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The Gulfwatch contaminants monitoring program in the Gulf of Maine: Are its data being used for ocean protection, with special reference to Nova Scotia, Canada?

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ABSTRACT

The Gulfwatch Contaminants Monitoring Program is part of the Canada-US, Gulf of Maine Council on the Marine Environment (GOMC). Programs monitoring legacy toxic substances, i.e., chemical contaminants, such as Gulfwatch, collect and analyse environmental samples (e.g., blue mussels), interpret the data, and report on chemical levels and trends (spatial and temporal) in coastal waters. This study explored the extent to which its extensive information (data, reports, papers) has been used broadly and by Nova Scotia, a GOMC member. A mixed-methods study was conducted, using quantitative and qualitative metrics. Citations to some Gulfwatch papers and analysis of use of the Gulfwatch website showed that its data and information were accessed, mostly by government departments. However, interviews revealed that the departments were not using the data to inform Nova Scotia provincial coastal policy or practices. Recommendations are presented to improve the visibility and use of information provided by long-term, environmental monitoring programs.

1. Introduction

Persistent chemical contamination of waterways by both legacy and emerging chemicals of concern makes it necessary to monitor their levels and trends (spatial and temporal) to properly manage risks to human and ecosystem health (NRC, 1990; Frati and Brunialti, 2006; Peterson et al., 2011). Such monitoring provides baseline data that can be used by managers to determine the status of contamination (Lauenstein and Kimbrough, 2007; and Apeti et al., 2010), risks to seafood, the effects of regulatory and remediation efforts (Madejón et al., 2013), and the impact of shipping accidents causing oil and chemical spills.

The Gulf of Maine Council on the Marine Environment (GOMC) is a joint Canadian and American inter-governmental organization with the mandate to protect and enhance the environmental quality of the Gulf of Maine and Bay of Fundy (GOMC, 2012). Its Action Plan Goal #2 is "Environment and Human Health", recognizing that environmental conditions support the health of people and the ecosystem (GOMC, 2012). As part of the goal to improve or maintain healthy environments, environmental monitoring is conducted annually by members of the Gulfwatch Contaminants Monitoring Subcommittee. Gulfwatch uses blue mussel (*Mytilus edulis* L.) tissues to monitor the presence, levels, and trends of metals, PAHs, PCBs, and OC pesticides (Jones et al., 1998; Chase et al., 2001; National Ocean Service, 2014; www.gulfofmaine.org).

The use of mussels in this context follows an established and rigorous methodology of Mussel Watch, used globally (Tripp and Farrington, 1985; Tripp et al., 1992; Chase et al., 2001; Farrington et al., 2016; Touahri et al., 2016) and locally (Walker and MacAskill, 2014). Mussels are sampled annually from a selection of sites from fifty-six established locations around the Gulf of Maine and Bay of Fundy (Fig. 1). Their tissue contaminant burdens are measured by two established laboratories (Chase et al., 2001; Jones and Krahforst, pers. comm.). The data are provided to the Gulfwatch team as raw data downloads from the laboratories and annual Gulfwatch data reports are prepared by a contractor (see www.gulfofmainecouncil.org/gulfwatch). Periodically, the data are re-analyzed and interpreted for trends, spatial and temporal (Jones et al., 1998; Chase et al., 2001; Jones et al., 2001; Jones, 2004; Sunderland et al., 2012; Chamberlain and Wells, 2015).

Simply producing such scientific information is not enough to ensure its consideration in policy- and decision-making related to environmental protection and conservation (e.g., Sutherland et al., 2004; McNie, 2007; Plasman, 2008). Applied scientists in many fields would agree that their data and information should be used to inform policy-

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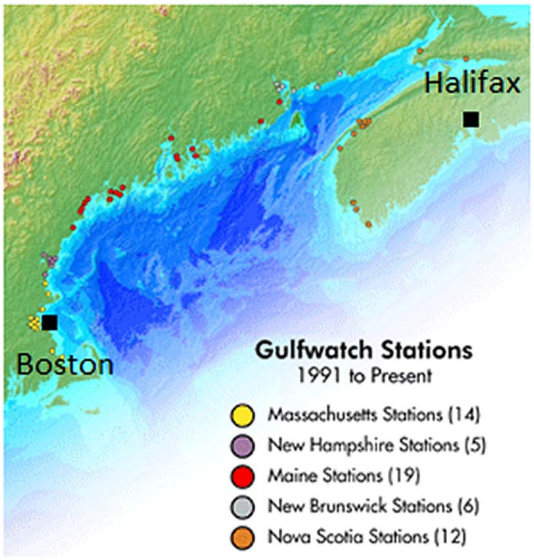

Fig. 1. Map of the Gulf of Maine, including the Bay of Fundy, showing the Gulfwatch sampling locations.

and decision-making. However, it is often assumed that simply making this information available is sufficient to ensure its timely and appropriate use. To date, very few studies have explored the information transfer from production to communicators, stakeholders, and decision-makers in Nova Scotia (Berquist et al., 2012). This study examined the use of Gulfwatch information products by marine managers and decision-makers with a mandate for seafood safety, aquaculture licensing and management, and overall water quality, as well as by the fishing industry. The study is unique in its approach to examining the use and influence of marine environmental monitoring information.

2. Methods

A mixed-methods case-study approach was used to collect both quantitative and qualitative data about the communication of Gulfwatch information and its uptake by various end-users.

2.1. Analysis of information products and citations

A bibliography (Chamberlain and Wells, 2015) was compiled of all published Gulfwatch documents, as well as other outputs (e.g., internal reports, conference presentations) by Gulfwatch Committee members and associated persons. Gulfwatch outputs, i.e., information products, were identified and compiled using several methods. Our research program had previously produced two bibliographies of GOMC publications (Cordes et al., 2006; Ross et al., 2014), from which Gulfwatch publications were identified. Additional documents were found through web searches using Google (Web and Scholar searches) and Web of Science. Publications about Gulfwatch by its committee members were also included.

To identify conference presentations, newspaper articles, fact sheets, or other forms of grey literature outputs, a request was sent to current and most past members of the Gulfwatch committee. Members had been active for many years presenting Gulfwatch information at scientific conferences and in publications within their respective organizations. Twenty people were contacted; only two responded. Our personal library of Gulfwatch-related materials was also searched; numerous fact sheets, conference posters and presentations (i.e., internal documents) not found on the web were documented.

Information products were organized by type of output and year (in five year blocks) and compared to determine use trends over time. As well, citations to an early comprehensive paper (Chase et al., 2001) were analyzed to determine how that paper was being used to inform readers. Citations were extracted from Google Scholar and Web of Science, compared for overlap, duplicates removed, and one list prepared. Citations over time were plotted and the most common types of publications citing the paper determined (i.e., journal articles, book chapters, graduate theses, etc.), then ordered from most common to least common to evaluate use of that paper (Table 1).

Table 1
The top ten sources that cite the Chase et al. (2001), Gulfwatch paper, as of 2014.

Source (journal, thesis)	Number of citations
Marine pollution bulletin	15
Chemosphere	6
Environmental monitoring and assessment	6
Theses (various universities)	5
Environmental international	4
Environmental pollution	4
Environmental science and pollution research	4
Aquatic toxicology	3
Ecotoxicology and environmental safety	3
Marine chemistry	3

2.2. Tracking usage of the Gulfwatch website

The Gulfwatch website analysis was conducted using web server access logs provided by the GOMC webmaster. The GOMC website uses two, access log, software packages to track how individuals use the site (e.g., pages visited, files downloads, time spent on specific pages, etc.). The program “AWStats” provided full lists of all website data and downloaded files (Destailleur, n.d.). Data collected included the pages visited on the Gulfwatch website, the number of visits, and the files that were downloaded by users. The data on viewed webpages were available for five years of archiving, whereas data on downloads were only available from January 2011 to the present. While the number of unique visitors accessing the web pages and downloading the online materials was not captured by AWStats, the data that were captured allowed for analysing trends in the usage of online Gulfwatch information. For web pages visited, the data were captured as yearly totals for 2009–2013 inclusive. Data on file downloads were captured as yearly totals, for 2011–2013 inclusive.

2.3. Analysis of website data

The file download data were organized to determine how the raw data files were used. The Gulfwatch website allows complete access to raw data in Excel and HTML files. Data on the contaminants (metals, PAHs, PCBs, OC pesticides) are available for each year from 1991 to 2012. To gauge interest in each of the different contaminants, the number of downloads of all like-types (e.g., all metals) of data were aggregated, rather than evaluating specific files of interest (i.e., all metals rather than solely “metals 1995”). Because there are six different ways to access each individual file type, for each year of available data, all similar entries were aggregated. For example, metals data from a specific year are available as three different file types from two separate data repositories on the GOMC website. All six locations were aggregated into “metals total” to give an indication of the total number of downloads of raw metal data, rather than individual years or file-types. The rationale for this approach was that the trends of usage over time should still be apparent even though the file types were combined for each type of data (metals, PAHs, PCBs, OC pesticides). Although it is possible that the same individuals were accessing the six data sources (i.e., hypertext markup language [HTML], excel, and text files from two separate locations on the Gulfwatch website) and multiple single-year captures of data, the demand for the raw data was clearly apparent.

Similarly, page visit data were condensed into six categories. For file