Science of the Total Environment 639 (2018) 785–792

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Predictors of coastal stakeholders' knowledge about seawater desalination impacts on marine ecosystems

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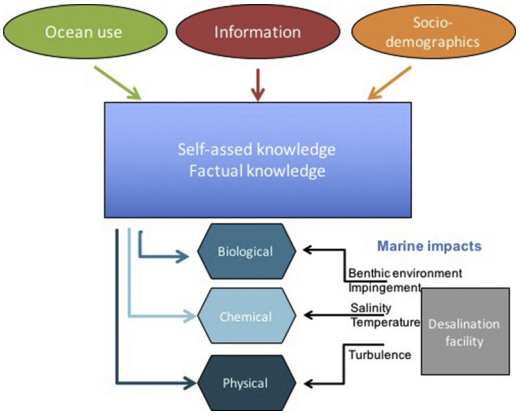
HIGHLIGHTS

- Assessment of ocean-related knowledge in the context of seawater desalination
- Coastal stakeholders' knowledge is highest for biological features.
- Socio-demographic and situation-specific variables both predict knowledge.
- Predictors vary for different types of knowledge.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 12 March 2018
Received in revised form 24 April 2018
Accepted 13 May 2018
Available online 26 May 2018

Editor: D. Barcelo

Keywords:
Ocean literacy
Seawater desalination
Marine protected area
Stakeholders

ABSTRACT

This study investigates variables that shape coastal stakeholders' knowledge about marine ecosystems and impacts of seawater desalination. The influence of trans-situational and situation-specific variables on self-assessed and factual knowledge among coastal residents and commercial marine stakeholders. Data were collected using a questionnaire based survey administered to a random sample of coastal residents and commercial marine stakeholders in eight communities in central California. Knowledge of biological features was higher than knowledge of physical and chemical processes. Both trans-situational and situation-specific variables were significant predictors of knowledge, in particular gender, education, and ocean use patterns. TV and social media were the only information sources that correlated negatively with knowledge. Predictors for distinct types of knowledge were different and provide insights that could help target specific ocean literacy gaps. The study also finds that commercial marine stakeholders were more knowledgeable than other coastal residents. Having an economic stake in the marine environment appears to be a strong motivation to be more educated about the ocean.

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https://doi.org/10.1016/j.scitotenv.2018.05.163
0048-9697/

1. Introduction

Coastal zone and marine management is increasingly moving towards more participatory approaches that engage stakeholders in management and decision-making processes. Consequently, the engagement of coastal residents as a stakeholder group is increasingly becoming an integral part of creating coastal and marine policies. Stakeholder participation incorporates local preferences in the management of coastal and marine resources (Marre et al., 2016; Rogers, 2013; Vanclay, 2012). An engaged public is also seen as essential for successfully addressing complex ocean- and coastal-related issues, including balancing the use and conservation of marine resources, and realizing future benefits of the ocean (National Ocean Council, 2013).

Because coastal citizens can significantly influence decision-making processes, public knowledge about the ocean and its resources is critical for ensuring that the public both understands the implications of marine and coastal policies, and can engage in discussions and decision-making about the use of ocean resources in an informed way (Steel et al., 2005; Steel et al., 2005). The recent U.S. National Ocean Policy, for example, called for increasing ocean and coastal literacy to empower coastal communities and enable them to become better stewards of ocean resources (National Ocean Council, 2013). At the same time, recent research suggests that the public has a poor understanding of the structure and functioning of coastal and marine ecosystems, of how humans affect the health of these systems, and of basic ocean science principles, despite the fact that a high percentage of the human population lives in coastal areas (Fletcher et al., 2009; Capstick et al., 2016). Therefore, understanding the level of public knowledge about marine and coastal systems and identifying variables that are related to higher knowledge are critical for identifying misconceptions and knowledge gaps, and for tailoring communication and outreach programs.

Two theories have been proposed to explain differences in knowledge about environmental issues. One theory states that environmental knowledge is primarily shaped by "trans-situational" socio-economic variables that apply in multiple settings. Examples include level of formal education, income, education, age, and gender. (Lovrich and Pierce, 1984). The other theory argues that knowledge is shaped more by contextual situation-specific factors that might increase knowledge irrespective of socio-economic status. These situational factors are more motivational in character and might increase knowledge-seeking behavior by those having a stake in a policy outcome, or having strong views on specific policies (Pierce, 1992; Steel et al., 1990). For example, people who live close to the ocean, use the ocean for recreation or commercial purposes, or have a strong attachment to ocean areas, may be very interested in the management of marine resources and thus may be highly knowledgeable about the ocean in general and management issues in particular (Perry et al., 2014; Cicin-Sain and Knecht, 2000). In addition, ocean literacy depends on the information sources used to learn about the ocean. Understanding where people learn about the ocean is essential to tailoring and targeting communication strategies and ensuring that credible information reaches the public and increases ocean literacy (Fauville et al., 2015).

Our study expands on existing literature by investigating public literacy in the context of seawater desalination and its impacts on marine ecosystems. Seawater desalination is an emerging sector in the USA that is likely to grow in the future. Even though seawater desalination is highly valued for its ability to provide a potable water supply that is independent of climate, the technology remains controversial due to high costs and potential environmental impacts (Liu et al., 2013; Fuentes-Bargues, 2014). On a global scale, desalination facilities have high energy demands that are likely to contribute CO_2 to the atmosphere (Lattemann and Höpner, 2008; Einav et al., 2003). More localized concerns about direct impacts on coastal ecosystems include mortality of marine organisms due to impingement and entrainment during water intake, impacts of brine discharge (including mortality of marine life), changes in seawater quality, adverse effects on fish resources, degradation of marine habitats due to toxic concentrations of brine, anoxic or hypoxic conditions, and stress from turbulent mixing at the point of discharge (Latteman, 2009; El Wahab and Hamoda, 2012).

Our study extends the limited research on public knowledge about the ocean. Previous studies have explored awareness of coastal and marine environmental issues (Fletcher et al., 2009), general ocean literacy (Fauville et al., 2015; Steel et al., 2005), and public ocean literacy in the context of specific marine issues such as marine protected areas (Perry et al., 2014) and fisheries (Steel et al., 2005). Our study expands this literature by investigating transitional and motivational variables, and the influences of information use on public knowledge about impacts of desalination on marine ecosystems.

We explore socio-demographic factors, situation-specific factors, and information sources associated with higher levels of self-assessed and factual knowledge about biological, physical, and chemical processes important for understanding desalination impacts on marine areas. In addition, we investigate whether commercial marine users are more knowledgeable about policy-relevant aspects of desalination and its impacts on the ocean than other coastal residents. As these stakeholders use the ocean for different purposes, their motivation for learning about the ocean and thus their levels of knowledge may be different.

2. Methods

2.1. Study area

The study was conducted in coastal communities adjacent to Monterey Bay, which is part of the Monterey Bay National Marine Sanctuary (MBNMS) in central California (Fig. 1). The MBNMS has been a federal marine protected area since 1992, and is managed by the National Oceanic and Atmospheric Administration (NOAA). The Sanctuary has a shoreline length of 276 miles and an area of 6094 square statute miles (NOAA, 2017). Five seawater desalination plants have been proposed in communities around Monterey Bay. Seawater desalination is recognized as a regional issue of concern for the MBNMS, and NOAA has developed a Desalination Action Plan that recommends using regional planning efforts for proposed desalination plants within the boundaries of the Sanctuary (NOAA Monterey Bay National Marine Sanctuary and National Marine Fisheries Service, 2010).

As part of this process, the public has been encouraged to participate in discussions about proposed desalination plants in public hearings and open house meetings, and to comment on Environmental Impact Reports for desalination plants. The public has also been invited to comment on any proposed revisions to the existing management plan for the Sanctuary.

2.2. Questionnaire based survey

Data were collected via a questionnaire-based survey in June and July 2016 among multiple coastal stakeholder groups around Monterey Bay, including coastal residents and commercial marine users. We first tested the survey instrument in a pilot study of 30 respondents. The survey instrument was well understood, and no modifications were necessary. Coastal residents were sampled in randomly selected households based on postal records in eight communities directly bordering Monterey Bay: Santa Cruz, Capitola, Aptos, Rio del Mar, Moss Landing, Marina, Monterey, and Pacific Grove. We applied a stratified sampling approach to account for differences in the size of participating communities. Questionnaires for households were either administered in person or left at the door with a cover letter stating that the questionnaire would be picked up 2 days later. Commercial marine user groups licensed to operate in the MBNMS, including whale watching, sea kayaking, and scuba diving operators, were sampled using a census sampling approach. Commercial marine user groups were surveyed at their place of work and the main owner of the business was asked to fill out the