackwell were not retrieved. The strategy employed in Google Scholar searches eliminated results that cited both the GESAMP report and the version republished as a book as the search string included "not Blackwell." The titles of the technical annexes are different than the title of the report, meaning citations to the annexes were not retrieved during Google Scholar searches.

search result required close inspection to confirm that a GESAMP report was being cited and to verify that the citing publication was indicative of influential use.

Table 7 shows that 327 of the 587 results located using Google Scholar were journal articles also indexed by Web of Science. In other words, a majority of the same citations (55.7%) were identified by both sources. This overlap provides insight into Google Scholar's indexing practices as more than half of the search results are also available in a reputable database known for stringently selecting the top scientific journals. However, the similarities between the two sources fall short of confirming the findings posited by authors who state that Google Scholar can act as a replacement for Web of Science in some subject areas (Lawrence, 2001). A sizeable number of the Google Scholar search results do not duplicate Web of Science data. Nonetheless, these results suggest that GESAMP's reports do not fall into a subject area that can use Google Scholar as a replacement for Web of Science. While a large percentage of Google Scholar search results are also articles indexed by Web of Science, there are still a number of Google Scholar search results that must be studied in order to fully understand the use and influence of this grey literature.

Since important additional insights may be drawn from the citing documents that are not duplicates of Web of Science data, a classification system was created to identify the "type" of document in which GESAMP citations appeared (see Chapter 3). Each of the 587 citations located in Google Scholar were individually examined and coded according to these categories, which revealed that a variety of citing document types is present (see Table 7). Several categories of citing documents represented scholarly or influential use of GESAMP reports.

Among the types of 587 citing documents, 69 are reports making up 11.8% of the total dataset. There were also 58 citing journal articles not indexed by Web of Science (9.9% of the total data), 51 book chapters (8.7%), and 21 books (3.6%). In addition, a small number of bibliographic citations (3) accounted for 0.5% of the 587 citing documents. Bibliographic results are considered non-influential, as they often simply consist of lists

of publications or library catalogue entries that do not show active use of the information published by GESAMP. As will be discussed below, Google Scholar indexes a sizeable body of important scientific and policy-related information, making the collection and interpretation of Google Scholar data crucial to a full understanding of the impact of GESAMP's publications beyond evidence found in Web of Science.

Reports

Reports are the most frequently occurring type of unique citing document (i.e., publications not also indexed by Web of Science). In total, 69 of the 260 unique Google Scholar search results are of this type, or 26.5% of the dataset. The reports that cite GESAMP often appear to be linked with policy applications, and are typically written as either technical reports or as reports with recommendations and often target specific geographic areas. For example, 14 reports cite GESAMP report 61 (GESAMP, 1996a), which deals with integrated coastal zone management. Several of these citing reports illustrate applications of GESAMP's report in a variety of geographic settings, including: *Integrated Coastal Zone Management in Sri Lanka: A Policy Review* (Aeron-Thomas, n.d.), *Integrated Coastal Management & Sustainable Aquaculture Development in the Adriatic Sea, Republic of Croatia* (Frankic, 2003), and *Coastal and Marine Resources Management in Latin America and the Caribbean* (Lemay, 1998). Many reports that cite other GESAMP publications tend to be geographically focused.

A number of reports that cite GESAMP report 61 also have distinct policy implications, consisting of policy reviews, guidelines for responsible fisheries, recommendations for integrated coastal management policy, methods for managing freshwater flow into estuaries, and historical overviews of coastal zone management. For example, the purpose of *Integrated Coastal Zone Management in Sri Lanka: A Policy Review* is to:

> develop and promote practical policy options to support rural livelihoods through a range of research, development and advocacy activities. An early output of this work during the Inception Phase is to undertake a review and synthesise the literature on each of the specific policy arenas outlined in the research. This paper represents the policy review of coastal zone management in Sri Lanka and provides a preliminary account of the issues which the proposed research will be directed (Aeron-Thomas, n.d.).

Managing Freshwater Inflows to Estuaries: A Methods Guide, another example of a report with distinct policy implications, states that integrated coastal zone management is rooted in the following principles, which coincide with the overall purpose of the document:

> • An approach that fully recognizes the interconnected nature of living systems and human activity at the landscape scale.
> • The practice of decentralized democratic governance that works to nest policies, laws and institutions into a tiered, internally consistent and mutually reinforcing planning and decision-making system.
> • The application of sound science to the planning and decision-making process (Olsen, Padma, and Richter, n.d., p. 1).

Reports that cite other GESAMP publications often take a similar focus on policy applications. Through the act of citing, these publications show a direct connection between GESAMP's scientific assessments and documents whose purpose is to influence policy. In this case, such reports provide confirmation that GESAMP's historically most-cited publications include documents produced for the purpose of affecting policy. Since these data show that such reports are an important indicator of the use of GESAMP's publications, citations obtained through Google Scholar should be considered in the metric designed to gauge use and influence of grey literature.

Journal articles

Articles published in journals not indexed by Web of science contributed 58 of the 260 unique Google Scholar citations, or 22.3%. Many of these articles are published in open-access or online journals. Like reports, citing journals often have a very specific geographic focus, as evidenced by titles such as *Korea Observer*, *Turkish Journal of Marine Sciences,* and *Indian Association of Environmental Management*. Titles that span a wide range of locales demonstrate the extensive applicability of the information published by the GESAMP.

Another factor worth noting is the prevalence of journal sources directly related to law. Articles citing GESAMP have been published in the *International Journal of Marine and*

Coastal Law, *Review of European Community & International Environmental Law*, *Environmental Law*, *Environmental Lawyer*, and the *Northwestern Journal of International Law & Business*. These articles address issues such as compliance, regulation, and enforcement of law and policy on both national and international scales, backed by the scientific support of GESAMP. For example, law articles that cite GESAMP report 71 include "The Protection of the Marine Environment from Land-based Pollution and Activities: Gauging the Tides of Global and Regional Governance" (Powers, 2008), "Harmonisation in the Baltic Sea Region" (Kirk and Silfverberg, 2006), and "Biodiversity Conservation in the Wider Caribbean Region" (Barker, 2002). Journal articles, such as these, represent an important measure of influence not available from Web of Science. Instead, using Google Scholar to locate evidence of the use of grey literature draws attention to online journals that exist outside the scope of Web of Science's indexing practices.

Books / Book chapters

Citing publications identified as books and book chapters comprise approximately 28% of unique Google Scholar citations. In total, 52 book chapters were identified (20% of unique citations) as well as 21 books (8.1%). Most of these citing publications were indexed by Google Books. Google Books hits are interspersed with other types of results by Google Scholar. Other citing books were located on the Web sites of publishers, such as Springer, which make many books and book chapters available digitally.

A variety of topics are addressed. For example, report 39 is cited a total of 22 times by books and book chapters, including *Australasian Marine Pollution Laws* (White, 2007), *International Oil Pollution at Sea: Environmental Policy and Treaty Compliance* (Mitchell, 1994), and "The Effect of Changing Climate on Population" (Keyfitz, 1992). These three titles (and abstracts provided by Google Books) show that one GESAMP report was cited in law, policy, and social science contexts. For example, the abstract for *Australasian Marine Pollution Laws* reads "The book analyses the international conventions, the Australian and New Zealand legislation and the regulatory structures in both countries relating to the protection and preservation of the marine environment from

ship pollution" (White, 2007). This statement strongly confirms that the book focuses on law and policy regarding marine pollution. In another example, *International Oil Pollution at Sea* dealt with the question:

> How do environmental treaties influence international behavior? […] Although an international treaty governs how tankers must dispose of oil, compliance has been a problem. *Intentional Oil Pollution at Sea* is a detailed case study of how international environmental treaties can be made more effective. Combining theoretical analysis with a rigorous empirical evaluation of changes in the compliance process over time, it identifies policies that have increased compliance by governments and the oil transportation industry with discharge restrictions, equipment requirements, enforcement, and reporting (Mitchell, 1994).

Like the previous volume, the description of this book implies a use of GESAMP information in contexts involving direct policy and compliance implications. A further illustration is "The Effect of Changing Climate on Population," which was published in time for the Earth Summit Meeting in Brazil, June 1992 (Keyfitz, 1992). This book chapter summarized "the scientific findings of Working Group I of the IPCC in its first part and challenges and expands upon existing views of climatic change in the subsequent chapters" (Keyfitz, 1992, abstract). The abstracts are informative and illustrate how Google Scholar provides well-rounded coverage of types of sources which provide evidence of the use of grey literature. The range of subjects of books and book chapters that cite GESAMP reports confirm the importance of drawing data from Google Scholar in building a measurement of the influence of grey literature.

Conferences

Documents arising from conferences are frequently distinct from other forms of publication and indicate direct interactions of participants. Citing documents associated with conferences accounted for 20 of 260 citations, or 8.1%. In many cases, conference documents that refer to GESAMP reports are directly associated with the development of policy decisions. These documents, which include workshop handouts, conference proceedings, or papers, represent cases of GESAMP reports being presented as authoritative information to groups. Conference publications that cite GESAMP report 39, for example, help to illustrate why citations of this type are important in establishing

the influence of grey literature. By way of illustration, the paper "Environmental Quality Assessment on the Continental Shelves and in Large Bodies of Water: Current State of the Art" (Huber, 2000) published in *The Role of the Military in Protecting the World's Water Resources Proceedings* references GESAMP several times. The purpose of the conference "was to explore the use of the military as an instrument of engagement in the environmental security context of assessing and protecting the environmental quality of the world's bodies of water" (Butts, Bradshaw, and Smith, 2000, p. vii). Reference to a GESAMP report in a conference that identified ways in which the United States' military could reduce its environmental impacts demonstrates active application of GESAMP's assessments in policy processes. This example is especially interesting as military policy is not an area where GESAMP reports are typically cited. In contrast, a citation in a paper presented at *The Role of Precaution in Chemicals Policy* (Jackson, 2001) conference represents a more predictable venue for a GESAMP report. Each of these examples indicate application of GESAMP's publications in very specific contexts.

As part of the evidence of GESAMP's influence, conference documents show conclusively that its publications are actively used in settings directly related to policy formation. The conference documents discussed in this section demonstrate a wide-range of topics in which GESAMP's reports were cited. By indexing this type of information source, Google Scholar gives attention to the scope of grey literature use, and reinforces the recommendation that studies of the influence of grey literature should incorporate findings from Google Scholar.

Online Papers

Citations were located in online papers posted online, which are similar in appearance to journal articles but without evidence of having been published in a journal. Twenty such papers were located, or 7.7% of unique Google Scholar citations. Papers hosted by institutional repositories, white papers, working papers, and other forms of grey literature that adhere to traditional journal article norms are included in this category. These citations are examples of grey literature citing other grey literature, recognizing that it might not be the same quality. For example, several papers were published by

intergovernmental agencies, including "White Paper Coastal Zone Management in the Mediterranean" published by the United Nations Environment Programme (UNEP), Mediterranean Action Plan (MAP), and the Priority Actions Programme Regional Activity Centre (UNEP/MAP/PAP, 2001). The abstract states "This paper can be best used as a reference document for stimulating debate within the framework of MAP activities: conferences, workshops, focal points meeting; MCSD meeting; SMAP correspondents meeting; etc. In this sense, it could be revised and gain a certain level of formal acceptance" (UNEP/MAP/PAP, 2001, abstract). Even though editorial standards of these papers are undisclosed (or nonexistent) and the papers may not be peer-reviewed, citations in this type of publication shows awareness of GESAMP and the applicability of its publications to a variety of subjects. While the 20 online papers may not represent scholarly, peer-reviewed sources, as is the case with Web of Science, they still are a valid indicator of how GESAMP's reports are used and worthy of notice even if the quality of the citing document is not guaranteed by transparent editorial standards.

Meetings

As with conference materials, citations in meeting documents indicate direct interaction with GESAMP's reports. Ten such citing documents were identified, comprising 3.5% of the unique citations. For example, citations to GESAMP report 71 appear in *IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs)*. This document refers to GESAMP's appraisal of the general degradation of the ocean and how sewage contributes to marine eutrophication (IOC-IUCN-NOAA, 2003). Whereas conference papers tended to be single-authored works published in a set of proceedings, this meeting document reads as a single report. Meeting documents are not all standalone, single authored reports, however. For example, four authors presented the paper "Coastal Zone Community of Practice: A Proposal to the GEO User Interface Committee" at the *Ninth Session of the Global Ocean Observing System Scientific Steering Committee (GSSC-IX)* (DiGiacomo, McManus, Malone, and Christian, 2006). This document cites findings from GESAMP report 71 that the health of human populations is directly linked to the health of marine ecosystems.

Documents from meetings and conferences serve much the same purpose, as they originate in settings where direct interaction between authors and information users occurs. Grey literature's influence in these contexts could vary substantially; audiences or meeting participants could just as easily ignore policy implications set out in GESAMP reports as they might overlook reports or journal articles. Nonetheless, the ability of Google Scholar to locate citation data from sources that represent direct use of the information gives another reason to include such data in determining the overall influence of this literature.

Dissertations

Three instances of GESAMP reports cited in dissertations were located. Two dissertations cite GESAMP report 39. The first, *The European Community and Marine Environmental Protection in the International Law of the Sea: Implementing Global Obligations at the Regional Level* is a doctoral thesis completed at the Utrecht University in the Netherlands (Frank, 2006). The second is *The Effect of Nitrogen Loading on an Estuarine Faunal Community: A Stable Isotope Approach*, a thesis for a MSc degree from the University of Maine (Keats, 2002). A third, titled *Ecological Effects of Ulva lactuca L. in Avon-Heathcote Estuary*, cites GESAMP report 71, and is an MSc thesis in Zoology from the University of Canterbury in New Zealand (Murphy, 2006). That each of the dissertations was completed on a different continent but deal with marine issues specific to their geographic area suggests that GESAMP's publications have global applicability. Similarly, the topics covered by the dissertations range from law to marine science, showing GESAMP reports are used for different purposes. While dissertations represent a small percentage of the citations (1.2%), they demonstrate use of grey literature in academic contexts and again emphasize the importance of including citation data from Google Scholar in building a measurement of the influence of grey literature.

Proposals

Two citations representing 0.8% of unique citations were classified as proposal documents. Both proposals, which cited GESAMP report 61, were generated by the United Nations Development Programme (UNDP), and follow roughly the same type.

Belize: Conservation and Sustainable Use of the Barrier Reef Complex, published in 1993, aimed to further the steps taken by the government of Belize in a pilot project regarding the integrated coastal zone management process (UNDP, 1993). The proposal stated these steps could be achieved "by consolidating and implementing the institutional structures, financing mechanisms, regulatory frameworks, and conservation priorities identified during the pilot phase" (UNDP, 1993, p. i). The cycle of coastal zone management as posited by GESAMP is cited in this proposal. The second proposal, *Community-based Coastal and Marine Conservation in Milne Bay Province,* released in 2000, dealt with coastal, marine, and fresh-water systems in Papua New Guinea (UNDP, 2000). The proposal outlined the funding structure of the project which planned to conserve the Milne Bay area due to its importance as an area with rich biodiversity.

Like dissertations, citations originating from proposals are infrequent but nevertheless provide valuable insight into uses of grey literature. In these cases, proposals were drafted to adopt the measures recommended in GESAMP's reports. Proposals show considered use in situations where authors strive to be convincing and confirm that GESAMP is viewed as a reputable, authoritative source of information that will be considered legitimate by reviewers of proposals. If GESAMP's reports were considered unreliable, they would not be read or cited. Understanding and determination of use and influence of this grey literature is once more amplified by the citations returned by Google Scholar.

Other

Two citing documents which did not fit into any of the more specific classification categories were labelled "other." One citation is from a "Books Noted" section of the journal *Environmental Management*, where GESAMP report 6 (GESAMP, 1977a) is listed ("Books Noted," 1979). While this citation does not demonstrate explicit use, it shows awareness of GESAMP as a source of important information and was included in the dataset because it demonstrates a potential predictor of future use. A newsletter published by Global Ocean Ecosystem Dynamics, which includes several short articles, is the second citing document (Kideys and Galina, 2004). While similar in appearance to

journal articles, the citing article was labelled “other” since it was published in a newsletter. Newsletters are an avenue for spreading awareness of GESAMP publications, and the readership may be more diverse than for scientific journals. Further, short articles mean that citation choices need to be direct, and may prove to be more visible given the fact there are so few citations in the papers. Determining the readership of newsletters containing several references to a producer of grey literature could be an informative exercise. In this case, the newsletter citation is a unique indicator of an avenue for GESAMP’s promotion and showed evidence of the use of the group’s publications in an intriguing way.

Bibliographic Citations

Bibliographic sources are the most common type of non-influential citations to GESAMP reports. In most cases, these citations came from library catalogues and publication lists. Only three sources (1.2% of unique citations) qualified for this category. This small number shows that Google Scholar focuses mostly on scholarly sources. Most citations noted in Table 7 demonstrate intellectual influence of grey literature and confirms that Google Scholar filters out non-substantial sources as searches are conducted.

Ten Least Frequently Cited GESAMP Reports (Web of Science)

Aggregate Citation Data

The citation data collected using Google Scholar for the ten least-cited GESAMP reports were compared to the corresponding data collected for each report from Web of Science. Table 8 shows that 38 citations were located in Google Scholar compared to 19 from Web of Science, which suggests that sources indexed by Google Scholar contain more evidence of use of GESAMP’s reports that obtained the least attention in the journals indexed by Web of Science (but see discussion on “Bibliographic Citations” below). In contrast, as noted above, the ten most-cited reports were referenced fewer times in Google Scholar than Web of Science. Six citing documents located using Google Scholar were also found in Web of Science, leaving 32 unique citations which were classified by

publication type. Analysis of the types of citing documents illustrates how evidence of use of grey literature obtained from Google Scholar differs from Web of Science.

The citation frequencies for the least-cited GESAMP reports are often different to citation totals for the same reports located in Web of Science. For example, report 16, published in 1982, was only cited three times in Web of Science data, but eight times in Google Scholar citation data, indicating increased use on the Web. It is perhaps surprising that report 16 has achieved higher citation levels on the Web, given the age of the report and the tendency in science to value newer information. More recent GESAMP reports, e.g., 75 and 76, published in 2007 and 2008 respectively, are also cited more frequently in Google Scholar sources than in Web of Science data. Citation of these reports suggests that evidence of use of newer publications first becomes apparent in Web sources indexed by Google Scholar. This tendency seems to mirror citations to the ten most-cited GESAMP reports (discussed above), which showed that the newest reports were cited more often in Google Scholar than in Web of Science. At the time of this study, reports 75 and 76 were not frequently cited in Web of Science indexed sources, likely because of the time it takes for peer-reviewed journals to be published and subsequently indexed in the database. The data in this study shows, however, that citations from Google Scholar sources are available for recently published grey literature on the Web before Web of Science. Reports 75 and 76 may show higher citation counts in Web of Science in the future. However, Google Scholar citation data provides more evidence of use for recently published materials. As a consequence, Google Scholar citation data can be an informative source for grey literature publishers who want to learn about current uses and influence of their publications.

Citation Data by Publication Type

Web of Science

Six of the citation results overlap between Web of Science and Google Scholar, representing about 16% of the citations to the least-cited GESAMP reports. This low level of duplication for the ten least-cited reports contrasts with the results obtained for

the top ten GESAMP reports, where duplication was greater than 55%. The difference is partly attributed to three GESAMP reports which received no citations in Web of Science and 16 in Google Scholar.

Journals

Citing journal articles, not indexed by Web of Science, were located four times, or 12.5% of unique citations. Three GESAMP reports, specifically numbers 7, 11, and 20, were referenced in the same article (GESAMP 1977b, 1980, 1984 That article, "South African Marine Pollution Control Legislation," published in *Acta Juridica* in 1986, focussed on South African legislation and implications of international law on this legislation (Rabie and Lusher, 1986). GESAMP itself is discussed at length in the article, and the authors rely heavily on GESAMP's definition of marine pollution, which they note was adapted by other countries and conventions. Through their substantial discussion of GESAMP and the variety of subjects covered by GESAMP's reports, the authors demonstrated a reliance on GESAMP as an authoritative source of information on numerous scientific topics. This paper serves as a particularly informative example of the influence of the group in its early years.

Another citing journal article published very recently attests to different uses for GESAMP's grey literature over a range of years. "Revisiting the Thames Formula: The Evolving role of the International Maritime Organization and its Member States in Implementing the 1982 Law of the Sea Convention" was published in the Spring 2009 issue of the *San Diego Journal of International Law* (Allen, 2009) and notes the value of several of GESAMP's reports.

Reports

Reports contributed three citing documents, making up 9.4% of unique citations. *Guidelines for the Management of Dredged Material*, which refers to GESAMP report 16 (GESAMP, 1982), was published by the United Nations Environment Programme (UNEP) and the Mediterranean Action Plan (MAP) in its Reports Series (UNEP/MAP, 2000). Similar to GESAMP's own reports, the citation in this volume, made available by

Google Books, is given in the section of the report dealing with the conditions in which dumping dredged materials are permissible. *Water Quality Criteria for the South African Coastal Zone*, published by the Foundation for Research Development in 1984 in a series called "South African National Scientific Programmes," is a second citing report (Lusher, 1984). Finally, *Chronic Oil Pollution in Europe* (Camphuysen, n.d.) cites GESAMP report 75 (GESAMP, 2007). Published by the International Fund for Animal Welfare after 2007, the report cites several GESAMP publications, and uses report 75 to support evidence of annual oil discharge from ships into the oceans. While the percentage of citations for the least-cited GESAMP reports is not as high as with the ten most-cited, report documents still stand as important indicators of influence.

Conference Documents

Three conference documents were located, representing 9.4% of unique citations. Three cited GESAMP's newest reports, numbers 75 and 76. Report 75 is cited in the *Proceedings of the 34th Annual Aquatic Toxicity Workshop* held in Halifax, Nova Scotia, in 2007 (Kidd, Jarvis, Haya, Doe, and Burridge, 2008). Citations to several GESAMP reports are included in the plenary lecture and two additional papers given at this conference, which focussed mostly on marine issues relating to Atlantic Canada. In contrast, conference documents that cite GESAMP report 76 have a wider international scope. For example, the paper "An Ecosystem Approach to Freshwater Aquaculture: A Global Review," published in the proceedings of the *Building an Ecosystem Approach to Aquaculture* conference "addresses the relevance of the ecosystem approach to freshwater aquaculture (mainly in Asia) through literature review and eighteen case studies" (Hambrey, Edwards, and Belton, 2008, abstract). Another citing conference paper in the same proceedings, "Applying an Ecosystem-Based Approach to Aquaculture: Principles, Scales and Some Management Measures," discusses economic approaches to aquaculture with global implications (Soto et al., 2008).

Citations in conference documents show some use soon after the publication of GESAMP reports, which may hold true for other grey literature publishers. Citations of this sort

highlight the importance of using data from Google Scholar in addition to Web of Science in building a metric of the use and influence of grey literature.

Books / Book Chapters

Three citations were located in books or book chapters, accounting for 9.4% of unique citations. Two (6.3%) were from books by Michael J. Kennish, and one from a book chapter (3.1%) All three citations refer to GESAMP report 16. *Ecology of Estuaries: Anthropogenic Effects,* published in 1992, focuses on the science of estuaries, covering subjects such as "organic loading, oil pollution, polynuclear aromatic hydrocarbons, chlorinated hydrocarbons, heavy metals, dredging and dredged-spoil disposal, radionuclides, as well as other contaminants and processes" (Kennish, 1992, abstract). GESAMP report 16 was cited to provide evidence of waste disposal. This book also cited GESAMP report 6, which was one of the ten most-cited reports discussed above. Kennish also published the *Practical Handbook of Estuarine and Marine Pollution,* which relies heavily on GESAMP's definition of marine pollution in setting the stage for the book, discussed at length on the opening page of the volume (Kennish, 1997, p. 1). The citation to report 16 highlights problems of waste disposal at sea. The book also cited GESAMP reports 6, 32, and 39, which are among the ten most-cited GESAMP reports discussed above. The third citation is in a chapter titled "Deep Abyssal Plains" in the 1992 *Advances in the Science and Technology of Ocean Management* (Angel, 1992). This chapter refers to GESAMP report 16 twice in a discussion of the differences between marine contamination and pollution and in an elucidation of environmental capacity. This example shows a reliance on GESAMP as an authoritative source of information, and builds on the group's definitions of issues affecting marine environments. Considered together, citations from books and book chapters show additional uses of the GESAMP reports (also see Section 4.5 below).

Meetings

Two meeting documents were located, representing 6.3% of the citations. One, titled "Oslo Commission: Procedures and Decisions Manual," endorses GESAMP report 16 as a guiding document for the selection of dumping grounds in the sea (OSPAR

Commission, 1984). The introductory section of this 1984 document outlines how GESAMP report 16 (which is referred to as being published imminently) provides detailed information about waste disposal at sea. The second meeting document, which was produced by the Mediterranean Action Plan in 1989, deals with "Implications of Climatic Changes in the Mediterranean Region" (UNEP, 1989). This document discusses GESAMP's contributions to knowledge regarding the effect of atmospheric aerosols globally, and cites GESAMP report 23 (GESAMP, 1985). Since GESAMP reports are not often cited in documents dealing with climate change, this document is particularly interesting. While the number of citations in meeting documents is low for this group of GESAMP reports, retrieval of older sources through Google Scholar confirms that such searches should form an element in the evaluation of use and influence of grey literature.

Subject Bibliographies

One subject bibliography result was located which refers Web users to GESAMP's reports as important sources. This subject bibliography, based at the University of Nebraska-Lincoln, deals with the awareness of the effects of offshore oil and gas development (Gardner, Landry, and Riley, 1994). Since only one subject bibliography was retrieved in Google Scholar searches for both the ten most-cited and ten least-cited GESAMP reports, it seems clear that this type of document is not a priority in Google Scholar's indexing algorithm.

Other

Three citing documents that are of note were assigned to the "other" category. Two cite GESAMP report 16: one is a review of the report and the second a patent. The book review, published in 1982, does not demonstrate direct use but does give insights into how the report was viewed, and how GESAMP was regarded in the scientific community (Caspers, 1985). Connections between reviews of reports and subsequent use merit tracing, but are beyond the scope of this study. The second document that refers to GESAMP report 16 is a patent application filed in 2001 for an "Apparatus and Method of Concomitant Scenario Topography With the Aid of a Digital Computer" (Fleischer, 1997). Whether the patent was approved was not confirmed, but the authority of

GESAMP's literature is once again highlighted in a manner similar to citations in proposals. Citations are used to convince readers of the importance of a project (or in this case, product). The third "other" citation is from a Food and Agriculture Organization (FAO) newsletter (FAN, 2007) that announces GESAMP report 76 (GESAMP, 2008 [incorrectly listed as report 74]). This type of citation is an example of methods to increase awareness of GESAMP reports.

Bibliographic Citations

With 11 of 32, or 34.3%, bibliographic documents were the most frequent publication category for this dataset. Although bibliographic citations comprise the largest category, an anomaly within Google Scholar is responsible for the majority of the results. Ten bibliographic citing documents were associated with GESAMP report 76, since Google Scholar returned individual pages from the report itself as valid, unique search results. Each citing document had a unique URL and was presented as a normal search result and accepted as a citation. The only other bibliographic citation referenced GESAMP report 36 (GESAMP, 1989b). If the anomalous results for report 76 are disregarded, no discernible difference exists between the most-cited GESAMP reports and the least-cited in terms of bibliographic citations.

The anomaly represented by the ten bibliographic citations for report 76 requires qualification to the statement that Google Scholar citations outnumber Web of Science citations two to one. Only 21 unique citations remain when bibliographic sources have been subtracted. "Influential" Google Scholar citations slightly outnumber Web of Science (21 to 19), but, the difference is inconsequential when considering citation totals.

Citation data obtained via Google Scholar for both highly cited and infrequently cited GESAMP reports provides clear evidence of use. Citing documents were shown to encompass a variety of publication types, each of which presents insights into how this literature is used that cannot be obtained in traditional citation studies that rely on Web of Science. Thus, studies of grey literature should capitalize on the wealth of unique citation

data retrievable from different sources via Google Scholar to build a comprehensive understanding of its influence.

4.3 GOOGLE CITATION DATA

This section presents an analysis of citation data collected from Google. Aggregate search results for the ten most frequently cited and ten least-cited GESAMP reports (according to Web of Science ranking) are analyzed first. Comparisons between Google citation counts and those obtained from Web of Science illustrate that the evidence of use of individual reports differs between the two sources. Google citation data are also analyzed in terms of the type of publication of citing documents. Unique insights regarding the publication types of citing documents located during Google searches are discussed in terms of how these findings illustrate the influence of GESAMP's reports.

Ten Most Frequently Cited Reports (Web of Science)

Aggregate Citation Data

Aggregate citation data collected from Google searches for the ten GESAMP reports most-cited and the ten least-cited reports in Web of Science are presented in Tables 9 and 10. Table 9 shows that a total of 466 citations were located via Google for the ten most frequently cited reports, compared to 601 citations collected for the same reports in Web of Science, a difference of 135 citations. Of the 466 citations collected from Google, 66 were duplicates of citations collected from Web of Science. This finding of 400 unique citations contrasts with the overlap between Google Scholar and Web of Science citations where 327 of 587 Google Scholar citations duplicated Web of Science data. Google's attempts to index as much of the open Web as possible may explain this difference, as the search engine aims to be comprehensive whereas Google Scholar focuses on scholarly resources.

A comparison of the number of citations to individual GESAMP reports does not account for the difference in citation counts between Google and Web of Science. For eight of the

					Categories Showing Influence				
Report #	WoS	Google Exports	WoS (from Google)*	Google Unique**	Report	Book	Book Chapter	Subject Bibliography	Online Paper
38	88	29	5	24	3	0	4	0	2
32	84	38	14	24	2	1	1	2	1
39	81	89	6	83	25	8	10	3	3
50	76	43	8	35	9	0	2	1	0
61	54	52	7	45	11	1	3	4	1
6	47	31	4	27	3	6	4	1	0
57	44	42	9	33	10	0	1	2	4
71	43	95	8	87	21	9	6	9	7
28	42	18	2	16	2	1	0	1	0
58	42	29	3	26	3	6	1	2	1
Total	601	466	66	400	89	32	32	25	19
				% Unique	22.3	8.0	8.0	6.3	4.8

	Categories Showing Influence						Non-Influential Categories	
Report #	Journal	Conference	Meeting	Dissert -ation	Proposal	Other	Bibliography	Commercial
38	3	1	1	1	0	1	8	0
32	2	0	0	0	0	0	14	1
39	4	2	5	1	0	7	13	2
50	1	1	0	0	0	2	19	0
61	0	2	1	0	0	6	14	2
6	1	0	0	0	0	0	12	0
57	0	3	0	0	0	4	8	1
71	1	4	3	0	2	8	15	2
28	0	0	1	0	0	1	9	1
58	2	0	0	0	0	4	7	0
Total	14	13	11	2	2	33	119	9
% Unique	3.5	3.3	2.8	0.5	0.5	8.3	29.8	2.3

* Citations that duplicate Web of Science citations

** Citations not found in Web of Science. These unique citations are further categorized as influential or non-influential.

Table 9. Google - Ten Most Frequently Cited GESAMP Reports

					Categories Showing Influence	
Report Number	**WoS**	**Google Exports**	**WoS (from Google)***	**Google Unique****	**Report**	**Subject Bibliography**
23	3	7	1	6	0	1
16	3	16	0	16	4	1
29	3	13	1	12	0	1
11	3	19	0	19	3	3
7	3	11	0	11	0	1
5	2	18	0	18	2	0
75	2	20	1	19	4	3
20	0	15	0	15	1	0
36	0	6	0	6	0	1
76	0	17	0	17	0	1
Total	19	142	3	139	14	12
				% Unique	10.1	8.6

	Categories Showing Influence					Non-Influential Categories	
Report Number	**Meeting**	**Book**	**Dissertation**	**Journal**	**Other**	**Bibliography**	**Commercial**
23	0	0	0	0	0	5	0
16	0	2	0	0	1	8	0
29	0	0	0	0	0	11	0
11	0	0	1	0	0	12	0
7	0	0	0	0	0	10	0
5	0	0	0	0	0	15	1
75	4	0	0	1	3	4	0
20	0	1	0	0	1	12	0
36	0	0	0	0	0	4	1
76	0	0	0	0	6	9	1
Total	4	3	1	1	11	90	3
% Unique	2.9	2.2	0.7	0.7	7.9	64.7	2.2

* Citations that duplicate Web of Science citations

** Citations not found in Web of Science. These unique citations are further categorized as influential or non-influential.

Table 10. Google - Ten Least Frequently Cited GESAMP Reports

ten reports, fewer citations to each report were found in Google. For report 38, for instance, 49 fewer citations were retrieved from Google than in Web of Science. Similarly, report 50 received 33 fewer citations. For two reports (39 and 71), the opposite occurred with more citations located in Google than in Web of Science. Eight more citations for Report 39 were obtained from Google than Web of Science. In the case of report 71, Google citations outnumber Web of Science results by 52 citations. Released in 2001, Report 71 is the most recently published of the ten most-cited reports and its more recent publication date may account for greater evidence of use on the Web than in Web of Science. Information conveyed in the report can be disseminated more quickly on the Web than by traditional channels of scientific communication.

Google Citation Data by Publication Type

Reports

References in reports accounted for 89 of 400 or 22.3% of unique citations. All searches for GESAMP's publications returned at least two citations from reports. For example, GESAMP report 28 (GESAMP, 1986) published in 1986, was cited twice: once in a 1995 report from the Organisation for Economic Co-Operation and Development on the risk reduction of mercury (OECD, 1995), and once in a World Health Organization report on the environmental health criteria of methylmercury (WHO, 1990). These citing sources show use of Report 28 extending a decade after it was published. Furthermore, both reports are grounded in concerns regarding human health. While Google has often demonstrated evidence of use of newer publications, these findings suggest that the search engine is also adept at locating a wide breadth of evidence of use in reports.

Compared to report 28, report 39 received a considerably higher number of citations from reports (25). This outcome is not surprising, since report 39 is one of the most highly cited of GESAMP's publications. Examples of citing reports include *Analysis of Oil Pollution at Sea by Means of Sea Craft in Spain* (Martínez de Osés, 2006), *Water Quality Concerns in the Florida Keys: Sources, Effects, and Solutions* (Kruczynski, 1999), and a report titled *Coastal Tourism in the Wider Caribbean Region: Impacts and Best*

Management Practices (CEP-UNEP, 1997). That GESAMP report 39 has been cited in several geographic contexts and citations encompass a range of nearly 20 years suggests that it has maintained wide-ranging relevance. Uncovering characteristics of citations from reports increases understanding of the applicability and longevity of grey literature, and Google searches aid in this regard.

Books & Book Chapters

Online books (in large part located by the Google Books tool) added 32 of the 400 or 8% unique citations, and book chapters added another 32 citations (also see Section 4.5). Book chapters were occasionally located in compilations of essays indexed by Google Books, but were more likely than books to be located on publishers' Web sites. Books and book chapters together account for 16% of the total dataset. GESAMP reports 39 and 71 are the most frequently cited in books and book chapters (18 and 15 total citations in both categories, respectively). Books and book chapters published between 1990 and 2007 cite report 39, suggesting, as has been noted elsewhere, that this report remains relevant. Individual as opposed to corporate authors (associations or agencies) were responsible for the citing books. Titles suggesting international implications in terms of both science and policy include: *The Law of the Sea* (Kimball, 1995), *International Ocean Governance: Using International Law and Organizations to Manage Marine Resources Sustainability* (Kimball, 2003), and *International Environmental Law: Fairness, Effectiveness, and World Order* (Louka, 2006). Book chapters citing report 39 include entries in the *Britannica Online Encyclopedia* ("Atlantic Ocean," 2009), and an atlas published by the American Association for the Advancement of Science (Harrison and Pearce, 2000), in addition to several individually authored essays.

Further insights about citations in this category were provided from an analysis of citations to GESAMP report 71. Nine books and six book chapters cite the report, which was published in 2001. Citations in legal books, such as *Australasian Marine Pollution Laws* (White, 2007), *Principles of International Environmental Law* (Sands, 2003), and *Killing Our Oceans: Dealing with the Mass Extinction of Marine Life* (Kunich, 2006), highlight the applicability of this report to national and international marine law. Citing

book chapters seem more scientifically based, including "Reducing Our Toxic Burden" (Platt McGinn, 2002), and "Assessing Marine Ecosystem Health" (Wells, 2005). The book and book chapter citations to report 71 point attention to the value of GESAMP's literature to numerous disciplines.

Citations from online books and book chapters are substantial evidence of the use of grey literature not indexed by Web of Science. Many of the examples suggest relevance in terms of policy and law in addition to scientific applications, showing the variety of ways in which GESAMP's reports have been used. Like peer-reviewed journal articles, books are generally regarded as reviewed, rigorously edited and authoritative sources of information. The number of significant citations from such sources available online reinforces the importance of using Google to search for evidence of use across the Web.

Subject Bibliographies

Subject bibliographies are sources similar to bibliographic citations but they recommended GESAMP reports for very specific purposes. These sources were published on the Web to inform potential users of relevant publications in specific subject areas. A total of 25 such citations were located, or 6.3% of unique Google results. Searches for nine of ten GESAMP reports returned at least one subject bibliography. Examples include an International Maritime Organization (IMO) Web site which lists GESAMP reports as relevant to waste characterization, marine dump site selection, impact assessment, and field monitoring, among other subjects (IMO, 2005). Another example is a set of papers and policy documents on a shrimp action plan for Bangladesh which includes hyperlinks to several GESAMP reports (NACA, 2003). Several subject bibliographies refer to GESAMP report 71, including a section of a Web site published by PUMPSEA regarding "Peri-Urban Mangrove Forests as Filters and Potencial [sic] Phytoremediators of Domestic Sewage in East Africa" (PUMPSEA, 2005). Two other sources refer to report 71, namely, a United Nations System-Wide Earthwatch (2007) page, and a Web site of a Massachusetts-based research team at Woods Hole, which focuses on an international scientific assessment regarding sustainable development and environmental governance (Woods Hole Research Center, 2009). Subject bibliographies

suggest that Web site creators have taken time to consider and recommend GESAMP publications. Even though direct evidence of use of GESAMP publications is not given, use is suggested by the recommendations that these sources provide.

Online Papers

A total of 19 or 4.8% of unique citing documents were online papers. Seven of the ten GESAMP reports received at least one such citation. Report 71 received the most, being referenced seven times. Report 57 was cited four times, and number 39 cited three times. The online availability of report 71 and growing access to Web information in the early 2000s may explain why report 71 is cited as frequently by online sources.

Online papers themselves constitute a form of grey literature whose authority or reliability may be questioned. Typically, these documents have been placed on the Web without an explanation of the peer-review or editorial processes to which they were subjected. Accountability is suggested, however, by the Web site on which it is hosted. Web sites that host papers citing GESAMP report 71 include, for instance, sites of the International Tanker Owners Pollution Federation Limited, the Rachel Carson Homestead, and the Marine Affairs Program at Dalhousie University.

Citations to GESAMP documents from online papers are virtually indistinguishable from the citations in journals indexed by Web of Science in terms of the perceived motivations for providing references. Information from GESAMP reports were drawn on largely to introduce topics as well as to highlight the contributions of the group in addressing marine environmental problems. The subject matter of online papers may help to distinguish the citing documents from those found in Web of Science. Papers titled "External Costs of Maritime Transport" (di Silvia, Chiffi, and Molocchi, 2008) and "The Environmental Impact of Naval Practices in Navy Bases" (Lewey and Wybrow, 2002) both cite GESAMP report 71 and their subjects are not likely be noted in Web of Science sources. Questions regarding the authority of the information in online papers may continue to be raised. However, online papers are a type of citing document that can be

located using Google which show important additional use and influence of grey literature.

Journals

Citations from journals not indexed by Web of Science constituted 14 of the 400 or 3.5% of unique results. Many of the citations were to GESAMP reports published in the late 1980s and early 1990s, with four citations to report 39 (1990), three to number 38 (1989), and two to report 32 (1987). Citing journals from this dataset include *Environmental Informatics Archives*, *Vermont Journal of Environmental Law*, *Journal of Theoretical Politics*, and *Issues in Ecology*. The titles of these journals show a range of subjects where GESAMP publications have been cited. These periodicals may not be considered top journals by Thomson Reuters, or the subject matter may be deemed inappropriate. Since they were located in the Google search, these citations extend understanding of the use of GESAMP's reports beyond findings from Web of Science.

There are no marked differences in the way GESAMP publications are cited between journal articles located via Web of Science or Google. The editorial standards for the online journals may vary from those sources indexed by Web of Science but authors of online journal articles are assumed to have used the information published in GESAMP's reports in a responsible manner. Venturing into a discussion of which sources are more influential is unnecessary; instead, it should simply be noted that online journals exist which contain citations to grey literature.

Conference Documents

Thirteen or 3.3% of unique citations were located in conference documents and proceedings. Conferences, by their nature, entail active interaction among participants, and use of GESAMP reports in such situations may be different than the citation process involved with a scholarly article, particularly, if discussion about a report ensues between presenters and audience members. GESAMP report 71 was the most-cited report among conference documents, with four instances, such as "The Environmental Impact of Naval Practices in Naval Bases" (Lewey and Wybrow, 2002) and "Japan's Position as a

Maritime Nation" (Hooi, 2007). GESAMP report 57 (GESAMP, 1996b) was cited three times, twice in a 2002 conference on aquaculture challenges in Asia (Eleftheriou, and Eleftheriou, 2002) and once in 2004 in conference proceedings published by the Fishery Survey of India (Nair, 2004). Even if GESAMP documents are not being used directly as discussion material at conferences, citations to the agency's information in the papers and presentations at those events represent important use of the information. A higher number of citations from conference documents were retrieved from Google Scholar than Google, which implies that this type of citation to grey literature is more likely to be found via Google Scholar searches because of the latter's indexing protocol.

Meeting Documents

Much like conference documents, meeting documents also imply that there is an interaction between information and participants different from the citations in scholarly articles. A total of 11 of 400 or 2.8% of unique citations was identified as originating from meeting documents. GESAMP reports 39 and 71 were cited most frequently with five and three citations, respectively. Four of the five citations to report 39 originate from proceedings from GESAMP's own meetings, from 1999 through to 2007. These citations do not simply list report 39 in a bibliographic reference list, but instead rely on report 39 as a source of information. The information contained in report 39 continued to be important to the group's work for over a decade after it was published in 1990. The fifth citation to report 39 originated from the Antarctic Studies department of the University of Canterbury, New Zealand in a 1994 "Kyoto Antarctic Treaty Consultative Meeting." Report 39 is cited in the context of its applicability to the marine environment in the Antarctic. This citation adheres to a more conventional display of influence, as it illustrates how information produced by GESAMP has been used by other groups.

The three citations to GESAMP report 71 all originate from sources external to the agency and show a variety of usages. One originated from a discussion paper prepared by representatives from Iceland at a 2001 UNEP meeting on the state of the marine environment (UNEP, 2001). This discussion paper emphasized the importance of the information contained in report 71 as the basis for the paper's subsequent arguments. A

citation in a 2002 meeting document of the Helsinki Commission on Agriculture and the Impact of Fertilizers on Marine Ecosystems used GESAMP report 71 to introduce the problems of fertilizers and eutrophication, as well as outline steps that needed to be taken and identify who is working on solutions (Kremser and Schnug, 2002). The third citation appears in a discussion paper for a 2006 meeting of several UN agencies (DiGiacomo et al., 2006), where GESAMP's information is used to provide the context for the discussion. All of these meeting documents highlight the active engagement with GESAMP's publications at meetings and confirm that such use of grey literature can be tracked using Google.

Dissertations

Two citations from dissertations were located in the Google search. A 2005 doctoral dissertation from the University of Wollongong in New South Wales, Australia, titled *Analysis of the Effectiveness of Indonesia's Coral Reef Management Framework* (Dirhamsyah, 2005), cites GESAMP report 30 in the text of the dissertation, and gives report 39 in the references (the latter seems to be the intended report). A second doctoral dissertation regarding environmental engineering from National Central University in Taiwan, entitled *The Implication of Taipei City Air Quality Variation Patterns from the Last Ten Years* (Chang, 2006) cites GESAMP report 38. Only the list of references of this dissertation was available. The author gives credit to the World Meteorological Organization before GESAMP. Dissertations are relatively rare in this dataset, but they represent undeniable evidence of scholarly use of GESAMP information. Dissertations did not figure prominently in either the Google Scholar or Google search. But as the open source concept becomes more widely accepted, dissertations may become more accessible and citations to grey literature in dissertations may become more common.

Proposals

Two proposal documents were located which cited GESAMP report 71. One proposal was drafted by the Advisory Committee on Protection of the Sea (Advisory Committee on Protection of the Sea, n.d.). This proposal, titled *Municipal Solid Waste Management and Enhancement of Environmental Quality in Sub-Saharan Africa,* used GESAMP

report 71 to highlight research that investigated the degradation of coastlines by sewage dumping. A second proposal, prepared by Whittington-Jones and Branston (2005), is titled *Managing Wastewater Discharges from Shipyard-Based Activities at Harbour Ports in the Western Indian Ocean Region (WIO)*. The document includes in-depth discussion of the purpose of the proposed project, its funding, and a review of relevant literature. Use of GESAMP's publications in these contexts is interesting since proposals are written to stress the importance of research and convince others of the salience of a subject. Referencing grey literature in such a context implies that the sources are highly regarded and indicates important use.

Other

In total, 33 of 400 or 8.3% of unique citing documents could not be classified in any of the categories established for Web results but still represented use of grey literature. Reports 39 and 71 received the most citations, with seven and eight, respectively. Many of the entries for report 39 are educational Web sites that contain short entries referring to GESAMP's information. Similarly, report 71 is cited on educational Web sites, in a blog entry, and in three news items. Examination of citing sources in this category demonstrate the number of ways that GESAMP's information has been used outside of journal articles or reports and highlights how the evidence of use of GESAMP's publications is available on the open Web. Citations in publication types such as blog entries suggest that this literature has been used and understood by a general audience. Similar conclusions can be drawn with regard to the appearance of citations in news reports that are meant for readers with a range of backgrounds and knowledge bases. In this context, GESAMP's publications have been re-contextualized in a manner that allows the group's findings to be shared with a wider spectrum of people regardless of their knowledge. The "other" category can, in a sense, bring to light how grey literature is directly connected to general Web users as opposed to specialists. The use of grey literature in this context is not necessarily scientists communicating with other scientists, or managers and policy makers, and instead signals the usefulness of the information to a general audience.

Bibliographic References

Bibliographic references were the most frequent citations (119 out of 400 or 29.8% of unique citations). Bibliographic references included Web pages, such as GESAMP's own Web site, that simply list report titles and dates of publications without showing any further indication of use. Several URLs indexed by Google direct users to GESAMP's Web site, so that the same publication list was identified several times per report. The Web sites of United Nations agencies, e.g., the Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP), also host lists of GESAMP publications. The Web pages may raise awareness of GESAMP and its work but do not signify use of the reports.

Other Web results classified as bibliographic references included the complete list of GESAMP reports hosted on the Japan Oceanographic Data Center's Web site (JODC, 2004). This list is an interesting example of an organization not directly affiliated with the United Nations which promotes awareness of GESAMP reports. The list also implies that GESAMP's reports contain information relevant to Japan's marine areas, highlighting the international applicability of the reports. A similar Web site, hosted by the Australian Government, focused on the Great Barrier Reef Marine Park (Australian Government, n.d.b). In this case, the Web site is a catalogue of a collection which includes several GESAMP reports. These examples speak to GESAMP's visibility online and give clues about where its literature may be applied, even though conclusive use of the documents is not evident.

Library catalogues that included GESAMP reports were also classified as bibliographic citations. Australian Institute of Marine Science (Australian Government, n.d.a), Singapore Polytechnic Library (Singapore Polytechnic, n.d.), the Online Catalogue of the UN Economic Commission for Africa (UN Economic Commission for Africa, n.d.), and the Smithsonian Institution Libraries (Smithsonian Institution Libraries, n.d.) are examples of this type. Library holdings indicate availability of GESAMP's publications, but not use as the reports could sit unused on library shelves. However, the range of

library collections containing GESAMP's reports points to the applicability of this literature.

The sizeable number and form of bibliographic citations internal and external to the United Nations indicates that users have numerous opportunities to be directed to GESAMP's reports via Google. In an age when "to Google" has become synonymous with information retrieval, grey literature may be more visible if it exists in the medium that many information-seekers are most likely to use. Although bibliographic citations do not represent direct use of the GESAMP reports, the type of citation indicates that numerous opportunities for locating the reports are available.

Commercial

Nine search results originated from commercial sources. Sites, such as Amazon or the National Academies Press, restricted scanning of publications that Google reported as citing GESAMP reports. The restrictions on browsing prevented verifying these instances as direct citations. Other Web sites offer copies of GESAMP reports for sale. These citations do not provide evidence of direct use of GESAMP's publications. Only 2.3% of the citations fall in this category, which may indicate that grey literature reports are seldom seen as commercial products.

Ten Least Frequently Cited Reports (Web of Science)

Aggregate Citation Data

A total of 142 citations were collected from Google for the ten least-cited GESAMP reports. Only three of these results were duplicates of Web of Science data, meaning that a total of 139 unique citations were located. The citation totals for the ten GESAMP reports differ considerably between Google and Web of Science, as Google retrieved substantially more citations for all ten of the reports. The difference in citation totals can be examined to discover insights into the influence of GESAMP publications that have not been frequently cited in Web of Science. Classification of these 139 citations by

publication type helps to determine if the higher counts are indicative of increased evidence of influence. Higher citation counts show that GESAMP's least-cited reports are visible on the open Web, even if many of the Google results are not shown to represent direct use.

Citations to GESAMP's newest publications in this group suggest that evidence of use is made available on the Web before it appears in Web of Science. For example, the two most recent reports, 75 (published in 2007) and 76 (published in 2008) have received two and zero citations in Web of Science, respectively. The same reports were cited 20 and 17 times, respectively, in documents retrieved by Google. While further review of the Web citations is needed to ascertain the kind of influence (if any) these citations represent, the higher citation counts alone suggest the reports are more visible on the Web than Web of Science data notes. Google Scholar data also supports this finding by showing increased use of GESAMP reports 71, 75, and 76, compared to data from Web of Science. Considered alongside similar evidence in the dataset for the ten most frequently cited GESAMP reports (discussed above), a conclusion can be drawn that the use of newer publications can be shown more effectively on the Web via Google and Google Scholar than by Web of Science. The implication of this conclusion is that data obtained via searches with Google and Google Scholar should be included in a measure of the influence of grey literature, particularly when an understanding of the immediate visibility and influence of recently released publications is sought.

Citation Data by Publication Type

Reports

In total, 14 of 139 or 10.1% of citations arose from reports. Four reference GESAMP report 16, including documents produced by Environment Australia (2002), the Scottish Environmental Protection Agency (Baxter et al., 2008), and the World Bank (Batstone, Smith, and Wilson, 1989). *National Ocean Disposal Guidelines for Dredged Material*, published by Environment Australia in 2002, is a comprehensive appraisal of Australia's disposal guidelines. Published 20 years earlier in 1982, GESAMP report 16 was still

deemed pertinent two decades later. Similarly, the *Scotland's Seas: Toward Understanding their State* published by the Scottish Environmental Protection Agency is a document addressing national implications. While this document is briefer than Environment Australia's report, the goal of providing an overview of important environmental issues remains the same. The relevance of grey literature may continue long after its publication, as citations to GESAMP report 16 highlight. In addition, citations in reports have been shown for GESAMP publications that were cited infrequently in Web of Science, making a Google search useful when comprehensive understanding of the influence of grey literature is desired.

Subject Bibliographies

Subject bibliographies accounted for 12 of 139 or 8.6% of unique citations. This percentage is slightly higher than that determined for the dataset of the ten most frequently cited GESAMP reports. Eight of the ten reports in this dataset were cited at least once in a subject bibliography, and reports 11 and 75 were cited three times each. All citations to report 75 originated from United Nation System-Wide Earthwatch (2005), on the subjects of hazardous waste and major environmental assessments (2007), and a background document on GESAMP related to a report on international scientific advisory on the environment and sustainable development (2003). That individuals or groups take the time to promote GESAMP publications indicates familiarity with and use of their publications. While these Web sites do not exactly meet the criteria of traditional citations, they are added to the content of Web sites as a recommendation to readers by the Web site creators who themselves likely consulted GESAMP's reports.

Meeting Documents

Four sets of meeting documents were located, all of which reference GESAMP report 75 (which was published in 2007). All four sets of documents related to UN agencies for meetings that occurred between 2006 and 2009. One is a background report prepared for IMO's Marine Environmental Protection Committee (Lloyd's Register, 2006). Two documents published in 2006 refer to GESAMP report 75 as an in-progress document, since it was not officially published until 2007 (Lloyd's Register, 2006; IMO, 2006).

Uses in this context could help to raise the profile of a forthcoming publication. Citations to report 75 in meeting documents are an example of a growing practice of placing meeting documentation online for wide acces/s. Citations in sources such as meeting documents suggest that the information available on the open Web may be especially pertinent for determining uses of recently published grey literature.

Books

Three citing books were located; two which cited GESAMP report 16 and the other referred to report 20. As with other citation types, these citations give evidence of the continued relevance of GESAMP reports. The books citing report 16 (itself published in 1982) were published in 2001 (DENR, 2001) and 2007 (Harding, Diamond, and Alder, 2007), and the book citing report 20 (itself published in 1984) was published in 2000 (Kütting, 2000). Books comprised only 2.1% of the total dataset and no citing book chapters were located. Overall, insight about the use of grey literature based on citations from books and book chapters was limited.

Dissertations

One dissertation cited a GESAMP report, namely report 11. The dissertation, entitled *Sublethal Effects of Metal Contamination on Marine Sponges: Responses at Different Biological Levels*, includes GESAMP report 11 in its list of references, but does not give an in-text citation to indicate how the report was used (Pujol, 2007). Citations from dissertations made a minimal contribution to the citation totals for this dataset.

Journals

One citing article from a journal not indexed by Web of Science was located. "Revisting the Thames Formula: The Evolving Role of the International Maritime Organization and its Member States in Implementing the 1982 Law of the Sea Convention" cites GESAMP report 75 (Allen, 2009). This 2009 article cites a 2007 GESAMP report, which gives further evidence that use of grey literature may occur in online journals more quickly than in periodicals covered by Web of Science.

Other

Eleven "other" citing documents were located. Reports 75 and 76 received the most citations of this type – three to report 75 (published in 2007) and six to report 76 (published in 2008). As was previously noted, citations from the Web may indicate use of grey literature more quickly than other sources, such as Web of Science. Documents that cite report 76 are quite varied, including two references made in newsletters (Aquatic Animal Pathogen and Quarantine Information System, 2008; Atlantic Coastal Zone Information Steering Committee, 2008). Report 75 is also cited in context of news releases. Citations in newsletters promoting a publication can increase awareness of grey literature before it is released. As an additional example in this category, the Wikipedia entry on "Aquaculture," as of January 26, 2009, included a citation to GESAMP report 76 (Aquaculture, 2009).

Bibliographic citations

Google located 90 citations classified as bibliographic citations, representing 64.8% of unique citations. The percentage of bibliographic citations is considerably higher for this dataset than for the ten most frequently cited GESAMP reports. This means that the two-thirds of Web citations to reports not frequently cited in Web of Science do not show direct evidence of use. For all but three of the reports, bibliographic citations make up more than half the citation total (and the case of reports 29, 7, and 5, approach 100% of the citations).

The three reports with lower bibliographic citations are 16, 75, and 76, which exhibit a wider range of uses. Removing citations that do not show direct evidence of use supports a finding noted earlier that evidence of use of newer reports appears on the Web before Web of Science. The majority of citations for GESAMP's most recent reports, 71, 75, and 76, obtained via Google and Google Scholar offer evidence of their use. Influential citations from Google for all three reports outnumber those located in Web of Science. Search results from Google show that 16 of the 20 citations to report 75 and 8 of 17 citations to report 76 represent direct use as compared to two citations to report 75 and none to report 76 in Web of Science indexed sources. As for report 16, 8 of 16 citations

represent use and influence, and discussion below helps to explain why an older report (published in 1982) continues to be cited on the Web.

The sources of bibliographic citations for the least-cited GESAMP reports were similar to those citing the most frequently cited reports. Many are found in the various pages of GESAMP's Web site, or the Web sites of FAO and UNEP. Some bibliographic citations were located in PDF versions of UNEP reports, which often include full bibliographies of related publications. For example, the PDF version of UNEP Regional Seas Report number 135 includes a list of GESAMP reports (UNEP, 1991). Other bibliographic citations were located in the catalogues of the same libraries noted in section 4.3 above, which presumably acquire copies of all of GESAMP's reports. Bibliographic citations can demonstrate the visibility of GESAMP's publications on the Web to a certain degree but are otherwise limited in their ability to show their influence.

Commercial

Three citing documents were classified as commercial. One citation each was found for reports 5, 36, and 76. A UNEP Web site, which offers a number of UNEP *Regional Seas* and GESAMP *Reports and Studies* publications for sale, listed report 5 (UNEP, n.d.). The United Kingdom Amazon order page included report 36, although the publication is listed as currently unavailable (Amazon, n.d.). Finally, report 76 is listed for sale at Earthprint.com's Web site (Earthprint, n.d.). This Web site claims to be the "World's leading environmental and agricultural bookstore" and, even though report 76 is available for free online, the report is available at this Web site for $70. These citing documents comprise 2.2% of unique citations. While commercial Web sites do not show direct use of GESAMP reports, the ability for readers to submit ratings and reviews for publications listed for sale on Web sites like Amazon's could suggest use of certain publications. However, no reviews were found for the GESAMP reports offered for sale. Nonetheless, since commercial sites can increase awareness and availability of grey literature, evidence of citations in commercial sites obtained via a Google search can be factored into a measure of the use of grey literature.

4.4 ACRONYM SEARCHES AND GOOGLE WEB LINKS

Google Scholar

A keyword search for "GESAMP" conducted on January 4, 2009, returned "about 2,440" results. Preferences for this search limited results to English-language pages and 100 results per page were displayed. Search results could not be displayed beyond those available on the 10th page of hits, which stopped at the 988th hit. When the number of results per page preference was reduced to 10, the search engine only allowed displaying to the 99th page and the 988th hit. To test the display algorithm of Google Scholar, separate searches on the terms "Canada" and "America" were conducted, both of which returned more results than the GESAMP search, and once again it was not possible to view results past page 10 for either search. This outcome suggests that the maximum number of pages of results Google Scholar would display during of the period of this study was 10 pages with 100 results per page.

After establishing that it would be possible to access approximately 1,000 results, as noted in Chapter 3, an interval for selecting results was set to obtain a sample size of 100 hits. The data were entered into a ProCite database, which contained fields for the author of the Web page or article, page title, journal (if applicable), URL, date of publication, and date of access noted. This information was similar to the citation data obtained from Web of Science and provided an opportunity for comparison. However, many Web sites do not give some types of data, such as, publication date or author.

Collecting data via Google Scholar was complicated by "citation" results that did not allow access to the Web page. Such results showed who had cited the Web page or article, but did not provide hyperlink access to the site itself where it would be possible to confirm reference to GESAMP publications. An example of such a citation result is shown in Figure 13.

[CITATION] 2001-proof. Eco-ethics and salmon farming in southern Chile: if the benthos could only talk

S Mulsow, R Kennedy, Y Krieger, C Guarda, M … - **GESAMP**

Cited by 3 - Web Search - Import into RefWorks

Figure 13. Example of a Google Scholar "[CITATION]" Search Results

When such a result was selected from the sampling frame, attempts to locate a copy of the citing "document" were made via the resources and services of Dalhousie University Libraries. When this step proved inordinately time-consuming, a decision was made to ignore a Google Scholar result that lacked a hyperlink and select the next search result in the output from Google Scholar.

During the sample selection, the internet browser failed while results from page 8 were being noted. The search was repeated, and while a new search might not return hits in exactly the same order, the sample obtained for analysis was deemed suitable for this exploratory study.

Findings

A variety of document types were identified in the Google Scholar search on the acronym "GESAMP" (see Table 11). The majority of the results were categorized as representing influence. In total, 91 of the search results from nine different categories show the influence of GESAMP's publications. Conversely, four categories of the search results were perfunctory and assumed to convey limited insight regarding influence of GESAMP's grey literature. The perfunctory Web hits included four from commercial Web sites, two from bibliographic sources, two from obituaries, and one that does not actually contain any mention of GESAMP. While these nine results may increase awareness of the group, they do not show any degree of direct use of the reports.

Citation Category	# of Hits	Influential? (Y/N)
Web of Science	47	Y
Journal	16	Y
Online Paper	8	Y
Report	8	Y
Conference	5	Y
Commercial	4	N
Book Chapter	3	Y
Book Review	2	Y
Obituary	2	N
Bibliography	2	N
Unknown	1	Y
Dissertation	1	Y
Incorrect	1	N
Total	100	Y = 9; N = 4

Table 11. Google Scholar Search Results for "GESAMP"

The high percentage of results showing influential use of GESAMP information were located throughout the hundreds of results returned by Google Scholar, with no obvious pattern to their location in the list of displayed hits. Drawing a sample from the Google Scholar search output gave an efficient method for gaining a general understanding of contexts in which grey literature is used and is influential.

Almost half (47 out of 100) of the results were duplicate citations found in Web of Science. This degree of duplication suggests that Google Scholar indexes many of the sources also indexed by Web of Science. The overlap is particularly interesting given that the search in Google Scholar only used the acronym GESAMP, without mentioning specific GESAMP publications. When a comparable search for the acronym was conducted in Web of Science (a search for "GESAMP" as cited author was completed on March 9, 2009), 630 hits were returned. While no direct comparison between the results of the two searches was undertaken, the sizeable number of hits suggests that evidence of use of grey literature retrieved from both tools requires a comprehensive range of search approaches.

Besides sources that replicate citations located in Web of Science, the sample of citations gives evidence of use of GESAMP publications in a variety of sources showing influence. In this case, GESAMP has been shown to be mentioned in journals not indexed by Web of Science, reports, online papers, conference papers, book chapters, and a dissertation, among others. While detailed analysis of how GESAMP information is used in each of these contexts was not undertaken, a general assessment of the variety of publication types emphasizes the merit of undertaking detailed searches for grey literature when the history and publication record of a publisher of grey literature is complex, as is the case with GESAMP. Similar studies of grey literature could use the same sampling technique as was applied in this research in order to obtain an initial understanding of where evidence of use of publications may turn up. If this step is completed at the outset of a study of Web-based citations, definitions of publication types and types of use likely to be encountered in further study can be established.

Google

A keyword search for "GESAMP" was conducted with the Google search engine on December 22, 2008. Preferences were set to limit the search to English-language Web sites, and return 100 results per page. Google reduced the initial 36,700 search results to 445 "unique" results. In the latter results set, multiple listings for mentions of GESAMP on a page of a Web site are eliminated by the search engine. The process Google uses to determine what constitutes a duplicate search result remains unclear, however. As explained in Chapter 3, a sample of 100 search results was drawn from the 445 "unique" results.

When available, the data collected from Google search results included author or agency responsible for a Web site, the title of the Web site, the date a document was uploaded to the Web or the date of the most recent update, relevant publication information (such as the title of journals or books in which citations originated), the URL of the page, and the date the data was collected. In some instances, information such as publication date was simply not available. The uncertainty of whether the date a Web page or document was

actually loaded to the Web and the date listed as the last update actually related to the section of a site that mentioned GESAMP means that some date information may not accurately relate to the reference to GESAMP in a Web page. In other instances the author or agency responsible for producing a Web page was unclear. These uncertainties makes relating data obtained in this search in Google to Web of Science and monograph citation data difficult. Nonetheless, the search for the acronym GESAMP in Google still yields insights into how GESAMP is referred to on the Web.

The search on the term "GESAMP" in Google encountered few instances of Web sites that could not be accessed. Unlike the search in Google Scholar, no "citation" results proved inaccessible. Instead, a small number were dead links or were blocked because they represented potential security risks to the computer used to gather data. In these cases, the URL was noted as well as the error message to illustrate the possibility that Web users seeking information on GESAMP may experience difficulties accessing that information from Google; this experience is common in Web-based information retrieval and is not unique to GESAMP.

Findings

A wider variety of types of citing documents were located via Google than by Google Scholar. As shown in Table 12, the majority of search results were classified as evidence of information use. In total, 16 of the 20 categories showed influence in some way. These categories were, in turn, responsible for 74 of the 100 results in the sample. The four categories labeled as not showing influence contributed 26 of the results of the sample. This wider variation in the distribution of Google results than the search in Google Scholar, and the lower degree of overlap with Web of Science, suggests that Google may be better suited for gaining an understanding of the myriad of ways grey literature can be referred to in sources available on the Web. Furthermore, the high percentage of search results showing influence suggest that Google is a reliable tool for understanding the Web presence of a grey literature publisher, even if the nature of information posted on the Web is sometimes ephemeral.

Citation Category	# of Results	Influential? (Y/N)
Bibliography	16	N
Meeting	12	Y
Educational Web sites	9	Y
Journal	7	Y
Detailed Bibliography	6	Y
News	6	Y
Presentation	6	Y
Book	5	Y
Commercial	5	N
Online Paper	5	Y
Web of Science	5	Y
CV	4	N
Report	4	Y
Other	3	Y
Wiki	2	Y
Blog	1	Y
Book Chapter	1	Y
Broken	1	N
Letter	1	Y
Pamphlet	1	Y
Total	100	Y = 16; N = 4

Table 12. Google Search Results for "GESAMP"

Although search results of categories representing influence outnumber categories not showing influence on the whole, bibliographies were the most common. Publication lists, library catalogues, and other bibliographies contributed 16 of the 100 items. This type of source may not indicate direct use of publications, but could be responsible for increasing awareness of GESAMP and its publications and ultimately use. The remaining results not showing direct use include five commercial Web sites, the CVs of four authors, and one broken link. Commercial Web sites and lists of authors' publications may help to increase the visibility of GESAMP's reports, but do not show specific use of the reports themselves. Even though sources that do not show direct use of grey literature are

discovered by a search in Google, distinguishing these sources from types that do show influence is informative in gaining an understanding of how grey literature is referred to on the Web.

The 16 categories of search results that represent information influence are quite varied. In this Google search, meeting documents were the most frequent type, with 12 results. This type of use was not identified in the Google Scholar searches for "GESAMP." References to GESAMP in educational Web sites, news services, presentations, Wikipedia-style articles, and blogs are also unique to the Google search.

Of the two searches on the GESAMP acronym, the search in Google gave a more rounded understanding of GESAMP's presence on the Web. This search engine may be the tool best suited to establishing a basic understanding of the range of evidence of the influence of grey literature in the rapidly evolving Web.

Link Searches

In total, 19 Web sites contained links to GESAMP's Web site (see Table 13). Links to Web sites signify a relationship that mirror citations in documents, since they show that Web site authors have made a judgment about the relevance of the linked Web site. A link often implies a recommendation about other Web-based sources and is embedded in a Web site to aid information users about a topic. Understanding where such links originate and their purpose helps to clarify the types of relationships present in Web links.

Of the 19 links, nine originated from the Web sites of UN-based agencies, including FAO (three Web sites), IMO and UNESCO (two Web sites each), as well as UNEP and WMO (one Web site each). An interesting array of linking motivations are exhibited in these Web sites: recommendations about GESAMP literature for purposes of increasing understanding of policy frameworks, acknowledgment and justification of the connection with a sponsoring agency (WMO) and its continued sponsorship of GESAMP, as well as promotion of enhanced dissemination of scientific information for purposes of education,

science, and policy. Four additional links in the UN-related category originated from within GESAMP's own Web site. These internal links are largely navigation aids for users of the Web site. In total, 13 of the 19 links were from UN sources.

The remaining six links were found in Web pages of governmental bodies (i.e., the European Commission, the Japanese Oceanographic Data Center, and the United States Environmental Directories) and NGOs (e.g., Conservation International Marine Portal and the Large Marine Ecosystems of the World group). These links imply an understanding or trust in GESAMP's grey literature publications.

	# of Links
UN Sources (13 links)	
FAO, UNEP, WMO, etc.	9
GESAMP	4
Non-UN Sources (6 links)	
European Commission – Maritime Affairs	1
Japan Oceanographic Data Center	1
U.S. Environmental Directories	1
Peri-urban mangrove forests as filters and potential phytoremediators of domestic sewage in East Africa	1
Conservation International Marine Portal	1
Large Marine Ecosystems of the World	1
Total	**19**

Table 13. Google Link Search Results

4.5 MONOGRAPH CITATION DATA

Overview

Citations to GESAMP reports in printed monographs provide additional important evidence of use that is usually not available from other sources. The search began by identifying 500 printed books and government publications in Dalhousie University's library collections that might contain citations to GESAMP publications. The search in the catalogue was limited to "Monograph" results, which returned records as either books

or government publications. The volumes comprising the sample were then individually examined for citations to GESAMP's grey literature reports. Of the selected 500 monographs, 51 contained citations to at least one GESAMP report, meaning that about one out of every ten monographs contained references to GESAMP publications. The 51 monographs were subjected to analyses comparable to those employed with the Web of Science, Google Scholar, and Google datasets.

Books accounted for 43 of the 51 citing monographs and government publications were the remaining eight. The total number of citations from monographs was calculated by counting each appearance of a GESAMP report in their reference lists or bibliographies. This method followed the citation counting procedure used in Web of Science citation data where the bibliographies of each citing article were examined for GESAMP references. Like a journal article, each of the 51 citing monographs could cite more than one GESAMP report. Many citing monographs were collections of essays or included individually authored chapters. In these cases, the list of references of each essay or chapter was examined for citations. In total, 114 citations were located from the 51 monographs, that is, 17 citations in the eight government publications, and 97 citations in the 43 books. The average number of citations per title is similar, with government publications containing 2.1 citations per title compared to 2.6 citations per book.

One monograph appears in multiple editions in Dalhousie's library collections, and was selected three times in the subject search on "marine pollution." Editions three, four, and five of *Marine Pollution* by R.B. Clark cited different GESAMP reports in each edition of the book. All three editions of this title were deemed acceptable for the sample, as multiple editions of non-citing monographs could also have been selected in sampling.

Searching Monographs

Citations obtained from books and government publications indicated that both types of monographs were important sources of citation data. A question emerged as to whether the same set of citations could be obtained from digital versions of the books and government publications. It was assumed that digital versions of printed books were not

as likely to be available as government publications. Google searches were conducted to determine which books and government publications were accessible as full-text files. The titles of citing monographs were entered in Google and Google Scholar searches, within quotation marks, and the first pages of positive hits were scanned. Seven of the eight citing government publications were retrieved, a success rate of 87.5%. Only 22 of the 43 books were available, and access was subject to various restrictions. None of the books could be located as complete full-text files. Portions of 14 books were available from Google Books which allowed searches for terms, such as "GESAMP." These searches located the total number of times the acronym appeared in texts as well as the corresponding page numbers. Google Books limits the number of pages that can be freely previewed, but indicates when search terms are located on blocked pages. Eight books were available in severely limited previews from Google Books. In these cases, full pages were not available, but searches could be completed for terms in the books. Ultimately, the restricted access to the full texts of monographs prevented proceeding with data collection with digital versions. This limitation may disappear as more and more books become available in digital form. Currently, citations contained in monographs must be located through direct examination of the printed editions.

Subject Areas of Citing Monographs

The subjects of the citing monograph are given in Table 14. A number of insights can be drawn from the distribution of citations across subjects. Of the 24 subject areas consulted in this study, citations in 11 were found, confirming that GESAMP reports have applicability in numerous fields related to marine science and management. The highest level of citation, in terms of the number of citing monographs per subject, occurred in Estuarine Pollution (50% of the sample volumes), Marine Pollution-Mediterranean Sea (37.5%), Coastal Zone Management (36.1%), Marine Pollution – Environmental Aspects (30.8%), and Marine Pollution (25.9%). In each of these instances, the percentage of monographs citing GESAMP reports was substantially higher than the percentage of monographs on those subjects in the total sample. For example, 36.1% of the 36 monographs on Coastal Zone Management (13 out of 36) contained citations to GESAMP reports. However, monographs on this subject only made up 7.2% of the

sample (36 monographs out of 500). On the one hand, the differences may, in part, be a reflection of the method for establishing the population of monographs to sample in this study. On the other hand, citations in monographs on subjects dealing with pollution are expected, given the history and mandate of GESAMP and its publications. As a contrast, low levels of citations are found in monographs on Air Pollution (1.4%), Climatic Change (1.0%), and Pollution – Environmental Aspects (2.3%). While citations to GESAMP reports in monographs on these subjects are not unusual, the history and mandate of GESAMP and its publications may also explain the low number of citing monographs in these subject areas, particularly with regard to Air Pollution. This subject area has not been a priority for GESAMP (although the air-sea exchange of chemicals has been) and the low number of monographs on that subject which cite GESAMP publications is a reflection of GESAMP's focus.

Subject	# of Citing Monographs	# of titles in the sample	% of Citing Monographs per Subject	% of Total Monographs per Subject
Air Pollution	1	70	1.4	14.0
Aquaculture	4	31	12.9	6.2
Climatic Changes	1	100	1.0	20.0
Coastal Ecology	5	25	20.0	5.0
Coastal Zone Management	13	36	36.1	7.2
Estuarine Pollution	2	4	50.0	0.8
Marine Pollution	15	58	25.9	11.6
Marine Pollution -- Environmental Aspects	4	13	30.8	2.6
Marine Pollution -- Mediterranean Sea	3	8	37.5	1.6
Oil Pollution of the Sea	2	17	11.8	3.4
Pollution - Environmental Aspects	1	44	2.3	8.8
Total	51	406		

Table 14. Subject Areas of Citing Monographs

Although most of the monographs in the sample covered subjects where citations were found (406 out of 500, or 81.2%), a sizeable number of volumes were searched in some

subject areas before citations were found. In the subject of Climatic Change, for example, after a search of 100 titles, only one title cited a GESAMP publication. However, the subject is still considered to be a citing area as GESAMP's publications have relevance to issues of climate change.

The distribution of citations among the subject areas suggests that further investigation of evidence of use of GESAMP publications focused on monographs should pay attention to the subjects that are the most citation rich. These subjects have already been noted, e.g., "Estuarine Pollution," "Marine Pollution – Mediterranean Sea," "Coastal Zone Management," and "Marine Pollution." Subjects that may show limited use of GESAMP publications are "Air Pollution" and "Climatic Changes."

Subject areas in which no citations were located are shown in Table 15. In total, 93 monographs in 13 subject areas did not contain any citations. In other words, 18.6% of

Subject Descriptor	# Monographs for Subject	% of Total Monographs per Subject
Cadmium -- Environmental aspects	6	1.20
Carcinogens	21	4.20
Diffusion -- Mathematical models	3	0.60
Energy development -- Environmental aspects	7	1.40
Hazardous substances -- Environmental aspects	3	0.60
Lead -- Environmental aspects	5	1.00
Ocean-atmosphere interaction	26	5.20
Ocean energy resources	4	0.80
Pollutants -- Environmental aspects	4	0.80
Sediment transport --Mathematical models	2	0.40
Tin -- Environmental aspects	1	0.20
Trace elements in water	7	1.40
Water quality -- Standards	4	0.80
Total	93	

Table 15. Subject Areas of Non-Citing Monographs

the monographs in the sample were on subjects that did not cite GESAMP reports. Hence, the majority of the monographs in the sample were on subjects in which citations were located, showing that the monograph search produced a reasonable sample of the monographs available on the topics.

Many of the subjects in which no citations were found were more specific than the citing subjects, e.g., "Energy development – Environmental aspects," "Hazardous substances – Environmental aspects," and "Sediment transport – Mathematical models." Since fewer monographs are likely to fall into a specific category than a broader one, the number of monographs available to examine for citations will be low. The non-citing subjects may have been too focused and not closely aligned with information in GESAMP reports that might lead to citation.

As the monograph searching process was developed, a number of non-citing subjects were identified as unlikely to show citations to GESAMP's literature even though the subject descriptors were associated with at least one GESAMP report. For example, it was not expected that many monographs on the subject "Carcinogens" would likely cite GESAMP's publications. The subject was included in the population of monographs because GESAMP report 46, *Review of Potentially Harmful Substances: Carcinogens* (GESAMP, 1991a) dealt with the subject. Monographs on the subject of carcinogens, which were consulted in this study, came from the collections in the Dalhousie University's Kellogg Health Sciences Library. Monographs in these collections, which focus more broadly on a medical approach to carcinogens, would not necessarily be expected to contain information dealing with marine issues. As the study progressed, this assumption proved to be correct, as all of the monographs consulted were medical, not environmental. Other subject areas such as "Diffusion – Mathematical Models" were also assumed to be unlikely sources of citations to GESAMP reports, which held true in the study.

In some instances the absence of citations was more unexpected than for the subjects "Carcinogens" and "Diffusion – Mathematical Models." In particular, no citations were

located in monographs on the subject "Ocean-Atmosphere Interaction," an area GESAMP has addressed in several reports, including numbers 13, 23, 26, 36, 38, and 59. Some monographs on the subject of "Ocean-Atmosphere Interactions" did cite the book version of GESAMP report 59, *The Sea Surface and Global Change*, which included the text of the report and background papers (Liss & Duce, 1997). Since the study of citations in monographs was focused solely on grey literature citation data, monographs that cited the Liss and Duce book were not recorded. In the case of this subject, the commercially published book was cited but not the grey literature version.

Monograph Citation Trends

The data from citing monographs can be analyzed in a similar manner to Web of Science data, including determination of the number of citations per year to all GESAMP reports, noting which GESAMP reports have been cited most frequently, and plotting citations to those reports over time. Like Web of Science data, each instance of a GESAMP report in a bibliography or list of references was counted as a citation. In cases where a monograph was a collection of essays or the chapters were authored individually, each reference list was checked. If two different essays in the same monograph cited the same GESAMP report, each reference was counted as a citation.

Figure 14 shows the distribution of citations to GESAMP reports from 1974 to 2008. The trend during this time period shows modest variation, ranging between about one to seven citations per year. The average number of citations per citing year is 4.4 (excluding non-citing years) and 3.4 citations per year when non-citing years are included (the sample included volumes published in every year from 1970 to 2008). There were six non-citing years in the 1970s and 1980s, and only two non-citing years between 1990 and 2008 (1991 and 2002). GESAMP's reports may have become more widely used in the 1990s and 2000s, at least in terms of monograph literature. This summation is supported by the difference in annual citation averages between the ranges 1974 – 1989 and 1990 – 2008, which are 2.3 and 4.3, respectively.

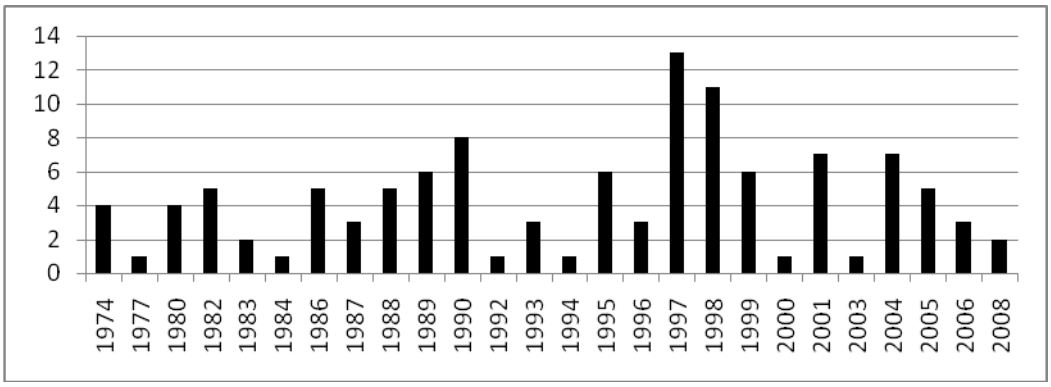

Figure 14. Citations to GESAMP Reports from Monographs Over Time

The years 1997 and 1998 stand out in Figure 14 with the highest annual citations of 13 and 11 citations, respectively. Identifying the reports that contribute to these totals gives some insight into the higher citation totals in these years (see Figures 15 and 16). Report 39, which was published in 1991, was cited three times in both years. Citations appearing several years after its publication gives testimony to the importance of the information contained in report 39. Report 65, which was published in 1997, was cited three times in that year, and report 61, which was published in 1996, was cited three times in 1998, showing that these reports were being cited in monographs soon after their publication. This rapid citation suggests that reports 61 and 65 treated timely marine issues. Six additional reports received one or two citations in 1997 and five in 1998. The distribution pattern for both years resembles observations regarding annual citation distribution in Web of Science data where a small number of citations to several reports coupled with a higher number of citations to one or two publications characterized higher annual totals. Illustrating citation data by year is informative for establishing the context in which grey literature is cited.

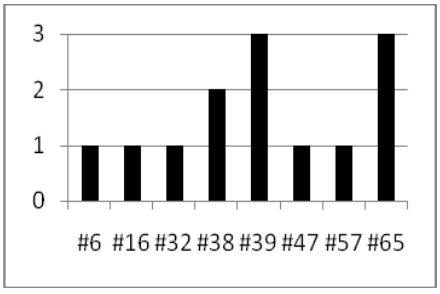

Figure 15. Citations in 1997

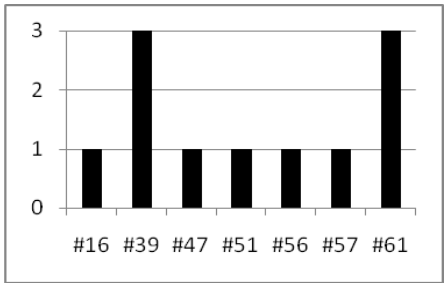

Figure 16. Citations in 1998

The monograph citation data can be viewed in terms of the number of citations each GESAMP report received (see Figure 17). Each bar in the figure represents a GESAMP report, with the exceptions a to f, which show citations to the earliest sessions of GESAMP meetings published before the *Reports and Studies* series was introduced. Citations to GESAMP reports co-published in UNEP's *Regional Seas* series are noted by "UNEP" added to the GESAMP series number. The label "#Other" was used for two citations which mentioned GESAMP reports, without naming a specific report.

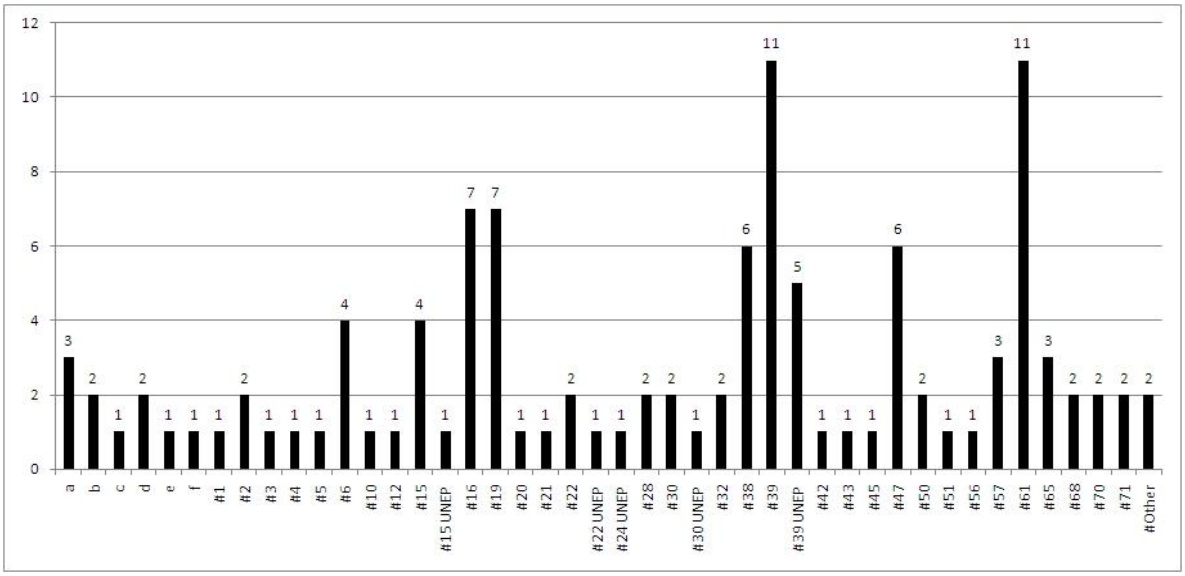

Figure 17. Total Citations to GESAMP Reports from 500 Selected Monographs

In total, 44 of GESAMP's reports and five UNEP *Regional Seas* reports were cited in monographs. As noted earlier, the UNEP reports duplicated GESAMP's versions. Therefore, citations to GESAMP and UNEP versions of reports (#s 15, 22, 30, and 39) could be combined, to give 40 GESAMP publications cited in the monographs. Most GESAMP publications were cited only once. The most-cited reports were report 39 (16 citations) and report 61 (11citations). Both of these reports ranked in the top five most-cited GESAMP publications based on Web of Science citations (see Figure 7). Reports 16, 19, 38 and 47 were cited six or seven times, comprising the middle ground in this distribution. Three of these reports, 19, 38, and 47, ranked in the top 20 most-cited GESAMP publications based on Web of Science citations (see Figure 7). Much like Web of Science data, the distribution pattern of the monograph citations shows a high number

of GESAMP reports were cited, with a few of the reports receiving many citations and most reports receiving only one to three citations.

Publishers of Monographs

Ten firms or organizations each published two or more of the citing monographs (see Table 16). A larger number of publishers produced one citing monograph each. Two UN-based agencies, the Food and Agriculture Administration and the United Nations Environment Programme, published three and four volumes respectively. While the numbers are low, this finding may demonstrate a continued connection between the sponsoring agencies and GESAMP.

Publisher	# of Citing Monographs
Food and Agriculture Organization	4
CRC Press	3
UNEP	3
Blackwell Pub.	2
Edward Elgar Pub.	2
Elsevier Applied Science	2
Graham and Trotman	2
Krieger	2
National Academy Press	2
Oxford University Press	2

Table 16. Publishers of Citing Monographs

Many of the citing monographs were published in either the United States or the United Kingdom (38 out of 51, as shown in Table 17). Only one of the citing monographs was published outside of North America and Europe. This geographic distribution may reflect a Western bias in access and use of GESAMP publications, or Western dominance in the book publishing industry, or the methodology used to select the sample. The Western bias may change as e-texts become more prevalent in the open Web and use of grey literature may become more global.

Country of Publication	# of Citing Monographs
USA	21
UK	17
Italy	4
Greece	3
Netherlands	2
Switzerland	2
Denmark	1
Malaysia	1

Table 17. Country of Publication of Citing Monographs

Authors of Citing Monographs

Since authorship of monographs is known, it is possible to determine which authors of citing monographs (or essays appearing in citing monographs) were involved with GESAMP. Ninety-one authors produced the citing monographs (including individually authored chapters). The list of authors of the monographs was compared to the database of individuals who had some involvement with GESAMP (see discussion of this database in Chapter 3). Four of the citing monographs were authored by at least one individual who was previously involved with GESAMP. Two of the monographs were books and two government publications. The four monographs contained nine out of total of 114 citations found in all the monographs, or 7.9%.While nearly one quarter of citations indexed by Web of Science were contributed by authors who had been involved with GESAMP, less than 10% of citations from the selected monographs were contributed by such authors. As noted earlier, comparable analysis of authorship is not achievable with citation data obtained via Google Scholar and Google, as statements of responsibility are sometimes missing in online sources. But, as the Web of Science and monograph citations show, the majority of citations were contributed by authors who were not directly involved with the group. In other words, knowledge of GESAMP's grey literature reaches beyond individuals with an "insider's" awareness.

Monographs have been shown to be as important a source of citation data for grey literature as any of the other sources consulted in this thesis. Citations collected from

monographs confirm that many of the subject areas generally associated with GESAMP's mandate and publications contain some evidence of use. However, the success rate for locating citing monographs was approximately one in ten, which could suggest that authors are not citing GESAMP's publications as often as could be expected. Completing citation searches in monographs may provide more information about influence through exclusion than is available through citations themselves.

Monograph citation data may be easily discounted because of the time required to locate and inspect items chosen from a vast body of literature. As shown in this thesis, online technologies are not currently advanced enough to be considered a substitute for the process of manually examining monographs. Citations will need to be collected from monographs manually until such time when tools such as Google Books can be used to automate the search process.

CHAPTER 5 DISCUSSION

Studies of the use and influence of scientific publications have, since the mid-1950s, been based on the citation data available from Web of Science (Bar-Ilan 2008b). While data available from this database can provide a particularly informative measure of the influence of scientific research, Web of Science does not encompass all evidence of use, especially for alternative forms of scientific publication such as grey literature. Scientific information published as grey literature often is a source of timely, salient information relevant to a variety of contexts, including further scientific studies and guidance in policy and decision making. This thesis used a case study of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), a producer of grey literature reports concerning important issues of global marine systems, to investigate how to build a more comprehensive understanding of the use and influence of scientific grey literature than simply relying on Web of Science alone.

Even though the grey literature produced by organizations such as GESAMP is subjected to rigorous peer-review and held to high editorial standards, grey literature publications are often stigmatized due to their assumed lack of adequate peer-review processes, which can tarnish their credibility. Negative assumptions about reputability are encouraged to a degree because Web of Science does not index highly regarded sources of grey literature such as GESAMP's publications. While citation data pertaining to some grey literature can be collected from Web of Science, its coverage of this genre is far from comprehensive. Grey literature can impart scientific information relevant to a variety of situations, making it important to determine whether the genre transcends negative assumptions about the quality of its findings. However, this understanding cannot be fully determined by relying solely on Web of Science citation data.

The lack of comprehensive citation data coverage for grey literature in Web of Science is coupled with increasingly varied forms of online scientific publication (Borgman, 2007; Charbonneau, 2006; Thelwall, 2008; Vaughan and Shaw, 2005). As a result, evidence of use is available and can now be easily accessed from sources excluded from Web of

Science's citation index. Therefore, more comprehensive collection and analysis of evidence is required to gain an understanding of the use and influence of grey literature. By considering data from Web of Science, Google Scholar, Google, Web links and monographs together, this study has shown that an expanded approach to citation study will produce a substantially more informed understanding of the use of grey literature. The purpose of this study was not to identify the "best" indicator of influence, but instead to illustrate that a multi-faceted approach to the collection of citation data and use indicators is required in order to fully understand grey literature's influence.

The research questions that guided this thesis are revisited here to demonstrate how the compilation and analysis of citation data from multiple sources have provided additional insights into the use and influence of GESAMP's grey literature. To effectively assess the influence of this literature, the metric must incorporate several sources of citation data, given the wide-ranging applicability of the genre. This thesis identifies several data elements that can constitute a comprehensive metric.

a. Where and how is influence of GESAMP's publications measurable?

Use and influence of GESAMP's publications can largely be determined from citation data collected from Web of Science, Google Scholar, Google, acronym searches, Web links, and monographs. Citations show direct application of GESAMP's body of publications in a variety of contexts, including science, policy, and law. Citation data from each source can be studied several ways to derive an actual measure of GESAMP's influence. For example, the total number of citations to GESAMP's entire body of literature provides a broad overview of use. Focusing on the citations in a single year illustrates when the agency's publications have been particularly pertinent. Similarly, citations for individual reports can be analyzed to learn where GESAMP has been particularly influential. Finally, citations can be linked to the subject areas of citing sources in order to discover the range of fields where grey literature has been deemed relevant. A high number of citations in subjects such as marine pollution, aquaculture, and coastal zone management suggests that GESAMP's publications have been influential in scientific contexts. Similarly, citations in law, policy, and decision making

subject areas indicate the findings imparted by the publications are being applied to enact change.

b. What do traditional citation analysis techniques reveal about GESAMP's influence?

Citation analysis has traditionally and extensively been undertaken employing data contained in Web of Science (Cronin, 1984; 2001). This thesis applied findings from this data to develop a detailed understanding of how GESAMP's publications have been referenced. Web of Science was thoroughly searched and 2,631 citations were collected for all of GESAMP's technical reports and related publications. More than 1,400 citations referenced GESAMP's grey literature publications, including its technical reports, reports of sessions, and co-publications in UNEP's *Regional Seas* series. Citations to the grey literature publications outnumbered citations to related non-grey publications (journal articles and books), which confirms that grey literature is not overlooked, even if questions about the credibility of this genre persist. GESAMP reports 38, 32, 39, 50, and 61 were the most cited and may be considered among the most influential that GESAMP has produced.

Citations to the GESAMP reports republished in books and journal articles contributed the remaining 1,215 citations located using Web of Science. The technical annexes for GESAMP report 38 published as a journal article received 50% of the citations. An additional 19% referred to the book version of GESAMP report 59 and the journal article versions of reports 62 and 39 accounted for 12% each. Overall, GESAMP's non-grey publications were cited more frequently on a per-publication basis; the eight titles generated nearly as many citations as GESAMP's entire body of grey literature. However, the eight non-grey items do not fully represent the areas in which GESAMP's publications have been influential simply because the subject coverage where the grey literature reports were cited is much broader. For example, a subject area, such as aquaculture, is not addressed in any of the eight journal articles and book, but is an area where GESAMP has focused considerable attention with five reports between 1991 and

2008. Nonetheless, citations to GESAMP's journal article and book publications show extensive use of a few documents and give insight into areas where the group has been particularly visible.

Year-by-year totals demonstrated historical citation trends for GESAMP's publications. The rate of citation remained generally consistent from GESAMP's inception in 1969 through to 1992 when a spike from 44 citations in 1991 to 115 citations occurred. Citations to reports 38 and 39, as well as their associated non-grey forms, were shown to be the major contributors for 1992, and the overall total was bolstered by a low number of citations to 36 other GESAMP publications. Annual citation totals rose gradually through the 1990s and reached a plateau of 163 on average per year in the early 2000s. Citation trends illustrate how GESAMP publications have been used historically, and closer examination of individual years highlights the contribution of particular reports (such as, reports 38 and 39 in 1992). The plateau since 2002 suggests that GESAMP has reached citation stasis, which indicates its overall influence has remained steady.

Approximately 5,410 authors were responsible for the citing publications. Of this pool, 5,236 or 96.8% had no identifiable association or experience working with GESAMP. This finding indicates that GESAMP is visible to a sizeable body of individuals outside those who have had direct experience with the group. Articles written by at least one of the 174 (3.2%) authors with GESAMP experience contained 627 of the 2,631 citations (23.8%) located in Web of Science, which suggests that this set of authors rely on the group's publications more heavily than those with no experience with the group. Still, GESAMP's influence transcends an "insider's club" of researchers and its publications have been shown to be used by a large body of authors.

The journals that cited GESAMP publications showed that the group's publications are primarily referred to in scientific sources. *Marine Pollution Bulletin* led the list, followed by the *Journal of Geophysical Research – Atmospheres* and *Marine Chemistry*. Seven of the top ten most frequently occurring subject categories were scientific, among which were "Environmental Sciences," "Marine & Freshwater Biology," and "Oceanography."

Social science subjects, e.g., "International Relations," "Environmental Studies," and "Law," received many fewer citations. Evidence arising from journals and the subjects they represent shows that the use of the group's publications is in predominantly scientific contexts, which points to the need to explore alternative sources of citation data in order to more fully understand GESAMP's complete influence, particularly in policy and law contexts.

Citation characteristics were examined in relation to the Journal Impact Factors of journals. The respective impact factors for the top ten most frequently citing journals were extracted from Web of Science. The impact factors ranged from a high of 4.335 for *Global Biogeochemical Cycles* to 0.972 for *Ocean & Coastal Management*. The average impact factor for the top ten citing journals was 2.633. Without benchmark data for grey literature publications, a definitive statement cannot be made about the findings regarding Journal Impact Factors. But citations can be characterized by this measure of quality and perceptions about the quality of grey literature can be tested by ideas of what a "good" journal impact factor would be for a respective discipline or subject area.

Web of Science's finite index of sources can be regarded as a benefit of using the database since a complete set of citation data can be compiled. In contrast, Google Scholar, Google, and monograph citation searches are all complicated by the uncertain understanding of the totality of what is available. The indexing practices of Google Scholar and Google are not only proprietary but are also continually changing (Thelwall, 2009). Constructing search strategies to locate all the citation data on the Web and keeping that data current are both unrealistic endeavors for organizations with as broad a publication history as GESAMP's. Likewise, checking every monograph published since 1969 from subject areas that could potentially contain GESAMP citations is an unrealistic goal. Web of Science indexes a large but limited number of journals published at regular, predictable intervals. Detailed search strategies can, therefore, identify all relevant citation data from the database giving researchers of grey literature a complete dataset to analyze.

The analyses of Web of Science citation data implemented in this study do not represent the full suite of interpretive tools available for the dataset. Analyses applied to other grey literature publications can be tailored to address questions that were not raised by this thesis. The flexibility with which Web of Science citation data can be analyzed in addressing questions is a major benefit of employing data from this source in a general metric of influence.

c. Given changes in publishing and scientific communication practices, what techniques are needed to complement traditional citation analysis?

Thomson Reuters indexes what it considers the top journals in scientific fields in building its Web of Science database. Reliance on Web of Science as the sole source of citations automatically disqualifies data available from non-indexed sources. In general, grey literature is, by definition, excluded from the sources Web of Science indexes, thereby complicating collection of evidence of its use and influence. Citation data for grey literature can be located, as has been shown by this thesis, but gathering these data is a more complex process than compiling citation data on a single scholar, for example. Web of Science is simply not designed to accommodate or index grey literature. Therefore, Google Scholar, Google, Web links, online acronym searches, and monographs were all examined as important, alternative sources of citation data.

Google Scholar Searches

Citations to the ten GESAMP reports most frequently cited in Web of Science as well as the ten least-cited reports were located using Google Scholar searches. Many of the results obtained in Google Scholar for the top ten reports overlapped with Web of Science data; still, a sizeable number of citations were determined to be unique to Google Scholar. Searches for the ten least-cited reports doubled the number of citations located using Web of Science, a small number of which duplicated the Web of Science data.

Search results for both sets of reports were classified by type of citing document. Results for the ten most-cited reports were almost entirely composed of citations that represented

active, influential use as only 0.5% of the citations came from sources that did not show direct use (e.g., bibliographies). Nearly 30% of the citations to the least-cited reports were bibliographic. In general, most citations for both sets of GESAMP's reports came from types of publication that showed some measure of influence. Among the latter types of citing publications were: government-commissioned or technical reports (26.5%), online journals not indexed by Web of Science (22.3%), online book chapters and books (20% and 8.1%, respectively), conference documents (8.1%) and meeting documents (3.5%). The variety of citing forms indicates that substantial evidence of the use of GESAMP's historically most-cited reports is available from Google Scholar in a number of forms not indexed by Web of Science.

The types of publications citing the least-cited reports also varied, although the number of citations for each category was less than for the top ten reports. Online journals (12.5%), reports and conference papers (9.4% each), books and book chapters (9.4%), meeting documents (6.3%), and Subject bibliographies (3.1%) comprised the majority of citations. Even though the overall totals from each of these categories are lower than for the top ten reports, they each demonstrate influential use. This data from Google Scholar emphasizes that relying solely on Web of Science data would generate incomplete conclusions about the influence of grey literature as important instances of use have been shown, which cannot be determined from Web of Science.

GESAMP's most recently published reports were cited more times in Google Scholar than in Web of Science. Citations to reports 71, 75 and 76 bear out this observation, and this finding suggests that Google Scholar is better suited for determining the immediate influence of reports than Web of Science.

Google Searches

Although fewer citations were located in Google searches of the ten most frequently cited GESAMP reports (based on Web of Science data) than in Web of Science, overlap of citations was far lower than was determined in the Google Scholar search. The lower total suggests that evidence of use of GESAMP reports may not be as prevalent in

Google as Web of Science. But the lower level of duplication highlights Google's tendency to index sources other than those contained in the academic journals indexed by Web of Science and opens a window on additional evidence of use not accessible in Web of Science. Citations to the ten least-cited GESAMP reports also showed a low level of overlap with Web of Science data, pointing to the wider visibility that grey literature can obtain in the open Web.

Citations to GESAMP's publications located in Google were categorized according to type using the same criteria established for Google Scholar. The process of categorizing results was arguably more important for Google results given the ephemeral nature of information available on the open Web. It is assumed that Google indexes the total range of information on the open Web, while Google Scholar presumably focuses on scholarly or academic sources. This means that the search strategies employed in the Google searches could return results that did not show direct use of information.

Citations to the ten most-cited GESAMP reports were more frequently located in bibliographic sources than in Google Scholar. While citations located by Google are more likely to be located in bibliographies (which do not show direct use), a sizeable number of unique citations do provide evidence of use and are, therefore, important data to include in a comprehensive metric of influence for grey literature. This conclusion also applied to the data for the least-cited GESAMP reports.

As with Google Scholar results, the citation data available from Google for the ten most-cited reports was presented in a variety of publication forms. Citations in reports were the most numerous (22.3% of unique citations). Other types contributed fewer citations, e.g. books and book chapters (16.0%) and conference documents (3.3%). As the detailed review of the types of citing documents outlined in Chapter 4 demonstrated, GESAMP's grey literature was used in several different contexts, including science, law, and policy. While the number of types of citing sources was not as varied for the least-cited reports as it was for the most-cited, evidence of use was still more widely represented than could be discerned in Web of Science data.

The number of citations to individual reports was almost universally higher in Web of Science data than Google presented. Even so, some variation between the two tools occurred. In the case of report 71, in particular, a higher citation total was located in the Google search. Report 71 was published in 2001, just as GESAMP began making its reports available online, which could explain the higher number of citations. Google may also be better suited to collecting evidence of this particular report's use. A large number of the citations came from reports, a type of publication that is infrequently indexed by Web of Science. Whatever the explanation, the evidence shows that this GESAMP report, published in the current decade, has received increased use on the Web, a characteristic which may apply to other grey literature.

The number of citations to the least-cited reports was universally higher in Google compared to Web of Science. Many of the citations can, however, be attributed to bibliographic sources, which suggest evidence of the use of these publications may not be any better represented by Google sources. However, two of GESAMP's most recent reports, numbers 75 (2006) and 76 (2007) received more citations in the open Web than was evident in Web of Science. This finding provides further evidence to suggest that records of use of the newest GESAMP reports appears in Google-indexed sources before Web of Science. Google has been shown to more likely return citation data for the latest published grey literature, making it an important tool in measuring the immediacy of information's influence.

Acronym Searches

Searching for "GESAMP" in both Google Scholar and Google provided additional insights into how the agency has been referenced on the Web. The majority of hits in the samples drawn from both search engines represented direct use and thereby influence of grey literature. For Google Scholar, 91 of the 100 results were deemed to show direct use, while 74 of the 100 Google results fit this description. These findings emphasized that Web-based sources comprise an important additional component in determining the influence of grey literature.

Slightly less than half of Google Scholar search results duplicated citation data obtained from Web of Science. Sources not identified by Web of Science (535) showed a variety of types demonstrating application of information from GESAMP reports. Some types of sources (commercial Web sites, obituaries, bibliographies, and false-positive hit) emphasized the wide range of information available in the open Web. Overall, nine influential and four non-influential categories were illustrative of GESAMP's presence in the sources indexed by Google Scholar.

The results from Google provided further insights into how the group is referred on the open Web. A total of 20 types of citing sources were identified in the sample of 100; 16 influential and four non-influential publication types. About three-quarters of the individual search results were considered influential. Distinguishing the type of citations was especially important consideration due to the ephemeral nature of information available on the Web coupled with Google's undisclosed indexing practices.

The 16 influential categories included meeting documents, educational Web sites, online journals, news stories, presentations, and subject bibliographies. The four non-influential categories encompassed bibliographies, commercial Web sites, author CVs, and broken links. Each of the categories (besides the broken link) shows how grey literature is advertised on the Web, and is potentially one of the ways information users would locate pertinent information. The sheer number of categories of influential and non-influential search results suggests that Google is the tool best suited for determining the wide variety of potential uses of grey literature information.

Search results for the acronym, "GESAMP," in the open Web showed that the majority of references from both Google Scholar and Google were from publication categories representing direct use. Many of the results referred to GESAMP rather than to specific reports, and therefore would have been overlooked in searches based on report titles. As a result searching for the acronym illustrated use in broader contexts than searches for

citations to specific reports. Similar profiles could likely be created and used to establish the Web presence of other grey literature publishers.

Web link Searches

Only 19 Web sites linked to GESAMP's homepage (http:www.gesamp.net). Six links originated from sources external to the UN. External links suggest use similar to traditional citations in that individuals or agencies have taken the time to become familiar with GESAMP's publications and have recommended them in turn. The six links show connections between GESAMP and governmental and non-governmental organizations, which both increase the visibility of GESAMP's Web site and reinforce the legitimacy of the group and the authority or importance of its publications.

Thirteen links were affiliated with the UN, nine of which originated from the Web pages of agencies that sponsor GESAMP. These links served to reinforce the connections between the sponsoring agencies and GESAMP by recommending relevant literature and by serving as a record of the publications sponsors were involved with producing. These links could increase GESAMP's visibility and could be a contributing factor in assuring potential information users that the reports are authoritative. That is to say, links to GESAMP's Web site from IMO could be viewed as an act of sponsoring agencies vouching for the information contained therein. The remaining links originated from various iterations of GESAMP's own Web site. These links were not informative about influence as they represented internal links on GESAMP's Web site intended to aid in navigation.

Although the majority of links originated from UN-based sources, they still provided insights into how information users may happen upon GESAMP's Web page and provided promotion for GESAMP's reports.

Links between Web pages allow for analyses that have not historically been a part of citation analysis. While the links themselves do not necessarily represent citations in the sense that specific publications are used to support an argument or provide credit for

previous findings, they clearly illustrate how information flows and show interconnections on the producer end. Even though grey literature is often freely available online, questions of its accessibility persist; will information users be able to locate grey literature information sources if they are not already aware of its existence? Identifying which individuals, groups, or agencies link to the Web site of a grey literature publisher is an initial step in answering these types of questions about its online visibility. Similarly, identifying the Web sites that link to those of grey literature publishers will identify by exclusion which sites do not provide links.

Monograph Searches

Of the 500 monographs that were selected and checked, 51 contained at least one GESAMP citation for a total of 114 citations. Printed books and government publications made up the sample: 43 citing books contained 97 citations and eight government publications supplied the remaining 17 citations. Physically searching printed monographs was required to collect the citation data since no digital source could provide access to the full sample of 500 books and government publications. Tools, such as Google Books, are only likely to improve and may replace the need for physical searches of monographs. For now, citation data from monographs requires manual searches.

Citations to 44 of GESAMP's grey literature publications were cited in the monographs. Reports 39 and 61 were the most frequently cited, followed by reports 16, 19, 38 and 47. On further examination, the frequency of citation discovered in Web of Science data for reports 39 and 61 was also demonstrated in the monograph data, but report 16 was not in the top 30 most-cited reports in Web of Science data and report 19 ranked twenty-sixth. Also of note, no citations to report 20 were located in Web of Science, whereas the monograph dataset contained one citation. The total citations show where GESAMP's publications have been most influential in monograph literature.

The monograph citation data illustrates a North America and Western Europe bias in terms of publisher and location of publication. Two of the three publishers that contributed the most citing monographs were UN related agencies. Publishers in the

United States dominated, followed by the United Kingdom. These findings may reflect the language preferences of the study, but may also reproduce the prominence of English as the primary language of science.

Ultimately, the distribution pattern for monograph citations does not directly coincide with Web of Science data, signaling that alternative insights into the overall influence of grey literature are available via citation data from monographs.

d. Based on findings from the case study, what elements will make up a comprehensive metric of use of grey literature?

Each citation or link dataset collected in this study provides unique insights into use and influence of GESAMP's publications. Each set supplies evidence that GESAMP's publications were used or its information was recommended in ways that cannot be determined through reliance on one source of citation data (see Appendix 4 for a list of the strengths and limitations of citation data sources). While Web of Science provides access to a very large source of citation data, this source is limited in its ability to represent the full extent of grey literature use largely because of its restricted scope. Each dataset represents an informative building block for measuring overall influence of GESAMP's publications. A composite metric emerges from consideration of multiple datasets which demonstrate where influence is evident. Thus, the proposed metric would combine findings from Web of Science, Google Scholar, Google, the acronym and link searches, as well as monographs in order to demonstrate use of grey literature from several angles. The overarching framework used to guide this study is reintroduced in Figure 18.

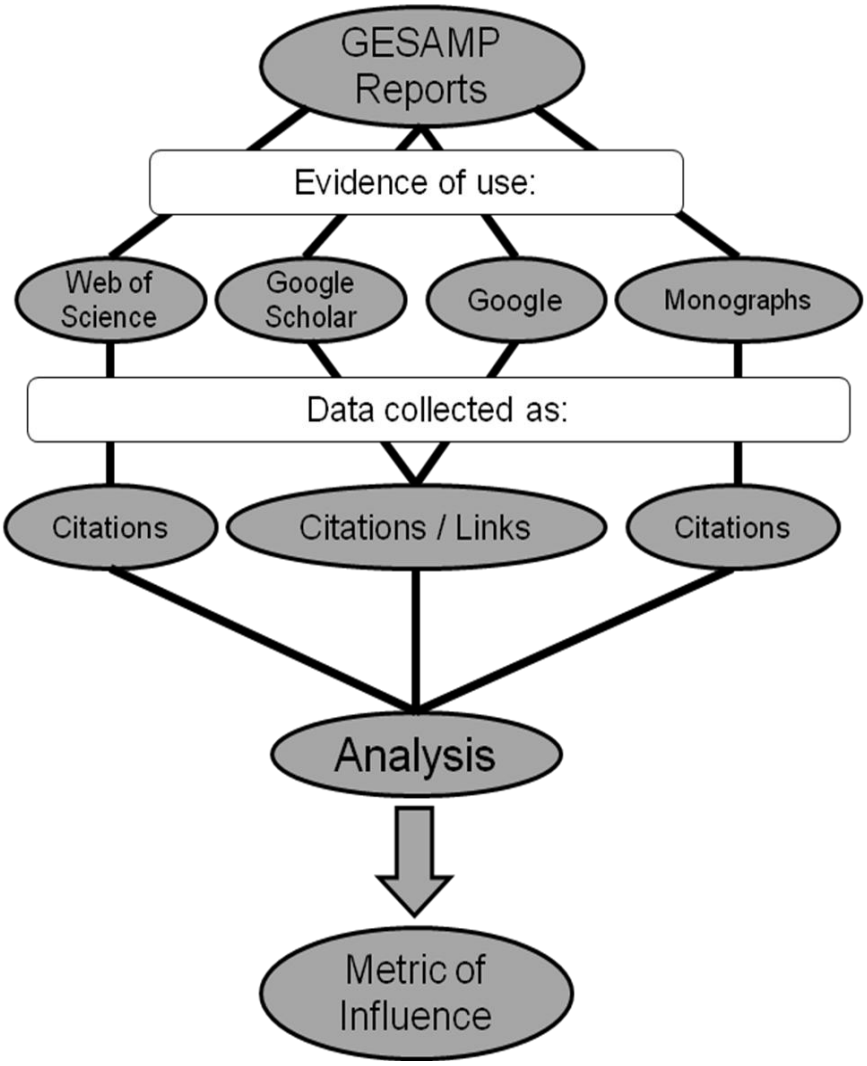

Figure 18. Model of a Metric for Measuring the Influence of Grey Literature

Web of Science data can be analyzed from a number of perspectives to reveal numerous insights about how publications have been cited in scholarly sources in primarily scientific contexts. As this case study of GESAMP has demonstrated, questions can be posed to this type of citation data while recognizing that this data only represents citations appearing in journals indexed by the database. Such questions include who cited the literature, in which journals and on what subject areas the citations appear, and

citation rates over time. The data can be analyzed further to determine whether citing authors are mostly individuals who have had an affiliation with GESAMP. Clearly, GESAMP's publications were cited in sizeable numbers, which indicates that the group's technical reports were disseminated through a variety of channels and that the publications and the group itself are both seen as legitimate and authoritative. Web of Science citation data is the traditional standard used for citation analysis, and the wealth of information that it includes makes it a required building block for understanding the influence of GESAMP's publications. However, Web of Science alone is not a sufficient source for evidence of use.

Google Scholar and Google searches represent a shift away from a traditional source of citation data towards data that more completely account for current developments in scientific publishing. The large number of influential citations in the results from Google Scholar and Google emphasize the importance of conducting citation searches on the Web. Only three of the 587 Google Scholar search results gathered in this study were considered perfunctory, which confirms that a large majority of results are indicative of influence. Unique Google search results are more likely to include perfunctory citations, with about 30% in this category, but the majority of citations represent more substantial use. It is also important to note the rates of overlap between citations retrieved with the Google search engines and in Web of Science. Whereas 44% of the Google Scholar results were unique to the search engine (i.e., not duplicated in Web of Science), over 85% of the Google results were unique. While there is a strong commonality between Google Scholar and Web of Science results, complete duplication between the two sources does not occur. The degree of commonality between Google and Web of Science results is low. This study has also shown that most Google Scholar and Google search results indicate influence (perfunctory citations are in a minority). Further, Google Scholar and Google results also supply evidence of uses of newer information available on the Web to a larger extent than citations in Web of Science will reveal. Findings from citations to publications located via Web searches, especially of publications in the last decade, are pivotal building blocks for a metric that aims to understand the use of grey literature.

Searching for GESAMP's acronym in both Google and Google Scholar also provided insights into how the organization is represented on the Web. The sample data collected from the two search engines provided further indicators of influence with different degrees of overlap with data from Web of Science. While online searches introduce the complication of dealing with Web ephemera, the understanding gained outweighs the time required to collect and interpret these data. The data included evidence not found in other citation datasets and therefore extended understanding of the use of grey literature. The importance of conducting searches on the name of publishers of grey literature as well as publication titles has been shown. Findings from this type of analysis become another building block in the metric designed to more fully measure influence of grey literature.

Web links demonstrate the use and influence of grey literature in a way that draws on tenets of citation analysis without relying on the traditional understanding of what constitutes a citation. Instead, this method collects data from sources that are becoming increasingly important in the global communication of information. By showing which Web sites link to the Web site of a producer of grey literature, the Web link evidence illustrates direct connections between those who are using or recommending use of GESAMP publications and pointing attention to the grey literature publisher itself. Many of the Web sites that link to the GESAMP Web site are hosted by UN-based agencies, which bear a similarity to the "informed" citing authors in Web of Science data. This later relationship may suggest that GESAMP's Web site visibility beyond the scope of other UN agencies is limited. In an era where scientific information, especially in grey literature forms, can easily be disseminated on the Web, determining whether Web links exist and from where they originate is an important component of understanding influence. As the evolution of publication and dissemination of grey literature on the Web continues, findings from hyperlink relationships will be a further element in the measure of grey literature use and influence.

e. Based on findings from the case study, what suggestions can be made about alternative methods for promotion and dissemination of grey literature so that its influence is more pronounced?

Multiple channels are currently utilized in the publication and dissemination of scientific grey literature. As information technologies advance, digital publication and dissemination are becoming increasingly important in a scientific milieu reliant on online systems. This thesis has shown that considerable evidence of the use of grey literature occurs in digital forms. Recommendations follow that encourage the development of digital means for raising online awareness of grey literature and facilitating its accessibility to ensure the genre can be used to its full potential.

Ensuring awareness of grey literature publications among information seekers is an important first step in facilitating its eventual use. Raising awareness can be accomplished through online publications, including the bibliographic citation sources located predominantly from Google during this thesis. As discussed in Chapter 4, publication lists and library catalogues do not indicate active use of grey literature but certainly represent a potential avenue for raising the profile of body of publications. A grey literature producer should ensure that lists of its publications are available online. Similarly, sponsoring or associated agencies should be encouraged to host copies of the list to increase the chances of retrieval; information seekers may be familiar with a sponsoring agency and subsequently be made aware of its sponsored grey literature publisher. Publication announcements in newsletters and blogs represent additional ways to spread awareness of grey literature. Newsletters and blogs are generally user-generated content, and as such, have the additional benefit of actively recommending the use of grey literature. Grey literature publishers could maintain visible links to their publications through lists, blogs, wikis, and newsletters as additional encouragement for the use of their grey literature publications.

Web link searches showed that important recommendations for use of grey literature were conveyed when one Web site provides a link to another. While only 19 links to GESAMP's Web site were retrieved, most of the links still provided insight into an

alternative way information seekers may be made aware of grey literature. Links originated from Web sites both related and unrelated to the United Nations. When groups, such as the Japan Oceanographic Data Center, link to GESAMP's Web site in the references sections of their site, they are actively promoting further use of GESAMP's information. Other groups, such as the World Ocean Network, provide hyperlinks along with in-text references to specific GESAMP reports which represent a focused recommendation that carries the same evidence of influence as a traditional citation. Links originating from United Nations agencies, such as the International Maritime Organization, acknowledge the very close relationship between GESAMP and the IMO. Moreover, a sponsoring agency may be more widely renowned for its work in general than its role as the publisher of grey literature it sponsors, and in such cases should use its higher profile to direct users to grey literature. The more online referrals a producer of grey literature can garner, the more likely its reports will be located and ultimately used. Sponsoring agencies could reasonably be expected to host hyperlinks to the grey literature publications they sponsor. Grey literature publishers should actively encourage related agencies and individuals to provide links to their Web sites.

Grey literature publications republished or repurposed in non-grey forms also promote awareness, as users may be prompted to examine the source material of a book or journal article and subsequently be made aware of the original form of the information. Ample evidence of the use of both grey and non-grey publication forms was shown in the discussion of Web of Science citation data. Non-grey publications were typically more highly cited than their grey counterparts, but publication in book and journal forms is not necessarily a viable option for grey literature publishers. Nonetheless, producers of grey literature should recognize the potential for reaching a wider audience by publishing in higher profile, non-grey forms.

Ensuring grey literature is accessible is the logical next step once awareness of grey literature publications has been established. Web sites must be stable, well-organized, and free of broken links that prevent users from accessing the desired information. Similarly, agencies like GESAMP may reconsider any non-essential steps imposed on information

seekers. Users must first register with a full name and valid e-mail address in order to access the free PDF files available on GESAMP's Web site. Optional demographic information such as address, occupation, and scientific interests can also be entered during the registration procedure. While requiring users to register an account is likely a strategy employed to track usage and understand user demographics, it may be enough of an inconvenience to dissuade potential users from accessing a report. Grey literature publishers concerned with maximizing usage need to consider these additional steps and evaluate whether they are advisable given the potential repercussions.

Commercial Web sites represent a potential avenue for accessing grey literature, especially for those users interested in obtaining information in print. Grey literature could be promoted through many of the tools common to many online retailers, such as lists of top selling publications, by offering recommendations to grey literature from publications with related subject areas, and by utilizing user reviews. While many information seekers would likely prefer a free copy of a report available as an online PDF document, there may be a market for printed grey literature wherein commercial Web sites would provide valuable access points.

Like the assumption that the more links that point to a Web site the higher its resulting visibility, the more sites that host information sources increases the likelihood that the latter will be accessed. Encouraging sponsoring or associated agencies to act as document repositories would present another potential avenue for accessing information. Hosting publications on other Web sites would provide further impetus to ensure they can be accessed without going through a registration process since document retrieval could be complicated. Multiple accessibility points may also be an effective strategy for encouraging awareness of grey literature.

Grey literature producers could also ensure that publications remain current in terms of relevant formats. PDF files are currently the standard for online publications, and many grey literature publishers are utilizing the format. However, as technologies such as E-Book readers evolve, trends may shift in terms of the way people access information.

Barriers to the effective use of grey literature can be mitigated to a certain degree by simply remaining technologically current.

The authority of information published online is often incorrectly regarded as questionable or unreliable. Grey literature producers, such as GESAMP who employ rigorous peer-review and have high editorial standards, could directly address any potential concerns by clearly describing the level of review to which publications are subjected. If information seekers are aware of grey literature as an information source and then successfully access it, it stands to reason that the validity of the information should be confirmed in order to promote the use of the publication.

f. What insights might the case study suggest about grey literature as a whole? Will the study yield insights into potential methodologies for understanding the "value" of other producers of grey literature?

Lack of context regarding what citations mean is a pronounced limitation introduced by using citation data to measure use and influence. The general context of citations for various grey literature publishers must be established, in order to understand what the total number of citations to publications, like GESAMP's, mean. Although 2631 Web of Science citations may seem like a substantial number, it is difficult to state from this study whether the group has been more or less influential than other producers of grey literature. This line of reasoning can be applied to other citation sources. For example, are 587 Google Scholar results a significant total for an agency's ten reports traditionally considered the highest profile grey literature publications? Similarly, is the return rate of 51 citing monographs out of 500 typical for publishers of grey literature? This line of questioning is important to consider, but cannot be answered without further research to establish benchmarks for use of grey literature.

Higher citation totals would be expected for grey literature publishers such as the Intergovernmental Panel on Climate Change because of the high profile of that group's research given current social and scientific concerns. While citation counts among producers of grey literature should not be thought of as a competition, knowing how

GESAMP's citation totals compare to those of other grey literature publishers would put the figure in context. If the goal of a citation study is to learn *how much* influence a producer of grey literature has had, then it stands to reason that benchmarks for citation totals must be determined. Citation totals alone do not fully depict influence. However, in GESAMP's case it would be helpful to compare the overall number of citations to publications to other comparable publishers or series, such as UNEP's *Regional Seas* series, for context. Being cited more frequently does not automatically signal that one publisher of grey literature is more influential than another. But, if in terms of citation counts, a producer of grey literature significantly outshines or lags behind other publishers with similar publication histories, then it may be possible to ascribe a higher or lower relative influence. Other research initiatives will need to be undertaken in order to understand where GESAMP fits in terms of the major producers of grey literature.

Journal descriptions give some indication of the context in which GESAMP's publications are cited. Citations to GESAMP publications were shown to be located predominantly in scientific journals, which implies that use in policy and decision making contexts for GESAMP's published information are not well represented in Web of Science. This may be attributable to Web of Science's indexing practices, or use of GESAMP publications in such contexts may simply not exist. Either way, illustrating exactly how GESAMP publications are cited in Web of Science indexed sources is not possible by simply analyzing journal and subject descriptions. Future studies may classify the subject areas of citing papers to better understand the Web of Science's index of citations. Understanding the context in which grey literature is cited is bolstered by an examination of the sources of citation but is limited in terms of what conclusions can be drawn for this study.

Understanding the influence of grey literature in public policy and decision making contexts requires investigations in addition to citation analysis. Many of the sources of citations located in this study were from papers or reports that had definite policy implications. However, in this study these documents were not thoroughly investigated in terms of the change or influence they produced in policy settings. Even if a report with

distinct policy recommendations cites a GESAMP publication or other form of grey literature, there is no evidence that this report has actually been used by its intended audience. These questions are further confounded by the citation practices employed in policy and decision making. Not only are policy documents difficult to locate even on the open Web, but there is some evidence that these documents do not cite scientific research in the same manner traditionally employed in the sciences.

Limitations

In addition to the limitations discussed above, further observations about the methodologies employed in this thesis can be noted. Citation data collected through searches in Web of Science, Google Scholar, Google, and monographs showed that for a comprehensive understanding of the influence of grey literature several sources of citation data are required. While each of these sources provided unique data and each covers a large body of literature, they do not represent all possible sources of citation data. Other citation databases and search engines not consulted in this thesis may retrieve additional citations. For example, Elsevier's Scopus database has been shown to index different journals than Web of Science, and the two vary considerably in their coverage of some subject areas (Jacso, 2005). Citations to GESAMP's publications and other marine environmental grey literature may, therefore, be indexed by Scopus, and that database should be considered for future research. Similarly, Google Scholar and Google are currently regarded as the most stable and comprehensive search engines available, but their respective indexes are undisclosed, making it impossible to determine what areas of the Web may be overlooked during citation searches. As this thesis was being finalized Google announced a new system for web searches called Caffeine. In addition, Microsoft recently launched a search engine titled Bing. New search engines may index different sources of citations than Google, or may clearly define their indexing practices and search algorithms, which could offer insight into the types of Web sources included in searches. Each source of citation data consulted in this study provided unique insights which showed that a more comprehensive understanding of influence could be established by consulting multiple sources of citations as opposed to relying on Web of

Science. However, alternative sources may need to be consulted in order to establish an even more detailed understanding of grey literature's influence.

For the purposes of retrieval efficiency, complete sets of citation data could not be collected from Google Scholar, Google, and monographs. Strategies for using the Google search engines as citation sources for grey literature were tested by collecting samples of citation data available online, but citation data was not obtained for all GESAMP publications. Further, the titles of GESAMP reports selected for the Google and Google Scholars searches were entered as search terms exactly as they appear on GESAMP's website, a strategy that did not allow for misspellings or other inconsistencies, which likely limited the recall of some citations on the Web. Unlike citation data retrieved from Web of Science, which is considered complete from GESAMP's inception through 2008, Google Scholar and Google citation data is presented as a sample of the types of results obtained by searches for references to grey literature. Monograph searching was similarly limited by the number of titles selected for scanning for citation data. While the method used to select the subject areas of monographs that may contain citations to GESAMP did achieve results, it was limited by relying on the collections of Dalhousie University's libraries in determining the number of titles to be scanned from each relevant subject area. For instance, more monographs were scanned in the subject area "Air Pollution" than "Marine Pollution," as there are considerably more items in the library collections for the former category, even though the latter might be expected to contain more GESAMP references. Other potentially relevant subject areas, including "Oceanography," may have been understudied given that the subject areas were chosen according to the descriptors associated with the selected GESAMP reports. While it is important to identify subject fields where particular grey literature publications may not be cited frequently, the monograph search strategy applied in this study lacked the flexibility to redirect attention to subject areas that likely contained additional citation data. Searches in Google Scholar, Google, and monographs were also limited to items available in English. While English is considered the primary language of science, scientific grey literature may be cited in publications in other languages. Considered altogether, the samples drawn from Google Scholar, Google, and monographs show that

citation data that would be overlooked by traditional citation analysis techniques is available, but the data obtained for this thesis do not represent the complete citation picture that could be derived from these sources.

While this thesis confirmed that a more comprehensive understanding of influence through citations requires consulting multiple sources of citation data, the methods of analysis focused on where evidence of use of grey literature could be collected rather than determining the extent of influence of those publications in comparison to other producers of grey literature. Until further research is completed to provide benchmarks for the citation frequencies for other producers of grey literature, the full significance of the level of citations retrieved for GESAMP's publications cannot be determined. The strategies for collecting citation data developed in this thesis could be applied to additional organizations which produce grey literature, such as the Northwest Atlantic Fisheries Organization (NAFO) and the North Pacific Marine Science Organization (PICES), both of which are intergovernmental scientific organization with mandates similar to GESAMP's. Comparison of the agencies' respective citation trends and totals would provide the means to ascertain relative levels of influence of each of the group's publications. The citation data for GESAMP's publications collected from Web of Science, Google Scholar, Google, and monographs appear to be important quantitatively, but without benchmarks it is not possible currently to draw firm conclusions about GESAMP's relative influence compared to other grey literature producers.

Future Research

In addition to the need to determine citation benchmarks for grey literature that will allow comparison of the influence of particular bodies of grey literature to each other and the benchmarks, future research could study in more detail the reasons why grey literature publications are cited. For this thesis, citation data was gathered and examined in terms of aggregate patterns, such as the rates and trends that characterize GESAMP's citation history. Greater understanding of the influence of GESAMP's publications would arise from analyzing the text surrounding citations within citing documents. This analysis could show, for example, whether the publications were cited to positively reinforce an

argument made in a citing source, or conversely to dispute a GESAMP finding. More detailed categories of citation motivation may also be identified, including citations that might be used to define a problem identified by GESAMP, to refer to specific data or findings, or to set the historical context regarding an issue. Increasing understanding of how and why GESAMP's publications are cited will provide further insights into the influence of this intergovernmental organization and also provide additional context for citations collected from multiple sources.

While determination of the influence of grey literature is a complex project, citations provide an informative indicator. As this thesis has confirmed, a metric of influence based on citations must draw on evidence from several sources, each of which supply unique insights to an overall assessment of use and influence.

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APPENDIX 1 – COMPLETE LIST OF GESAMP'S TECHNICAL REPORTS

Series #	GESAMP Report Title
76	Assessment and Communication of Environmental Risks in Coastal Aquaculture (2008)
75	Estimates of Oil Entering the Marine Environment from Sea-based Activities (2007)
71	Protecting the Oceans from Land-based Activities (2001)
70	A Sea of Troubles (2001)
68	Planning and Management for Sustainable Coastal Aquaculture Development (2001)
65	Towards Safe and Effective Use of Chemicals in Coastal Aquaculture (1997)
64	The Revised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships (2002)
62	Marine Biodiversity: Patterns, Threats and Conservation Needs (1997)
61	The Contributions of Science to Integrated Coastal Management (1996)
59	The Sea-Surface Microlayer and its Role in Global Change (1995)
58	Opportunistic Settlers and the Problem of the Ctenophore Mnemiopsis leidyi Invasion in the Black Sea (1997)
57	Monitoring of Ecological Effects of Coastal Aquaculture Wastes (1996)
55	Biological Indicators and their Use in the Measurement of the Condition of the Marine Environment (1995)
54	Guidelines for Marine Environmental Assessment (1994)
52	Anthropogenic Influences on Sediment Discharge to the Coastal Zone and Environmental Consequences (1993)

50	Impact of Oil and Related Chemicals and Wastes on the Marine Environment (1993)
48	Global Changes and the Air-Sea Exchange of Chemicals (1991)
47	Reducing Environmental Impacts of Coastal Aquaculture (1991)
46	Review of Potentially Harmful Substances. Carcinogens: Their Significance as Marine Pollutants (1991)
45	Global Strategies for Marine Environmental Protection (1991) Addendum 1: Can there be a common framework for managing radioactive and non-radioactive substances
43	Coastal Modelling (1991)
42	Review of Potentially Harmful Substances. Choosing Priority Organochlorines for Marine Hazard Assess (1990)
40	Long-Term Consequences of Low-Level Marine Contamination - An Analytical Approach (1989)
39	The State of the Marine Environment (1990) Annex 1 Annex 2
38	The Atmospheric Input of Trace Species to the World Ocean (1989)
36	Pollutant Modification of Atmospheric and Oceanic Processes and Climate: Some Aspects of the Problem (1989)
35	GESAMP Reports and Studies No.35: The Evaluation of the Hazards of Harmful Substances Carried by Ships (Revision of GESAMP No.17) (1990)
34	Review of Potentially Harmful Substances. Nutrients (1990)
32	Land/Sea Boundary Flux of Contaminants: Contributions from Rivers (1987)
30	Environmental Capacity. An Approach to Marine Pollution Prevention (1986)
29	Review of Potentially Harmful Substances: Organosilicon Compounds (Silanes and Siloxanes) (1986)
28	Review of Potentially Harmful Substances. Arsenic, Mercury and Selenium

	(1986)
26	Atmospheric Transport of Contaminants Into the Mediterranean Region. (1985)
24	Thermal Discharges in the Marine Environment (1984)
23	Interchange of Pollutants between the Atmosphere and the Oceans (Part II) (1985)
20	Marine Pollution Implications of Ocean Energy Development (1984)
19	An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea (1983)
17	The Evaluation of the Hazards of Harmful Substances Carried by Ships (1982)
16	Scientific Criteria for the Selection of Waste Disposal Sites at Sea (1982)
15	The Review of the Health of the Oceans (1982)
13	Interchange of Pollutants between the Atmosphere and the Oceans (1980)
12	Monitoring Biological Variables Related to Marine Pollution (1980)
11	Marine Pollution Implications of Coastal Area Development (1980)
7	Scientific Aspects of Pollution Arising from the Exploration and Exploitation of the Sea-bed (1977)
6	Impact of Oil on the Marine Environment (1977)
5	Principles for Developing Coastal Water Quality Criteria (1976)
3	Scientific Criteria for the Selection of Sites for Dumping of Wastes into the Sea (1975)
2	Review of Harmful Substances (1976)

APPENDIX 2 – WEB OF SCIENCE SEARCH STRINGS

Modified from Cordes, 2004.

Cited Work Searches Based on Agency Names and Series Titles

(This is a summary table, sorted alphabetically.)

FAO* FISH* REP* (year= 1970 or 1971 or 1972 or 1974)
FAO* INF* PE* (year= 1970 or 1971 or 1972 or 1974)
90*fao* or 102*FAO* or 112*fao or 147*FAO* or 129*FAO*

GESAMP*	n*GESAMP* (n=0,9 and A-Z)	
GSAMP* or GEASMP* or GESMP* or GESAM* or GESMAP* or GEZAMP* (n=0,9 and A-Z)		
G* REP* STUD*	n*G* REP* STUD*	(n=0,9)
GR* EX* SC*	n*GR* EX* SC*	(n=0,9)
IAEA* TECH* R* (1986)	263*IAEA* TECH* R*	
IMCO*FAO*	n*IMCO*	(n=0,9)
IMCO* REP*		
IMO*FAO*	n* IMO*	(n=0,9) (space avoids "2 Timothy" etc.)
IMO* REP*		
J* GR* EX*	n*J* GR* EX*	(n=0,9)
REG* SEA*	n*REG* SEA*	(n=0,9)
REP STUD* or REPORT STUDY* or REPORT STUDIES* or REPORTS STUDIES*	n*REP* STUD*	(n=0,9)
TECH* R* IAEA* (1986)	263*TECH* R* IAEA*	
UN ENV* PR*	n*UN ENV* PR*	(n=0,9)
UN REP* ST*	n*UN REP* ST*	(n=0,9)
UNEP* REG*	n*UNEP*	(n=0,9)
UNEP* REP* ST*	n*UNEP* REP* ST*	(n=0,9)
UNESCO* REP* ST*	n*UNESCO* REP* ST*	(n=0,9)
WHO* REP* ST*	n*WHO* REP* ST*	(n=0,9)
WMO* REP* ST*	n*WMO* REP* ST*	(n=0,9)

Cited Work Searches Based on Report Titles
The report numbers following the "/" are UNEP Regional Seas numbers

Report #	**Search string - cited work**
76	as* com* env*
75	est* oil*
71	prot* oc*
70	sea* tro*

68	pl* man* su*
65	to* saf*
62	mar* biodiv*
61	cont* sci* in* OR cont* sci* co*
59	sea* mic*
58	op* set*
57	mon* eco*
55	biol* ind* use* OR biol* ind* m*
54	gui* mar* e*
52	anth* inf*
50, 6	imp* oil*
48	glo* cha* air*
47	red* env*
46,42,34,29,28,22	rev* pot* h*
46	carc* mar* e*
45	glo* strat* m*
43	coa* mod*
42 / 120	cho* pri* o*
40 / 118	lon* cons*
39 / 115	sta* mar* env*
/ 114	tech* ann*
38 / 119	atm* inp* t*
36 / 117	pollut* mod* OR pol* mod* a*
35, 17	eval* haz*
34	nutrients
32	land*sea* b*
32	cont* riv*
30	env* cap*
29 / 78	organosil*
28 / 92	ar* mer*
26 / 68	atm* tr*
24 / 45	therm* dis*
23, 13	inter* poll* OR int* pol* at*
22 / 56	cad* le*
20	mar* poll* i*
19	oc* mod*
16, 3	sci* cri*
15 / 16	rev* h* oc*
15 / 16	hlth oc*
13	interch* poll* OR int* poll* a*
12	monit* bio* OR mon* bio* v*
11	mar* poll* i*
7	sci* asp* p*
5 / 42	prin* dev*

Searches for related papers/books:

cited author	*cited work*	*cited year*
j* imco* or caspers or fleckseder	wat* res*	
andren	mar* pol* b*	
	mar* pol* b*	1987
fowler	mar* env* r*	
howells	mar* pol* b*	

duce	gl* cy* or cycles* or bio* cy* or geo* cy*
gray	mar* p* b*
gray	Biod* cons*
IMO or int* mar* o*	Imo news*
huber	Mar* p* b*

Cited Author Searches

GESAMP*
GEASMP* or GESAM* or GESMAP* or GESMP* or GSAMP* or GEZAMP*
GR* EX* SCI*
IMCO*FAO*
IMO*FAO*
J* GR* EX*
UN GR* EXP*

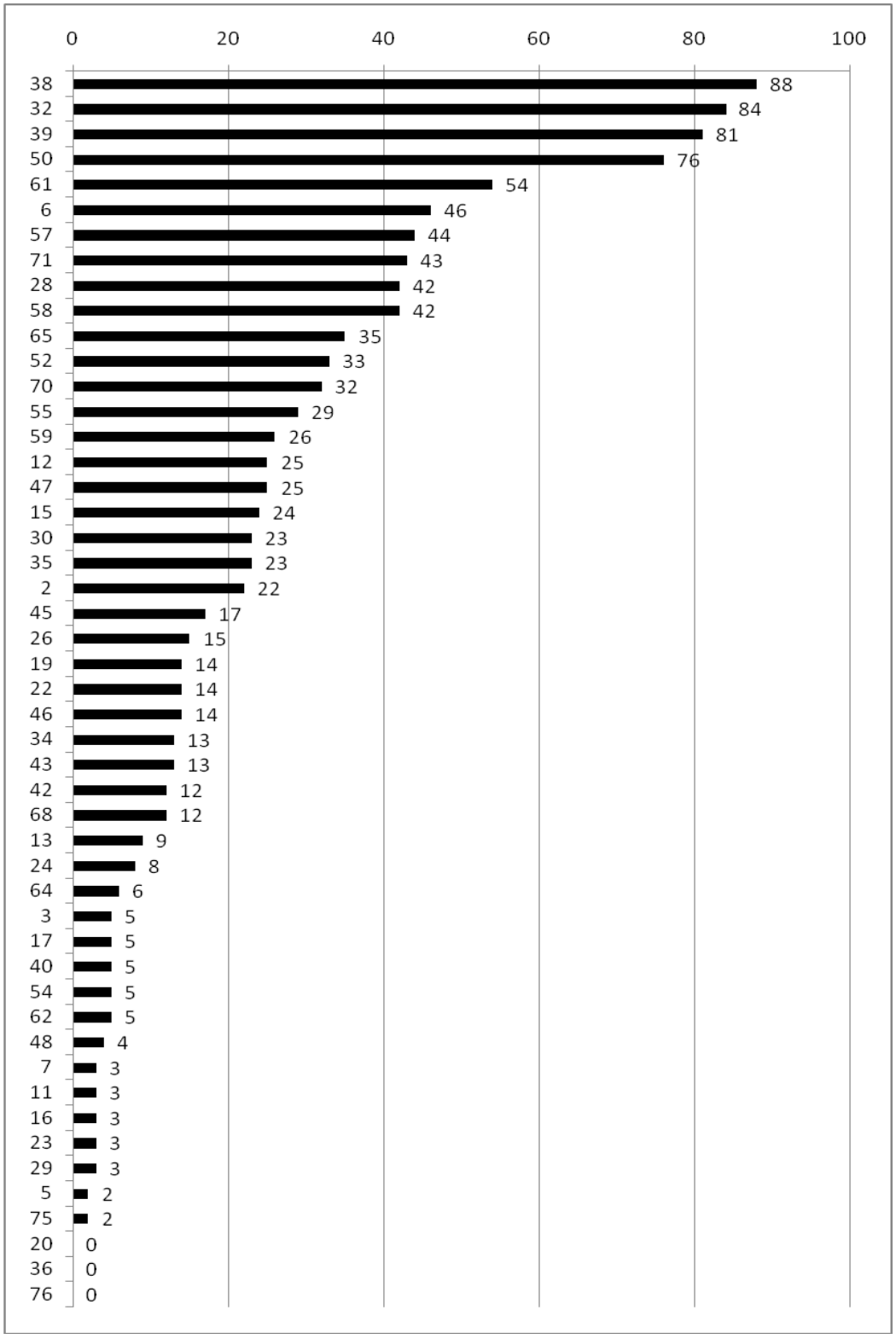
author searches: histories
WINDOM HL OR WINDOM H
PRAVDIC V

#59 book:
LISS PS or LISS P
HARDY JT or HARDY J
PLANE JMC or PLANE JM or PLANE J
HASSE L
FREW NM or FREW N
WOOLF DK or WOOLF D
PHILLIPS LF or PHILLIPS L
ASHER W
HUNTER KA or HUNTER K
GLADYSHEV MI or GLADYSHEV M
ZAITSEV Y
BLOUGH NV or BLOUGH N
EHRHARDT MG or EHRHARDT M
KORENOWSKI GM or KORENOWSKI G
ROBINSON I

Authors from Technical Annex to Report #39
ARNAUDO R
CRUICKSHANK M or CRUICKSHANK MJ
engler rm or engler r
fowler sw or fowler s
GOLDBERG E or GOLDBERG ED
HALIM Y
JERNELOV A

LISS P or LISS PS
MAGOS L
MCINTYRE A or MCINTYRE AD
PEARCE J or PEARCE JB
SALO A
WALDER C
WINDOM H

APPENDIX 3 – WEB OF SCIENCE CITATION TOTALS FOR EVERY GESAMP TECHNICAL REPORT



APPENDIX 4 – STRENGTHS AND LIMITATIONS OF CITATION DATA SOURCES

Source of Citation Data	Strengths	Limitations
Web of Science	- Indexed sources are clearly defined - Citation data shows important use in major journals - A complete body of citation data can be collected given the limited number of indexed sources - Consistency of bibliographic information allows the data to be probed from a number of angles	- Index of top sources excludes citation data in less renowned journals - Focus is mostly on scientific sources, largely excluding subjects such as policy - Database not designed to index or retrieve citations to grey literature - Monographs are mostly overlooked
Google Scholar	- Contains citation data showing use beyond Web of Science, including law and policy contexts - Most citing sources show intellectual, influential use of grey literature	- Full report titles entered in quotation marks exclude inconsistent citations - Limited display of search results - Proprietary index with undisclosed criteria
Google	- Contains citation data showing use beyond Web of Science	- Vast, ever-changing, proprietary index means it is impossible to state with certainty that all grey literature citations have been located

	- Shows use of grey literature on the open Web, in many publication types such as blogs, conference and meeting documents, as well as educational Web sites	- Gives the highest returns of non-influential use (such as library catalogues, publication lists, etc.) - Full report titles entered in quotation marks exclude inconsistent citations
Acronym Searches	- Sample results from Google Scholar and Google gives preliminary insight into how producers of grey literature are referenced on the Web	- Sample does not provide in-depth insight into the visibility of grey literature or its use.
Web Links	- Highlights the connections linking grey literature producers to other Web sites, and shows which entities recommend the literature	- Limited Web links may be available making it difficult to synthesize and interpret data with reliability
Monographs	- A largely untapped source of citation data - Monographs tend to represent considered syntheses of information; use of grey literature in such contexts highlights its role as a source of important information	- Potential human error introduced when scanning bibliographies for citations - Methodologies need to be adaptable in the event that a subject is not a viable source of citations - Digital book technology in its current state cannot replicate the process of citation searching in print monographs