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Management priorities for seawater desalination plants in a marine protected area: A multi-criteria analysis

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ABSTRACT

The development of seawater desalination plants to increase water reliability in coastal areas poses a threat to the health of near shore marine ecosystems and may affect the effectiveness of marine protected areas (MPAs) that have been established to meet international conservation targets. This paper applies a multi-criteria analysis approach to quantify stakeholder groups' priorities for seawater desalination plants that have been proposed in communities adjacent to a National Marine Sanctuary. All groups placed the highest importance on minimizing environmental impacts on protected areas and endangered species that could be affected by water intake and brine discharge emphasizing the need for integrated land and sea conservation. Minimizing socio-economic impacts on coastal communities was much less important. Stakeholders also weighted reducing pressure on water levels in rivers, streams, and aquifers as more important than increasing water for residential consumption, which may foster coastal growth rather than replacing water taken from other sources. The study further revealed differences in the importance of multiple management objectives among stakeholder groups, which highlights the need to elicit distinct priorities of all groups to understand concerns and potential conflicts of desalination with existing marine users. The analysis of consistency ratios revealed that around half of all surveyed stakeholders had high inconsistencies in their responses, which suggests either a lack of understanding of desalination, or reflects the complexity of establishing desalination plants in coastal areas adjacent to a marine protected area.

1. Introduction

Seawater desalination is increasingly being pursued in coastal regions worldwide, with more than 18,000 desalination plants already in operation [38]. The technology is used to alleviate shortages in drinking water in coastal areas due to changing weather patterns, recurring droughts, saltwater intrusion into coastal aquifers, and growth of coastal populations and industries. Despite the advantage of providing a water supply option independent of climate, seawater desalination plants also have the potential to negatively impact coastal ecosystems and communities, depending on the design, locations, and local context of these plants [22,43,8]. Examples of socio-economic impacts include increased price of water - since the technology is relatively expensive [10,15,33,63,9], loss of public access to coastal areas, disruption of commercial and recreational activities, and aesthetic alterations of coastal landscapes [43,6,64]. Indirect environmental impacts on marine ecosystems, such as ocean acidification and sea-level rise, may occur due to the high energy consumption of desalination plants and subsequent increase in greenhouse gas emissions [46,9]. Direct environmental impacts may include degradation of marine habitats (e.g., loss of seagrass beds), mortality of bottom-dwelling organisms [16,17], coastal eutrophication, changes in seawater quality, and changes in microbial communities and production due to brine discharge [4]. Other concerns are mortality of larvae and other organisms due to impingement and entrainment during seawater intake [34].

Desalination plants built in close proximity to marine protected areas (MPAs) may interfere with marine conservation efforts. MPAs are increasingly being established worldwide to meet national and international conservation targets. These areas are designated for many reasons such as securing or restoring marine biodiversity, managing fisheries and supporting the sustainable use of marine resources

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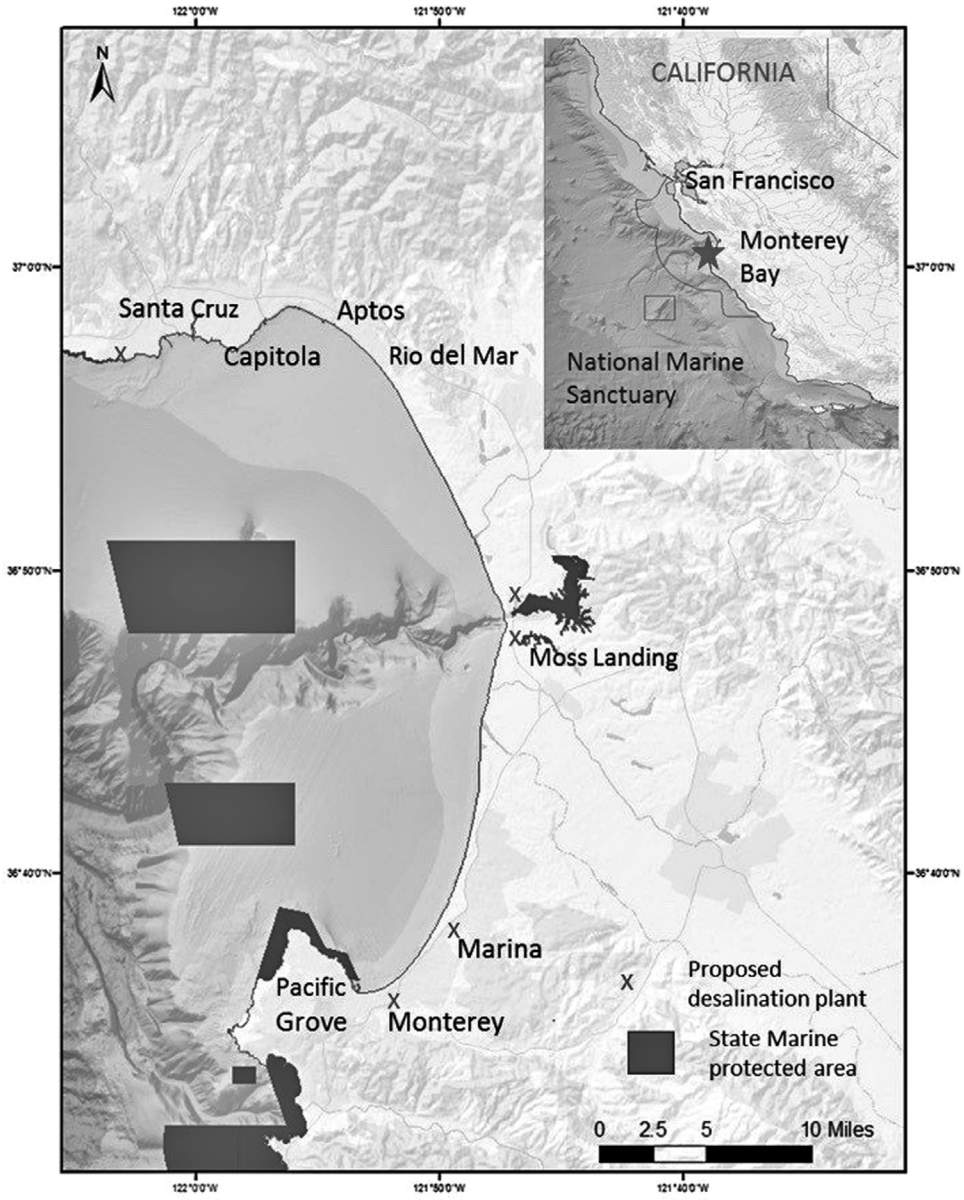

Fig. 1. Location of Monterey Bay and proposed desalination plants.

[23,26,40,57]. Water intake and brine discharge may reduce effective protection of values in MPA sites, or reduce the effectiveness of MPA networks, for example by reducing larval connectivity between MPAs [48].

Planning of desalination plants therefore requires careful balancing of ecological, social, and economic objectives, and the plants should be integrated into wider coastal zone management, since sectoral approaches to marine and coastal zone management typically fail [12]. However, systematic planning processes are often missing and desalination plants are usually established on a project to project basis.

In addition, engagement of coastal stakeholders in the planning process is critical and integral to many coastal and marine policies [45,56,67]. In the United States, gathering, weighting, and incorporating stakeholder input is an important part of coastal and marine resource management, including the development of desalination facilities [5] and management of MPAs [62]. To date, public input is solicited primarily in public meetings and comments on Environmental Impact Reports. Systematic assessments of quantitative preferences are commonly missing. Engaging coastal stakeholders, including local residents, in the early stages of the planning process provides critical information on management preferences for these plants and offers insights into social acceptability and support [25,35,37,66].

Unlike research on organized stakeholder groups, studies exploring management priorities of coastal citizens who are not part of organized stakeholder groups are still very limited, even though the public can have substantial influences on coastal development and management decisions [45,53]. This study addresses this gap and explores coastal stakeholders' priorities for proposed seawater desalination facilities adjacent to a National Marine Sanctuary. Such an assessment is critical to account for local preferences in the planning of desalination plants and to facilitate a more systematic approach to the planning of new facilities. While previous studies have investigated public attitudes towards desalination plants [24,30,41] and the acceptance of using desalinated water [19–21,65], an understanding of coastal stakeholders' management priorities for seawater desalination plants is lacking.

To quantify the importance of management objectives that should be considered in the planning process, a multi-criteria analysis (MCA) approach was applied. MCA refers to a collection of theories, methodologies and techniques that explicitly integrate and balance a set of criteria, and these methods have been widely used in environmental and natural resource management to facilitate balancing multiple