



# Bight '13 Contaminant Impact Assessment Synthesis Report EXECUTIVE SUMMARY



## About this report

This report is the executive summary of an integrative summary document synthesizing key findings about how sediment contamination has impacted marine ecosystems across 1,539 square miles of Southern California's coastal waters. The Contaminant Impact Assessment Synthesis Report reflects the findings of five reports produced by the Southern California Bight 2013 Regional Monitoring Program that chronicle the multiple scientific approaches taken to assess ecosystem impacts: Sediment Chemistry (Volume IV), Sediment Toxicity (Volume I), Benthic Infauna (Volume VI), Demersal Fishes and Megabenthic Invertebrates (Volume VII) and Contaminant Bioaccumulation (Volume V). The detailed technical reports are available online at [www.sccwrp.org/documents](http://www.sccwrp.org/documents). In previous iterations of the Bight monitoring program, the Contaminant Impact Assessment element was known as the Coastal Ecology element.

In addition to the Contaminant Impact Assessment element, which focuses on sediment contamination, the Bight '13 program examined four other aspects of Southern California's coastal ocean: the relative impacts of fishing vs. pollutant discharges on Bight subtidal rocky reefs (Volume II), the spread of trash and marine debris across aquatic environments (Volume III), the identification of human sources of microbial contamination in coastal runoff (to be published in 2017) and the effects of nutrient loading on Bight geochemical cycling (to be published in 2018).

# Introduction to Bight Monitoring

**H**ow has contamination in Southern California's coastal waters impacted the health of its marine ecosystems? And have these impacts intensified or lessened over time? These are key questions that Southern California's coastal managers need answers to, so they can more effectively protect the marine ecosystems of a region that is home to more than 22 million people.

**The Southern California Bight is a concave bend in the coastline that stretches from Point Conception in Santa Barbara County to Punta Colonet in Mexico.**

- » The Bight is where cold waters from the north meet warm waters from the south.
- » The mixing of currents, combined with varied habitat types, paves the way for rich ecosystem diversity, including more than 500 species of fish and thousands of invertebrate species.
- » The Bight is a major migration route for a diverse array of marine birds and mammals.



Brown pelican



Clam and polychaete worm



Sheep crab



Southern California Bight



Dana Point Harbor



Newport Bay



Orange County Sanitation District



Ports of Los Angeles and Long Beach

**Southern California's coastal waters are vulnerable to the impacts of human activities.**

- » About 5,600 square miles of watersheds across coastal Southern California drain to the Bight, nearly half of which have been intensively developed.
- » Most runoff that enters storm drains is not treated prior to its discharge into coastal waters.
- » Some 18 wastewater treatment plants discharge up to 1.5 billion gallons per day of treated municipal and industrial effluent into the Bight.
- » The Bight is home to the nation's largest commercial port, the second-largest U.S. naval facility and more than 30,000 boat slips and moorings.



**The Southern California Bight Regional Monitoring Program is a two-decade-old marine monitoring collaboration that examines how human activities have affected the health of Southern California’s coastal waters.**

» The program mobilizes participating agencies to collect data from across a much greater expanse than just their coastal discharge zones, enabling coastal managers to paint a broader picture of regional condition.

» Both regulated and regulatory agencies, as well as non-governmental and academic organizations, come together to engage in highly productive dialogue as they collaboratively design monitoring programs and interpret findings.

**What is Bight '13?**

The Southern California Bight Regional Monitoring Program is a region-wide monitoring collaboration conducted every five years. The fifth cycle of the program, known as Bight '13, was initiated in 2013.

**The Contaminant Impact Assessment is the Bight program’s foundational assessment program, tracking contaminant levels in coastal sediment and potential impacts on Bight marine ecosystems.**

» The Contaminant Impact Assessment is conducted every five years to monitor Bight sediment quality across space and time.

» Sediment makes up the vast majority of the bottom of the Bight, although the Bight also is home to areas not evaluated by the Contaminant Impact Assessment, including rocky reefs, kelp forests and other vegetated habitats.

» The Contaminant Impact Assessment involves multiple types of studies that are analyzed and synthesized using a multiple-lines-of-evidence approach, which provides greater confidence in the findings. This approach is used widely around the world.



Sea slug, center, surrounded by polychaete worms in sediment

**Bight '13 Contaminant Impact Assessment study questions**

- 1 What is the extent and magnitude of direct impacts from sediment contaminants?
- 2 What is the trend in extent and magnitude of direct impacts from sediment contaminants?
- 3 What is the extent and magnitude of contaminant bioaccumulation?

**Assessment areas**

Bight sediment assessments focus on the continental shelf and embayments, which make up about one-third of the Bight seafloor.

- » Continental shelf (offshore areas at depths of 3 feet to 650 feet)
- » Four types of embayments (marinas, estuaries, ports, bays)

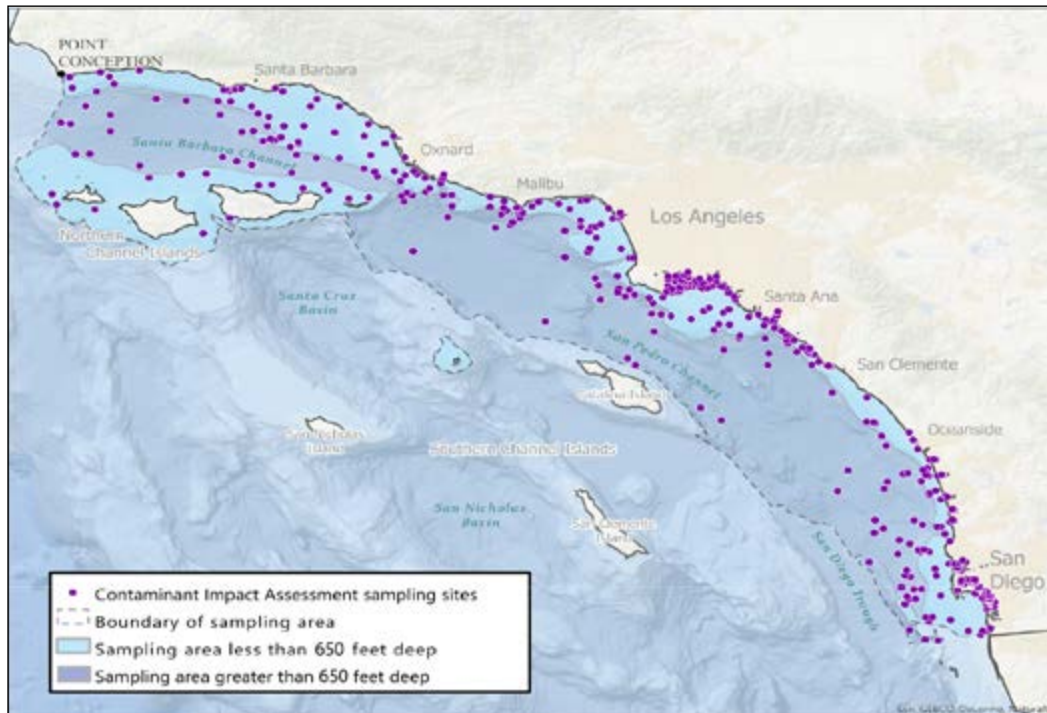
More limited assessment work is completed in deeper waters (more than 650 feet deep).



Particle-laden water at the mouth of the Los Angeles River in Long Beach after heavy rainfall

# Sediment Sampling

**Sediment sampling locations were selected via a stratified, random sampling design that removes possible bias and ensures findings are statistically representative.**



**Contaminant Impact Assessment sediment sampling areas**

» As part of Bight '13, 385 sites were sampled for sediment quality across 1,539 square miles.

» Sampling started at a depth of just 3 feet along the shore and extended more than 20 miles offshore, to a depth of nearly 3,000 feet.

» Researchers are able to perform a full analysis on sediment samples collected from sites less than 650 feet deep. The full analysis involves three distinct testing methods that are combined using a quantitative scoring tool.

» The full sediment analysis was performed at 201 out of the 385 sites, including at 170 embayment sites.

» More than 1,400 sites have been sampled since the program was launched in 1994.



**Deployment of sediment sampling device**



**Seafloor sediment collection**

## QA/QC efforts

With more than two dozen agencies collecting and analyzing Bight samples, quality assurance/quality control among participants is a major priority. All participants undergo rigorous field training and take part in laboratory intercalibration exercises, ensuring that data and findings are comparable and of high quality.

The quality-assurance activities enable labs across Southern California to maintain a high degree of quality and rigor for all environmental samples they process and analyze, not just for the Bight monitoring program. The close working relationship that participating agencies develop fosters a culture of collaboration.



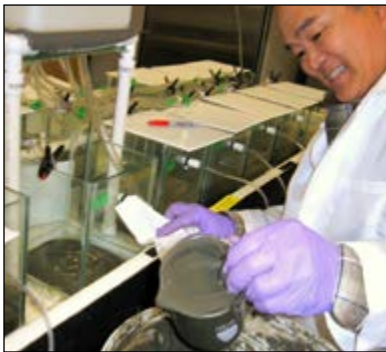
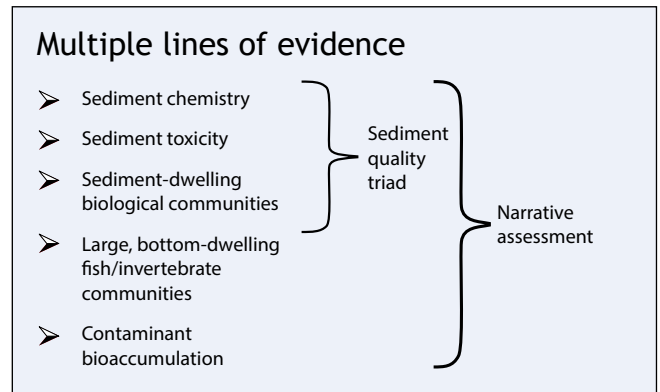
**Bight '13 taxonomy intercalibration exercise**

# Multiple Lines of Evidence

## The Contaminant Impact Assessment relies on five main lines of evidence to conduct a scientifically robust evaluation of how sediment contamination has impacted the Bight.

» Bight managers use three lines of evidence – sediment chemistry, sediment toxicity, and sediment-dwelling biological communities – to assess the quality of Bight sediment. These three lines of evidence are known as the sediment quality triad.

» The two other lines of evidence – bottom-dwelling fish/invertebrate communities and contaminant bioaccumulation – add to the overall contaminant impact assessment narrative.



Laboratory sediment testing

## Sediment quality is a particularly effective indicator of how contaminants impact ecosystems.

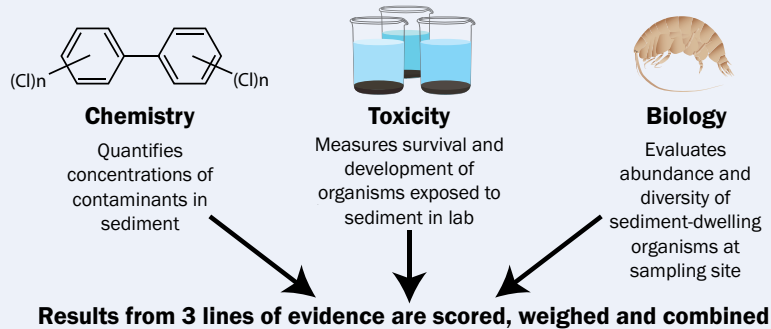
» While ocean currents can quickly disperse contaminants in the water column, many contaminants stick to suspended particles and settle to the ocean floor, forming a layer of sediment that can remain contaminated for decades.

» Organisms living on the ocean floor come into direct contact with sediment contamination via ingestion and absorption.

» When sediment-dwelling organisms are consumed by predators, the contaminants build up – or bioaccumulate – in each successive predator that consumes its prey. In this way, contamination is transferred through marine food webs.

## Sediment quality triad scoring tool

Full sediment analysis is possible at sites less than 650 feet deep because these are the depths where a multiple-lines-of-evidence approach called the sediment quality triad can be used to quantitatively score sediment condition. The sediment quality triad, which is used to regulate sediment quality in California embayments, is the gold standard for conducting sediment evaluations; it synthesizes three main lines of evidence:



### Final sediment quality assessment classifications

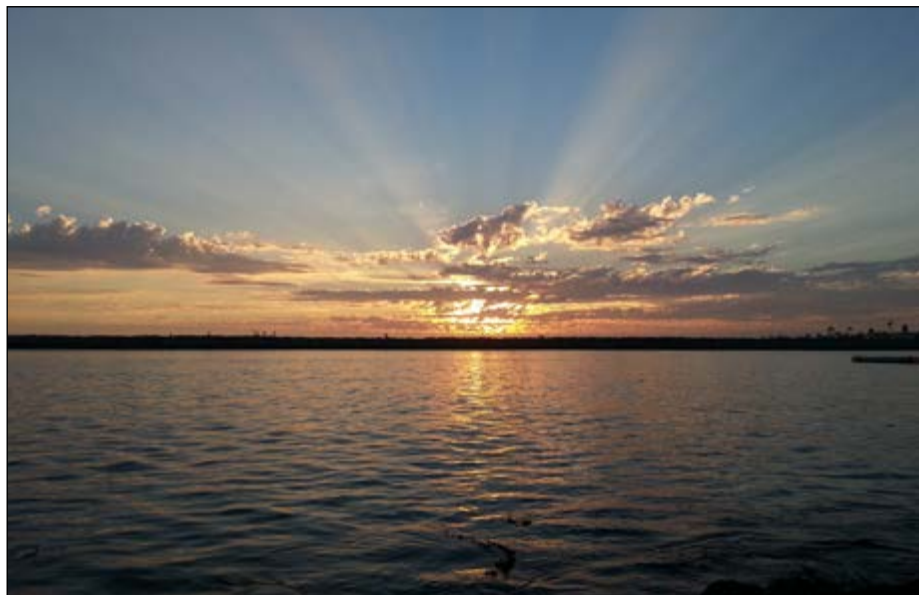
<b>Unimpacted</b>	<b>Likely unimpacted</b>	<b>Possibly impacted</b>	<b>Likely impacted</b>	<b>Clearly impacted</b>
Confidence that there are no adverse impacts	Adverse impacts not expected, but some uncertainty due to disagreement among lines of evidence	Possibility of small or uncertain adverse impacts	Persuasive evidence of adverse impacts, even if disagreement among lines of evidence	Clear and severe adverse impacts to sediment-dwelling aquatic life

**Sediment quality classifications of concern**



# Key Findings

The Southern California Bight Regional Monitoring Program's Contaminant Impact Assessment offers insights into how sediment contamination has affected 1,539 square miles of the Bight across time and space, as well as the disproportionate effects of this contamination on certain marine habitats. The Contaminant Impact Assessment builds on two decades of intensive sediment sampling and analysis across the Bight.



Bight coastal waters

## Bight '13 Study Question #1: What is the extent and magnitude of direct impacts from sediment contaminants?

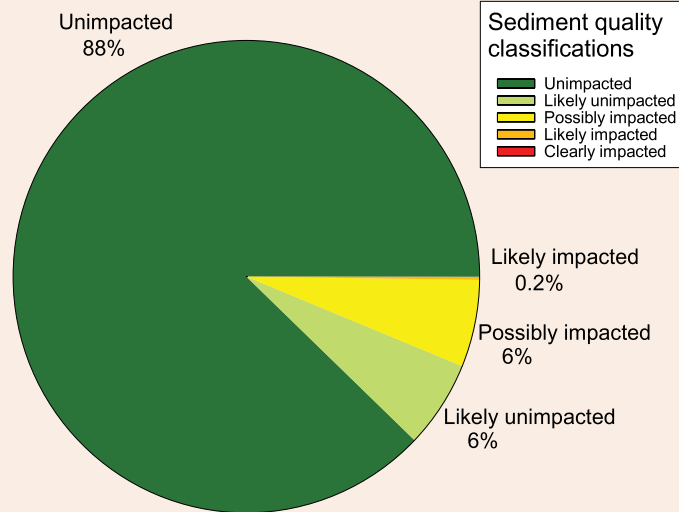
**About 94% of the area assessed in Bight '13 is unimpacted or likely unimpacted by sediment contamination.**

» The sediment quality triad approach indicates that about 6% of this area is possibly impacted by sediment contamination, and only 0.2% is likely impacted.

» None of the sampling sites in Bight '13 was classified as clearly impacted by sediment contamination.

### Overall snapshot of Bight sediment quality

Although the vast majority of the area assessed in Bight '13 was unimpacted or likely unimpacted by sediment contamination, the area of concern is the 6.2% that was possibly impacted or likely impacted. No areas of the Bight were classified as clearly impacted, which is the most severe classification.



**The continental shelf is not as impacted by sediment contamination as coastal embayments.**

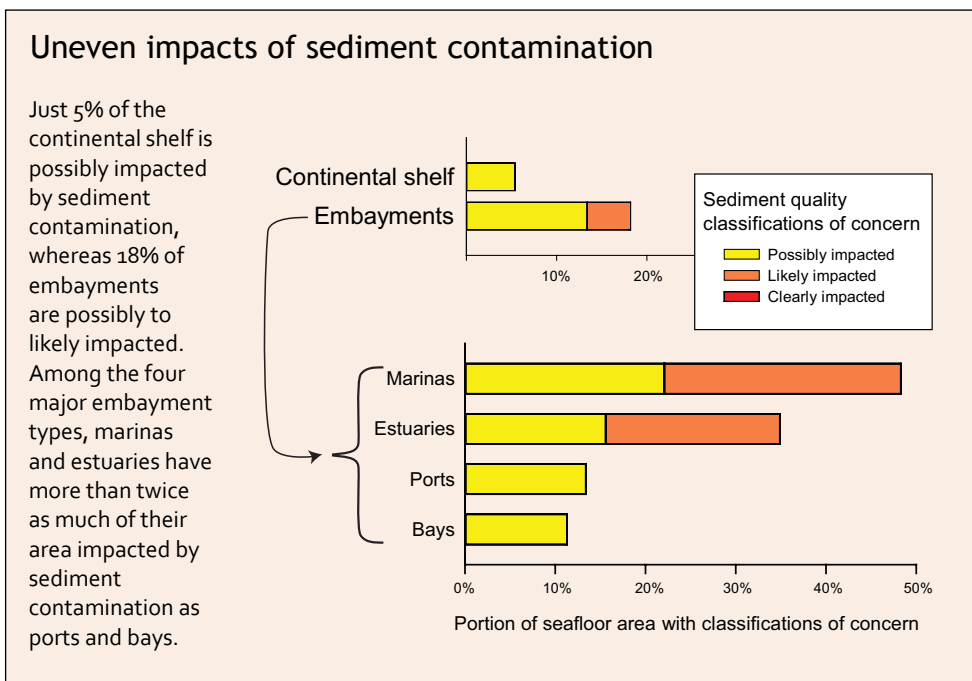
- » The vast majority of the area assessed in Bight '13 is the continental shelf – specifically, the area that starts at a depth of 3 feet and extends to a depth of 650 feet.
- » Just 5% of the shelf is possibly impacted by sediment contamination.



Newport Bay

**About 18% of embayment areas have sediment quality that is possibly or likely impacted by sediment contamination.**

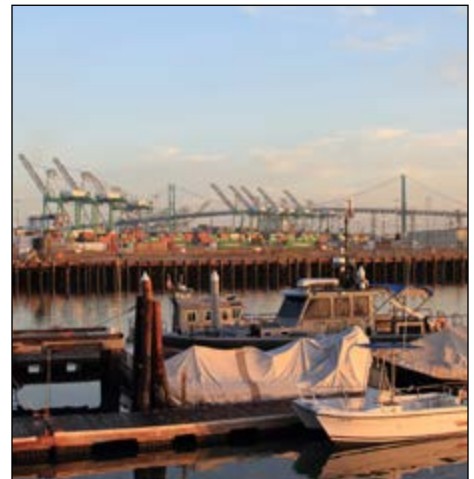
- » Embayments are the mostly shallow, protected areas close to shore where relatively calm waters facilitate settling of contaminant-laden particles. Embayments make up a fraction of the total area assessed in Bight '13.
- » Marinas and estuaries are the Bight embayment types subject to the most severe impacts of sediment contamination, with about one-half of assessed marina areas (48%) and one-third of assessed estuary areas (35%) possibly or likely impacted by sediment contamination.



Ballona Creek coastal estuary



Small-boat marina

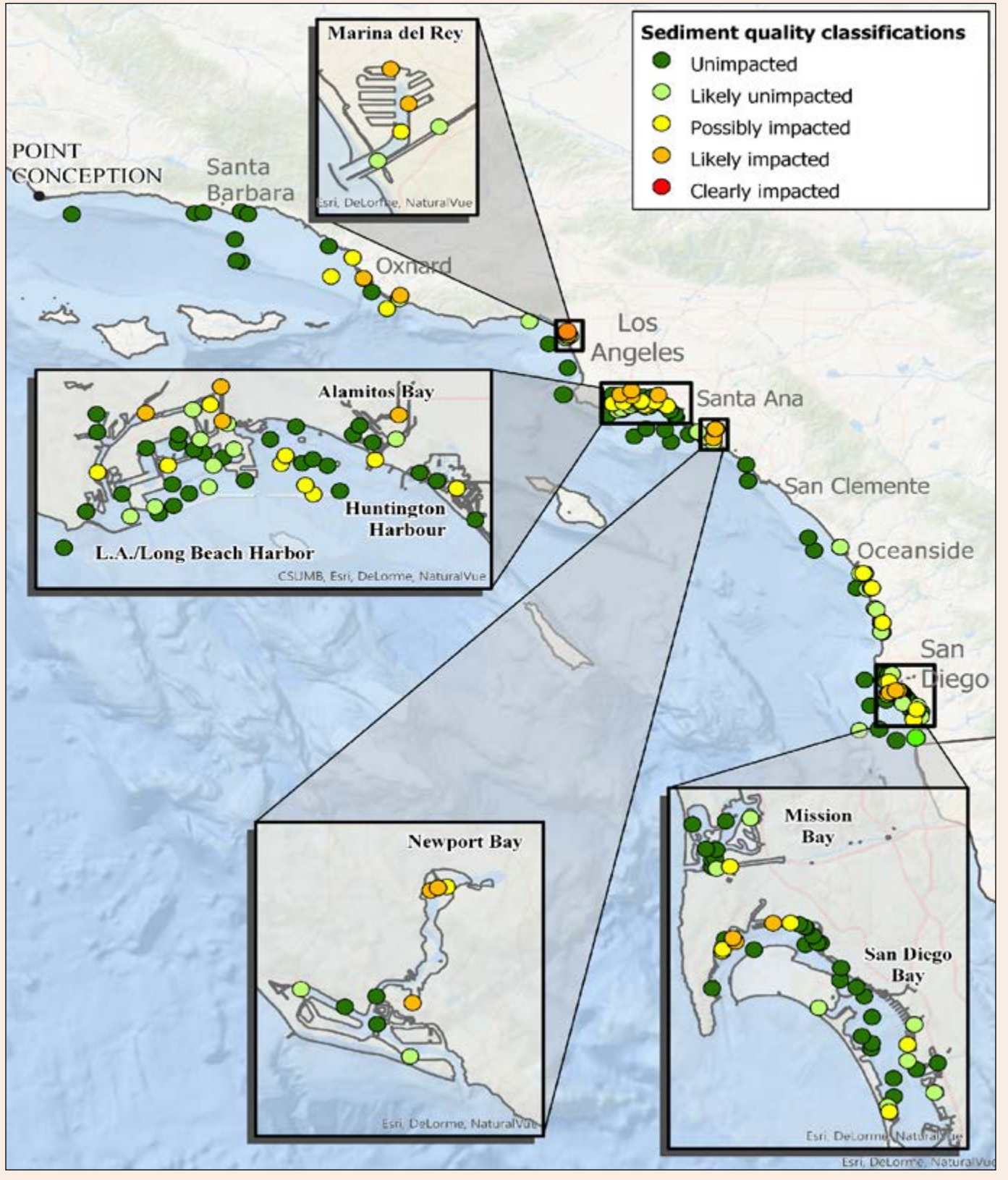


Ports of Los Angeles and Long Beach



## Sediment quality triad assessment scores by site

A full sediment quality triad analysis was conducted at 201 sites, generating quantitative assessment scores that fall into a five-part classification system. None of the Bight '13 sampling sites was classified as clearly impacted by sediment contamination.



## Other Bight '13 notable findings

The Bight program generates data that can be analyzed and parsed in a number of ways to glean additional insights about specific habitats, organisms and contaminants. Such insights help shape follow-up studies as well as the design of the Bight program's next cycle.

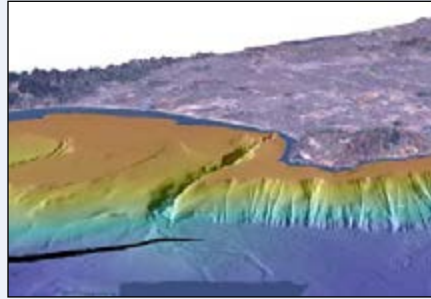
### Source control success story



**Los Angeles River**

Because the Bight program measures the concentrations of individual sediment chemicals, it has been possible over time to track PBDEs (polybrominated diphenyl ethers), a class of flame retardant chemicals banned in California in 2008. PBDEs enter coastal waters primarily via land-based runoff and tend to settle in embayment sediment. From Bight '08 to Bight '13, average PBDEs concentrations in embayments fell by 92%. A drop of this magnitude indicates that management source-control efforts have been effective.

### Toxicity in submarine canyons



**Computer rendering of submarine canyon**

The 2013 cycle of the Bight program was the first to sample in the submarine canyons that connect the continental shelf to deeper offshore zones. Bight '13 found that 17% of the area in submarine canyons contained sediment that was toxic to marine invertebrates, suggesting submarine canyons are funneling contaminants to deeper areas farther offshore. This finding, however, is difficult to interpret and contextualize because most submarine canyon sites are too deep for full assessments using the sediment quality triad approach to be conducted.

### Biological changes in sanctuary



**Channel Islands**

Sediment-dwelling biological communities in the Channel Islands National Marine Sanctuary have consistently received high biology-based assessment scores. For the first time, the Bight program documented a small but detectable decline in the health of these communities as part of Bight '13. Because sediment chemistry and toxicity testing were not conducted in the sanctuary for Bight '13, it is unclear if this decline is related to sediment contamination.

## Fish communities living near the Bight seafloor were generally healthy, with 93% of the area assessed in Bight '13 home to fish communities in reference condition.

» Demersal fish – or fish that live near the bottom of the sea – are a key focus of monitoring efforts because they consume sediment-dwelling organisms and can come into direct contact with contaminated sediment.

» Abnormalities such as fin rot, lesions and tumors were found in less than 0.1% of all 75,000+ fish sampled, the lowest of any Bight survey and well within expected background levels for fish populations.

» Coastal embayments are the Bight habitat type where fish communities were most likely to be found in non-reference conditions.



**Retrieving a fish trawl net**



**Sorting through the contents of a trawl**



**White surfperch**



## Baseline developed for future MPA monitoring



Camouflaged fantail sole resting on the Bight seafloor

For Bight '13, study participants assessed the health of bottom-dwelling fish communities living in many of Southern California's 50 Marine Protected Areas (MPAs), which were established in 2012 to curtail fishing impacts. Because Bight MPA monitoring data were collected just months after the MPAs were established, coastal managers now have a point of reference with which to evaluate the long-term effectiveness of Southern California's MPAs.

## Bight '13 Study Question #2: What is the trend in extent and magnitude of direct impacts from sediment contaminants?

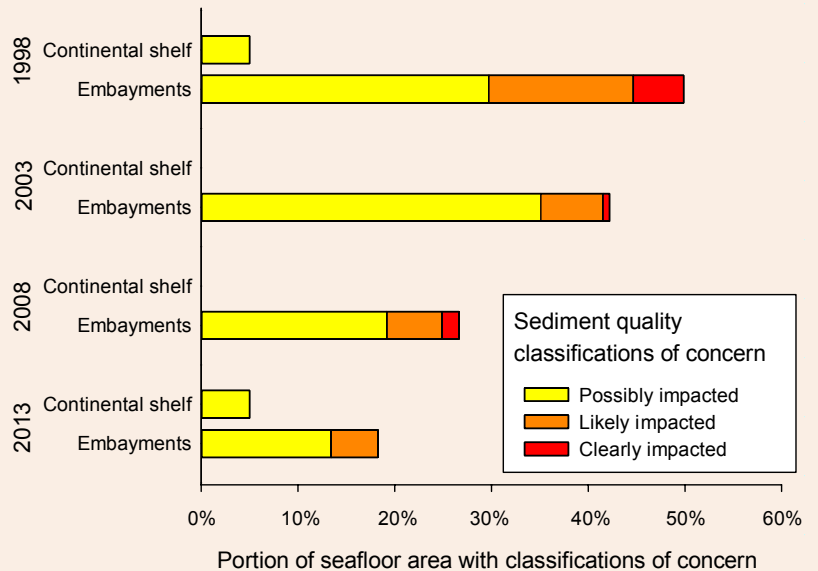
### Embayment sediment quality has improved over time, including in estuaries and marinas.

» The total area of embayments impacted by sediment contamination has decreased by about two-thirds since the late 1990s, from nearly 50% of the area in 1998 to 18% of area in 2013.

» The magnitude of sediment contamination impacts also has diminished: In 1998, 20% of embayment area was likely or clearly impacted, but by 2013, that area dropped to 5%, and no area was clearly impacted.

### Trend toward improved sediment quality

The portion of Bight embayments impacted by sediment contamination has fallen by more than half since 1998, while the impacted portion of the Bight continental shelf has consistently remained low or non-detectable.





**Bight '13 Study Question #3: What is the extent and magnitude of contaminant bioaccumulation?**



**Seabird egg sampling in South San Diego Bay**

**Contaminants have bioaccumulated at low levels in the eggs of seabirds across the Bight.**

- » Seabird eggs provide an opportunity to assess whether sediment contamination is traveling through food webs and building up – or bioaccumulating – in some of the highest-level predators.
- » The Bight program for the first time collected and tested Bight seabird eggs for a range of possible chemical contaminants, including DDTs (dichloro-diphenyl-trichloroethanes) and PCBs (polychlorinated biphenyls), both banned in California since the 1970s. Previously, the program measured these contaminants in fish.
- » With a few exceptions, egg contaminant levels were below seabirds’ risk thresholds of concern.

**Collecting bird eggs for bioaccumulation analysis**

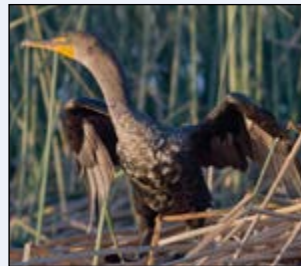
Seabird eggs were collected from the nests of four species that represent a range of foraging habits. Only abandoned eggs were collected.



**California least tern (endangered)**



**Caspian tern**



**Double-crested cormorant**

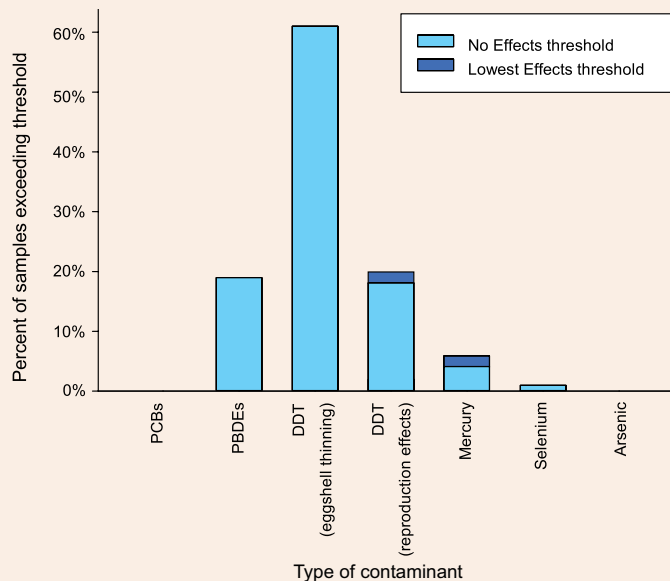


**Western gull**

**Low contamination levels in seabird eggs**

Although almost every seabird egg sample contained detectable contamination levels for a majority of the contaminants tested, contamination levels were almost uniformly below the thresholds at which adverse health effects may start to occur.

The most striking exception is DDT-triggered eggshell thinning. Nearly two-thirds of samples exceeded a risk threshold known as the No Effects threshold, although no samples exceeded a second threshold known as the Lowest Effects threshold. Despite the prevalence of eggshell thinning, historical data on eggshell thicknesses of Western gulls indicate that the eggshell thickness measured during Bight '13 were comparable to eggshell thicknesses measured in the 1940s, before the introduction of the largest quantities of DDT to the Bight.



Scientists use two thresholds to evaluate whether detectable contamination levels in an organism pose a potential health risk:

- » **No Effects threshold:** Contaminant concentration level below which adverse effects are not expected to occur
- » **Lowest Effects threshold:** Contaminant concentration level above which adverse effects may start to occur

# Implications of the Findings

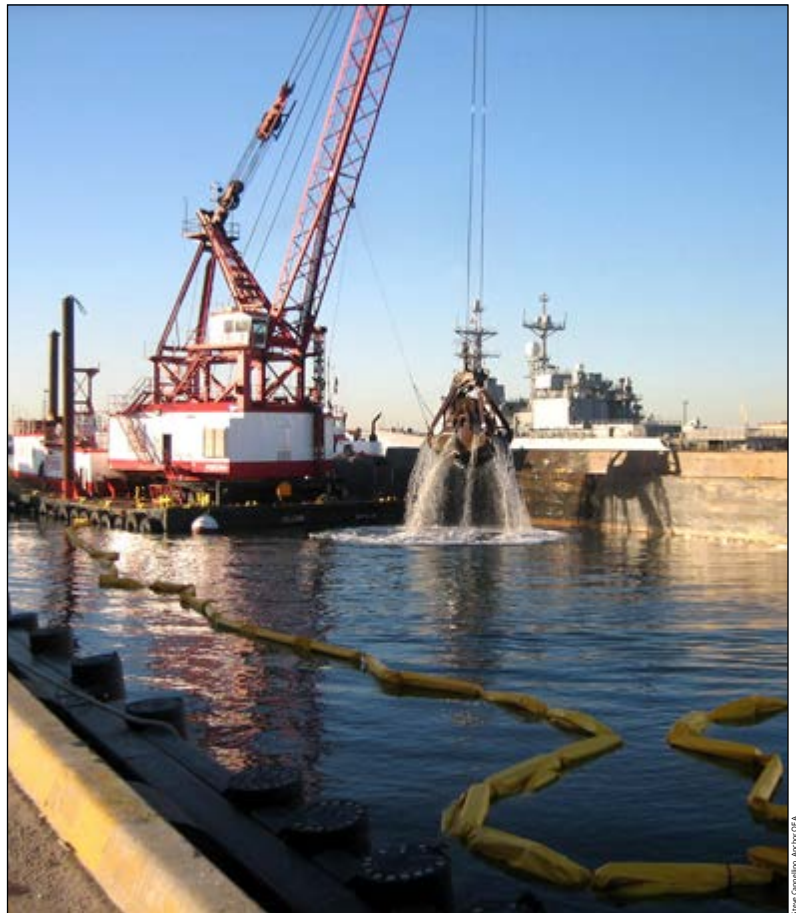
**T**he Bight program uses a multiple-lines-of-evidence approach to assess the ecosystem impacts of sediment contamination across 1,539 square miles of the Bight. But how can Southern California's coastal management community interpret and make use of these findings? This section explores some of the key management implications of the program.

## Ongoing regional monitoring of Bight sediment helps coastal managers maintain focus and direct resources to areas where contamination impacts are more severe.

- » Because Bight '13 showed that embayments are disproportionately impacted by sediment contamination, these coastal areas have remained the focus of clean-up efforts and other management actions.
- » Consistently high scores for sediment quality across the continental shelf serve to validate and reinforce the effectiveness of management programs already in place.



Installation of pervious pavers to reduce runoff to storm drains



Dredging can remove contaminated sediment from waterways

## Bight monitoring helps coastal managers coalesce around shared priorities and goals, including for the next Bight survey.

- » Bight participants are interested in expanding sediment quality assessment tools to be able to score the condition of sediment in deeper areas of the Bight, including submarine canyons. The sediment quality triad scoring tool was designed for use at depths of 3 feet to 650 feet, which constrains the Bight program's ability to track the impacts of contaminated sediment in key areas.
- » Unexpected findings obtained through the program help Bight participants design follow-up monitoring work. For example, because Bight '13 chronicled a decline in the condition of sediment-dwelling communities in the Channel Islands National Marine Sanctuary, more intensive monitoring can now be designed to help interpret and contextualize this finding.
- » Key findings of the program often spur Bight participants to develop coordinated studies outside the program, as regional monitoring raises more questions than it can answer. For example, regional monitoring is not designed to elucidate which specific contaminants may be responsible for observed impacts; however, follow-up causal assessment studies can help answer this critically important management question.

## Bight '13 Contaminant Impact Assessment participating organizations

Amec Foster Wheeler  
Anchor QEA  
Aquatic Bioassay and Consulting Laboratories  
City of Los Angeles  
City of San Diego Public Utilities Department  
Dancing Coyote Ranch  
EcoAnalysts  
Encina Wastewater Authority  
Eurofins  
Los Angeles County Department of Public Works  
Los Angeles County Natural History Museum  
Los Angeles Regional Water Quality Control Board  
MBC Applied Environmental Sciences  
National Oceanic and Atmospheric Administration  
Nautilus Environmental  
Occidental College Vantuna Research Group  
Orange County Public Works  
Orange County Sanitation District  
Physis Environmental Laboratories  
Port of Long Beach  
Port of Los Angeles  
Port of San Diego  
San Diego County Department of Environmental Health  
San Diego Regional Water Quality Control Board  
San Diego State University  
San Elijo Joint Powers Authority  
Sanitation Districts of Los Angeles County  
Santa Ana Regional Water Quality Control Board  
Southern California Coastal Water Research Project  
State Water Resources Control Board  
U.S. Environmental Protection Agency, Region IX  
U.S. Fish and Wildlife Service  
Weck Laboratories  
Weston Solutions



## Suggested citation

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