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Using experiential marine debris education to make an impact: Collecting debris, informing policy makers, and influencing students

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ABSTRACT

The Shore to Statehouse project supported the creation of an open-source, replicable, undergraduate experiential course on marine debris. Funded by the National Oceanic and Atmospheric Administration, the course allowed undergraduate students in Connecticut, USA, to collect marine debris locally, then create a policy report for state legislators. Here we share the results of the project including data on four accumulation surveys on the Long Island Sound, as well as the impact on student motivation, attitudes, and behavior levels. Results include finding over 1600 individual pieces of debris totaling 19.4 kg (42.8 lb). In addition, the students experienced statistically significant improvements in knowledge and behavior scores. This open-source course can be replicated, empowering students to remove debris, provide important information to local policy makers, and improve knowledge and behavior.

1. Introduction

Marine debris or litter is a complex global issue that negatively impacts the economy as well as the health of oceans, wildlife, and potentially humans. Exacerbated by the use of single-use or "disposable" plastics, many researchers posit that education coupled with policy may improve the problem. Experiential educational efforts are one approach to this multifaceted problem. This article describes the implementation of an open source, replicable, experiential undergraduate course developed with the support of a National Oceanic and Atmospheric Administration (NOAA) Marine Debris Prevention through Education and Outreach program. The course was implemented from January to May of 2016 at the University of Hartford, a small liberal arts college (approximately 5000 undergraduates) in Connecticut, USA. The class introduced students to the issue of marine debris, guided them in the process of collecting, organizing, and identifying debris, then challenged them to use this data to write a policy brief and present it to state legislators. In addition to reporting on the debris found, we measure the impact of the course on student participants, focusing on their knowledge of marine debris, their environmental attitudes, and environmental behavior. To place these responses in context, we compare this test group to participants in a traditional laboratory-based interdisciplinary environmental course at the same University.

1.1. Marine debris

Marine debris is a global problem impacting wildlife, potentially human health, water quality and the economy (Barnes et al., 2009; Engler, 2012; Gregory, 2009; Laist, 1997; NOAA, 2014a; Wright and Kelly, 2017). Marine debris is not a new problem, but our reliance on disposable and single-use plastic items means that debris accumulates in global waterways at an astonishing rate. About 20 million tons of plastic reach the ocean annually—the five oceanic gyres contain approximately 100 million tons of marine debris (U.S. EPA, 2011, Vannela, 2012). In the 1950s global plastic production was approximately 5 million tons annually; in 2015, 322 tons were produced globally, most to create items not in use within twelve months (PlasticsEurope, 2016; Thompson et al., 2009). These numbers continue to rise, with global plastic production reaching 311 tons in 2014 and (The instances of entanglement and ingestion have increased dramatically since 1997 from impacting 267 to 557 species globally (Kühn et al., 2015). Yet ingestion and entanglement are not the only problems; the influx of decomposing plastics and the subsequent leaching of toxic chemicals poses a danger to water quality, wildlife, and potentially human health (Barnes et al., 2009; Engler, 2012; Wright and Kelly, 2017). Plastic debris produces a toxic cocktail including the chemicals from plastics manufacturing and those it absorbs from marine environments (Rochman, 2015). In addition, marine debris can serve as rafts for all manner of creatures, which use the material to travel to new ecosystems (Barnes, 2002; Kiessling et al., 2015). Three hundred and

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eighty-seven taxa (including microorganisms, seaweed, and invertebrates) have been recorded rafting or floating on litter in all major global oceans (Kiessling et al., 2015). Marine debris negatively affects a wide range of industries including tourism and recreation, shipping and yachting, fisheries, aquaculture, and agriculture (Leggett et al., 2014; Newman et al., 2015; Sussarellu et al., 2016; Wallace, 1989). While an omnipresent effect of the modern convenience- and plastics-based society, marine debris is at its core a problem that many researchers believe can be solved. The questions remain whether, when, and how society will choose to approach the problem.

1.2. Addressing marine debris

Experts provide a range of recommendations to address this pervasive issue including educating communities, encouraging behavior change, and developing policies. In describing the scope of their work under the MARLISCO program (Veiga et al., 2016) remark on the importance of society becoming aware of and taking responsibility for the problem. Sheavly and Register (2007) note a link between knowledge and consumer choice regarding the use and disposal of waste. Umuhire and Fang (2016) observe that concern for and knowledge about coasts and oceans may increase a person's engagement in marine conservation. Yet, in a study of Chinese students, they find that while many showed concern for the oceans, they lacked knowledge (Umuhire and Fang, 2016). In evaluating the knowledge and behavior of British schoolchildren, Hartley et al. (2015) determine that interventions can improve knowledge of the issue and self-reported behaviors. The relationship between environmental knowledge, attitudes, and behaviors is complex (Kruse and Card, 2004; Owens and Halfacre-Hitchcock, 2006; Thapa, 2010). Increasing or improving environmental knowledge does not necessarily yield improved environmental behaviors (Oskamp, 2002; McKenzie-Mohr, 2000). The barriers that prevent environmental behavior change are varied and complex (Horhota et al., 2014; Oskamp, 2002). Gifford (2011) notes that environmental sustainability requires overcoming both structural and psychological barriers. He defines these psychological barriers, including limitations on the way we understand a problem, having ideologies that run counter to pro-environmental change, the way in which we compare ourselves to others (particularly in terms of our perception of their contribution to the problem), the way that humans proceed along a given path to avoid the costs and behavioral change associated with altering that path in a significant way, that we discount the work of authorities, that we have perceptions about the risks associated with change, or that humans ultimately engage in “positive but inadequate” changes in behavior (Gifford, 2011, p. 290). He delves deeply into each, remarking that to achieve environmental sustainability we must work toward understanding and overcoming these barriers. Environmental education has been promoted as an effective way to help individuals consider their relationship to complex environmental problems.

Environmental education instills knowledge, improves attitudes, and imparts efficacy and empowerment (Athman and Monroe, 2001). It not only increases information, but also includes critical thinking, problem solving, and decision-making via experiential learning (Athman and Monroe, 2001). Service learning is one form of experiential learning that includes service that meets a community need and reflection on that service (Bringle and Hatcher, 1996). Service learning takes many forms—it may include students engaging in work that helps them to practically apply what is learned in the traditional classroom (e.g., The Innocence Project, where law students examine the cases of incarcerated individuals they believe may be falsely accused) but it may take much simpler form. Undergraduate service learning often includes volunteering to address a community need (i.e., clean a beach, tutor a child, serve at a soup kitchen) that connects with the themes of a course (respectively, environment, education, or social policy). The use of experiential education to ignite student knowledge about and connection to the environment has proven beneficial. In evaluating the role of service learning on sustainability education, Helicke (2014) finds it allows students to delve deeply, experience autonomy, and gain a sense that sustainability goals can be achieved. Experiential learning in the context of marine debris often includes beach cleaning. Beach cleanups are not simply about the event, but about helping individuals connect the presence of litter with human behavior (Bravo et al., 2009). The authors of the Proceedings of the 5th International Marine Debris Conference (5IMDC) (2011) express the important role of removal in prevention strategies, explaining that participating in a beach or shoreline cleanup improves awareness and leads to changed behaviors. They write that the information gleaned from cleanups can help society understand the importance of the issue (5IMDC, 2011). Wyles et al. (2017) compare student responses to a range of coastal activities. Participants were assigned to beach cleaning, rock pooling, and coastal walking (Wyles et al., 2017) and measured on variables including awareness, mood, intentions, and the restorative value of the activity. They found all three activities yielded positive mood and pro-environmental intention; that beach cleaning and rock pooling yielded higher awareness about marine environments; and that beach cleanups were most meaningful but least restorative (Wyles et al., 2017). Bell et al. (2003) conclude that having students collect and interpret environmental data can improve comprehension. In this way, combining learning with beach cleanups has proven effective.

Engaging the public in cleanup efforts can also allow more and potentially better research on marine debris. In a study of a decade of citizen science cleanups in Britain led by the Marine Conservation Society, Nelms et al. (2017) note that large scale volunteer efforts, when held to high scientific standards, produce valuable and voluminous data which would be difficult to produce otherwise. A citizen science project whereby about 1000 schoolchildren in coastal Chile and on Easter Island collected data on the abundance and distribution of debris found they were able to produce scientifically reliable data (Hidalgo-Ruz and Thiel, 2013). In a comparative assessment of citizen science marine collection and that of professional scientists, Hidalgo-Ruz and Thiel (2015) find that high quality reliable data is possible through citizen science, though is most likely in cases including simple and clear protocols, volunteer training, professional supervision, and data validation.

Legislation is often recommended as a complement to education efforts when addressing the problem of marine debris. Derraik (2002) suggests consciousness-raising education paired with legislation. Sheavly and Register (2007) stress the importance of education coupled with strong policies that are enforced. The 5th International Marine Debris Conference proceedings describe the importance of integrating the local context into any policy choices (5IMDC, 2011). Carman et al. (2015) also find policy enforcement critical to solving this pervasive problem. Researchers and experts concur that powerful work to address this pervasive issue will connect education (notably on the sources of marine debris) and the local context with any relevant policy recommendations.

Researchers recommend that to effectively solve the wicked problem of marine debris, we must engage in education, consider human action, provide alternative consumer options, and incorporate policy solutions (Derraik, 2002; Sheavly and Register, 2007). The Shore to Statehouse project addresses these recommendations by creating an open-source college service-learning course that engages students in marine litter collection. Students catalog the debris to better understand the nature of a complex global problem in the local context, then analyze the debris and research how to prevent similar materials from infiltrating the ocean. Finally, they produce a report of their results and share it with state legislators. This article describes the pilot implementation in the spring of 2016 in Connecticut, USA. We share the results of the collection as well as the impact of the class on student attitudes, behaviors, and knowledge.