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Southern California Bight regional monitoring

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HIGHLIGHTS

- Expansive urbanization puts the SCB's coastal sediment quality at risk.
- Regional monitoring provides a holistic view of the SCB's sediment quality.
- Sediment quality in the SCB is largely in good condition.
- The habitats with the most impacted sediment quality are estuaries and marinas.
- Even the habitats with most impacted sediment quality are improving with time.

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ABSTRACT

The Southern California Bight (SCB) is a unique ecological and economic resource, home to some of the most productive coastal ecosystems, but also some of largest pollutant inputs in the United States. Historically, environmental monitoring of the coastal environment has been temporally intensive, but spatially focused on narrow areas closest to regulated discharges, providing a potentially biased perspective of overall coastal sediment quality. Beginning in 1994 and conducted approximately every five years thereafter, nearly 100 regulated, regulatory, non-governmental or academic organizations join forces to implement the SCB Regional Marine Monitoring Program (the Bight Program). The most recent Bight program sampled nearly 400 locations, from the head of tide in coastal estuaries to offshore basins 1000 m in depth, using a probabilistic survey design and measuring multiple indicators of sediment quality including chemistry, toxicity, and infauna. The three indicators were scored using regionally-developed assessment tools, and then combined for an integrated assessment of sediment quality. Results showed that the vast majority of SCB sediments do not have impacted sediment quality, but that not all habitats are in equally good condition. Most of the continental shelf is not impacted, despite the discharge of very large volumes (10^9 L/day) of treated wastewater discharges. In contrast, up to 50% of the area in estuaries and 45% of the area in marinas have impacted sediment quality. These generally quiescent waterbodies receive pollutant inputs from the region's extensively urbanized watersheds and high density of boating activities. Despite the relatively large extent of impacted sediment quality in embayments, sediment quality has been steadily improving in this habitat over the last decade based on surveys dating back to the 1998. The Bight Program has affected management actions in the region by focusing current efforts in habitats most impacted by poor sediment quality, and highlighting the improvements from previous management actions.

1. Introduction

The Southern California Bight (SCB) coastal environment is a unique ecological resource. Extending more than 600 km from Point Conception (USA) to Punta Banda (Mexico), the SCB is a dynamic region where the cold, southward-flowing California Current mixes with the warm, northward-flowing Davidson Countercurrent (Hickey, 1993). Highly productive reefs with the giant kelp *Macrocystis*, estuaries that provide fish nurseries and overwintering stops for birds along the Pacific Flyway, and over one dozen threatened or endangered marine mammals and birds can all be found in the SCB (Dailey et al., 1993). More than 350 fish and 5000 invertebrate species are endemic to the SCB, approximately 80% of which are at the range limits of their distribution (see Fig. 1).

The SCB is also a unique economic resource. Renowned for its beaches, the SCB hosts approximately 175 million beach visits annually, more than Florida, Hawaii, and New Jersey combined (Schiff et al., 2003). The five coastal counties in the SCB generated an estimated $22B/year in gross revenue and over 800,000 jobs

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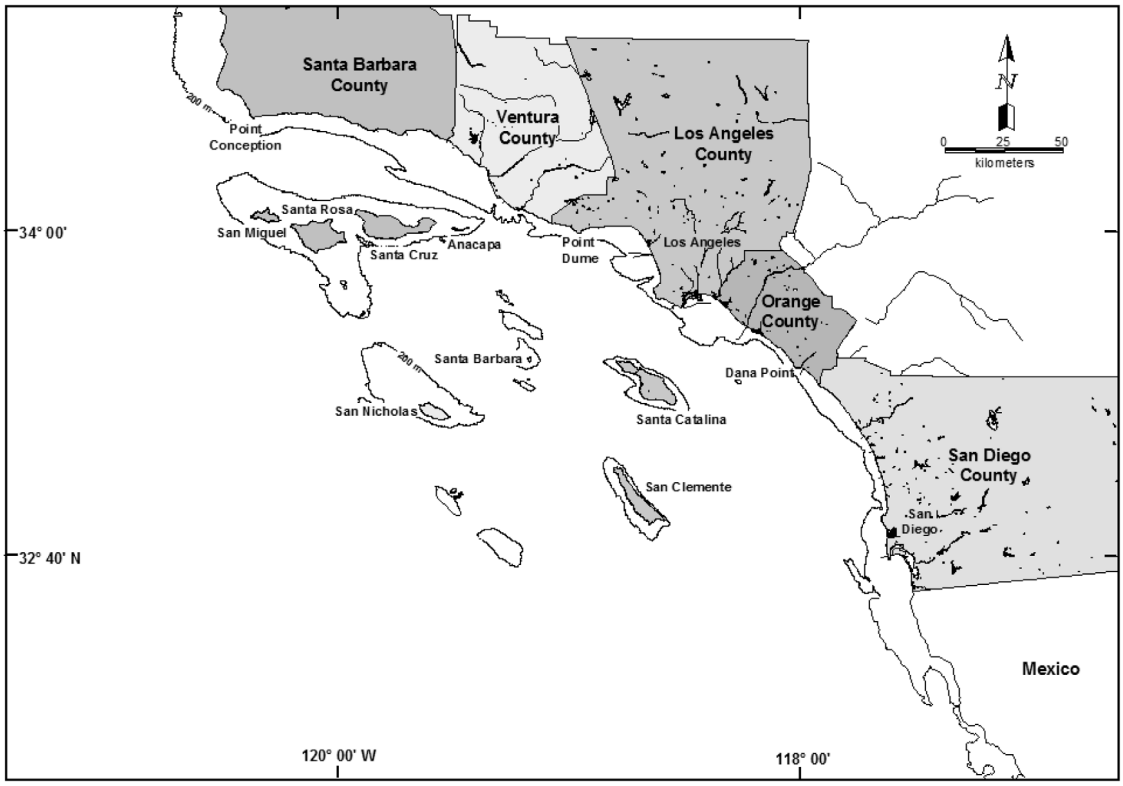

Fig. 1. Map of the Southern California Bight, which extends from Point Conception, California, to Punta Banda, Mexico, including the nine Channel Islands.

from ocean-related tourism and leisure activities in 2008 (Kildow et al., 2009).

The intersection of biodiversity and economics means that the SCB is a coastal ecosystem at risk from anthropogenic influences. More than 20 million people live within an hour's drive of the SCB coast. It is home to the two largest commercial ports (Los Angeles and Long Beach), the third largest naval facility (San Diego) in the US, and the world's largest manmade small-craft harbor (Marina del Rey). There are 17 wastewater treatment plants that discharge a cumulative 1.5B L/day of treated effluent to the ocean. While precipitation is relatively infrequent in the SCB (averaging 12 storms that total 30 cm per year), it is frequently intense with stormwater flows routinely increasing orders of magnitude in less than an hour (Schiff and Tiefenthaler, 2011). In total, there are 17 major watersheds that discharge largely untreated surface runoff from urban and agricultural land uses to the ocean.

Despite its enormous value and the potential risk, historical monitoring of the SCB did not provide a holistic view of impacts to the coastal environment. An estimated $32 M/yr was spent on routine monitoring of the SCB in 2003, with 75% allocated towards regulated discharges (Schiff et al., 2002). Combining monitoring data from individual programs presented enormous challenges, including differences in monitoring designs, sampling and laboratory methods, quality assurance and quality control (QA/QC), and data storage and management. Ultimately, even if all of these challenges could be overcome, most of the monitoring occurred near regulated discharges representing roughly 5% of the SCB area, potentially biasing the perspective of the SCB's overall condition.

The Southern California Bight Regional Marine Monitoring (Bight) Program was born from the frustration of environmental managers' inability to answer simple, holistic questions about the SCB coastal environment (NRC, 1990). Initiated in 1994, the Bight Program has grown both in size and scope with each successive survey, which has been conducted about every five years (1998, 2003, 2008, 2013). Originated by 12 agencies and limited to examining only the SCB continental shelf, the Bight Program has grown to approximately 100 agencies sampling at sites ranging from the head of tide in estuaries to the deepest nearshore ocean basins, at 1000 m. Moreover, the number of indicators used in the Bight Program has grown. An initial focus on sediment monitoring has now grown to include physical oceanography, eutrophication, seafood contamination, overfishing, beach water quality, and plastic pollution.

The goal of this paper is to describe the sediment contamination element of the Bight Program by addressing three key questions:

(1) What is the extent and magnitude of sediment contamination impact in the SCB?
(2) How has the extent and magnitude of sediment contamination changed over the last decade?
(3) How has the regional monitoring for sediment contamination program affected management actions?

An additional goal was to discuss the keys to success and future challenges faced by the Bight Program in attempting to answer these three questions.

2. Methods

There are three essential study design elements that comprise the Bight Survey for this paper. The first study design element is a focus on sediment quality. Therefore, we focus this paper on sediment associated indicators and assessment tools including sediment chemistry, sediment toxicity, and benthic infauna. The second design element is a probability-based design that enables unbiased estimates of average condition (i.e., mean sediment concentration) or areal extent (i.e., % of area). The third design element is implementing the Bight Survey through an integrated network of collaborating agencies. Therefore, this paper addresses the requirements for communication, training, quality assurance, and consensus-building.