SCCWRP

2016 ANNUAL REPORT

Dedicated partners, insightful results

Bight '13 cooperative monitoring helps illuminate regional ecosystem condition

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT
A Public Agency for Environmental Research

Welcome to the interactive version of SCCWRP's 2016 Annual Report! Click on the links below to jump directly to specific areas of the report. To request a printed copy of this report, contact pubrequest@sccwrp.org.

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SCCWRP 2016 ANNUAL REPORT

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Feature Articles

Courtesy of Amec Foster Wheeler

A field crew from the Southern California Bight 2013 Regional Monitoring Program uses a grab sampler to collect sediment from the San Diego Bay seafloor. Through this cooperative monitoring program, environmental managers track how sediment contamination has impacted coastal ecosystems. **Page 5**

Southern California Coastal Water Research Project 2016 Annual Report

Editor
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Cover Photo
A double Van Veen grab sampler is used to retrieve seafloor sediment as part of the Southern California Bight 2013 Regional Monitoring Program.

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Accomplishments with journal abstracts

People

Snapshot of Success

Steps taken by SCCWRP to improve aquatic science research and water-quality management in 2016

1 Scientific credibility

Goal: Establish and maintain credibility with colleagues in the aquatic science community

SCCWRP can more effectively transition science into application when the agency engenders credibility with scientific peers. SCCWRP uses two primary metrics to quantify success in this area:

» Publication rate

Publishing prolifically in scientific journals is an important measure of scientific success, as these articles go through a rigorous peer review process. A robust publication rate engenders credibility for SCCWRP in the broader scientific community.

Accomplishment

SCCWRP scientific staff published an average of **3.1** journal articles each per year over the past three years. This compares favorably with the **2** publications per year minimum that SCCWRP's partners at academic research institutions generally seek to achieve when being considered for promotion. **Page 27**

» Citation rate

Whereas the number of publications quantifies productivity, citation rate provides a measure of how widely read SCCWRP's work is and the degree to which it is influencing other scientists. SCCWRP's goal is for other scientists to reference SCCWRP's work when publishing their own.

Accomplishment

SCCWRP publications were cited **22%** more frequently in 2016 than the average for the aquatic sciences discipline, and **2.6%** of SCCWRP publications in 2016 appeared in the top **1%** of all articles cited in the aquatic sciences.

2 Scientific consensus-building

Goal: Promote consensus-building through scientific collaboration and leadership

The most expeditious path for the water-quality management community to incorporate scientific findings into decision-making is for scientists to achieve consensus. SCCWRP facilitates consensus-building through:

» Leadership

Attaining leadership roles with professional scientific organizations enhances SCCWRP's opportunities for interactions and consensus-building in the aquatic sciences.

Accomplishment

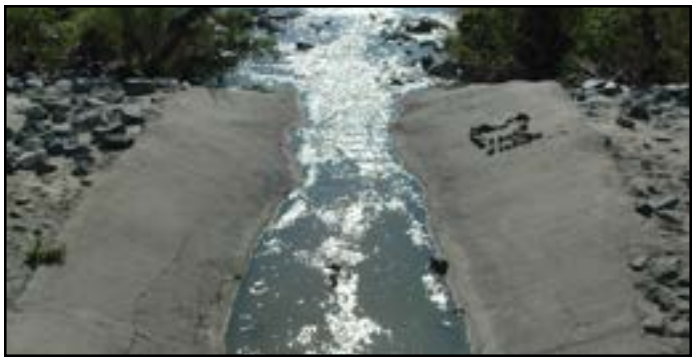
SCCWRP scientific staff held **115** leadership roles with professional societies, advisory committees, and scientific journals in 2016. **Page 63**

» Collaboration

External interactions, especially in leadership capacities, often translate to collaborative scientific publications. The number of external organizations with which SCCWRP coauthors scientific publications is a reflect of SCCWRP's success in building consensus.

Accomplishment

SCCWRP published scientific articles and reports with **114** different institutions in 2016. **Page 27**



What SCCWRP seeks to achieve

» Translate aquatic science research into management applications

» Optimally position the water-quality management community to benefit from scientific research

» Positively influence how aquatic systems are managed in Southern California and beyond

3 Management influence

Goal: Positively influence decision-making and actions by the end-user water-quality management community

Scientific credibility and consensus-building are important waypoints along SCCWRP's journey to produce science that positively influences management. The three feature articles in this report illustrate how SCCWRP – as facilitator of the Southern California Bight Regional Monitoring Program – helps the region's water-quality management community refine and evolve strategies to better protect Southern California's coastal ocean.

» Characterizing the issue

SCCWRP helps Bight managers design robust environmental monitoring studies that illuminate potential threats to coastal ecosystems, as well as document improvements over time.

» Developing tools and technology

SCCWRP helps develop new approaches and methods to improve the speed, accuracy and cost of Bight monitoring.

» Assessing effectiveness of management actions

SCCWRP helps Bight managers craft strategies to gauge the effectiveness of their actions and to inform next steps.

Accomplishment

SCCWRP helped managers position Bight contaminant bioaccumulation data to be used as a key technical foundation for an ongoing expansion of the State Water Board's Sediment Quality Objectives program.

Accomplishment

SCCWRP helped managers develop a rigorous regional baseline for debris across aquatic environments that can serve as a benchmark for evaluating future success of new statewide trash reduction initiatives.

Accomplishment

SCCWRP helped capture key data sets on Bight ocean acidification conditions that will feed into a West Coast ocean acidification model being built to improve managers' understanding of how corrosive waters will impact coastal ecosystems.

4 Long-term support

Goal: Provide technical support and expertise to SCCWRP's 14 member agencies to maximize their adoption and use of science

While influencing management decision-making is a signature SCCWRP accomplishment, SCCWRP maximizes the effectiveness of this influence by providing long-term guidance and assistance to its 14 member agencies.

» Training

SCCWRP develops user-friendly instruction materials and conducts hands-on training to ensure managers are properly educated about new tools and technologies.

» Intercalibration

SCCWRP facilitates intercalibration and quality-assurance exercises to ensure managers can demonstrate proficiency using new tools and technologies.

» Vetting

SCCWRP facilitates case studies and expert advisory committees to fully vet new tools and technologies.

» Outreach

SCCWRP conducts outreach activities to ensure managers and stakeholders buy into and fully embrace new approaches and technologies.

SCCWRP prides itself on the long-term support it provides to member agencies through programs like Bight regional monitoring.

Accomplishment

SCCWRP staff spent more than **6,000** person-hours in 2016 providing implementation support for Bight '13.

Director's Message

Regional monitoring's hidden value

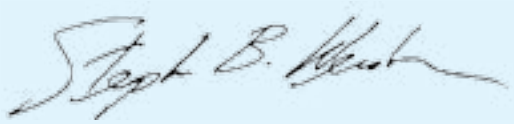
This year's Annual Report is focused on outcomes of the Southern California Bight Regional Monitoring Program, which my Commissioners consistently tell me is SCCWRP's most valuable endeavor. Through this 22-year-old initiative, environmental managers and researchers from across Southern California come together to evaluate their collective effectiveness as environmental stewards of our Bight resources. This regional assessment of condition, however, touches only the surface of Bight regional monitoring's value. Our member agencies derive other less obvious benefits from their participation in this marquee program – hidden benefits that underscore the value of regional monitoring.

Most prominent among these are the Bight program's method standardization activities. The Bight program is a collaborative model, in which participants contribute field sampling and laboratory analytical capabilities instead of contracting with a single organization to do it all. As a result, we take steps to ensure that the data produced by these many organizations are comparable enough to be compiled into a unified data set; we do this through training, and then we verify with audits and laboratory intercalibrations. Field collection teams go through checkout cruises, and laboratories are required to process blind samples. Commissioners remind me that these studies serve to independently evaluate the quality of all data being produced by their lab and field teams, transcending the Bight program, which represents only a small fraction of their total data collection activities.

SCCWRP's Commissioners also tell me they value the Bight program's opportunities to test-drive new lab and field technologies alongside existing ones. In this setting, they're able to provide meaningful feedback on new approaches, long before anything has been codified into permits or regulations. During Bight '13, our member agencies test-drove DNA-based methods for identifying microbial contamination in coastal waters. And through a partnership with the XPRIZE Foundation, our member agencies were among the first to test new ocean pH sensor prototypes that might one day replace the glass-electrode pH sensors they've relied on for decades.

Finally, SCCWRP's Commissioners appreciate the unique opportunities for consensus-building. The diverse group of water-quality regulators and regulated parties, academics and NGOs that comes together to agree on interpretation of the monitoring data engenders a high level of trust that benefits not only the program itself, but the interactions beyond.

Few could have imagined the runaway success of the Bight program when SCCWRP and its member agencies launched this regional monitoring collaboration in 1994. Today, the Bight program is a national model that has been emulated many times over. Its core design features have been replicated by the Southern California Stormwater Monitoring Coalition's freshwater regional monitoring program. It's also helped inspire creation of a regional multi-agency rocky intertidal network and a statewide harmful algal bloom monitoring program. SCCWRP has been glad to participate in these efforts and to observe that many of the same hidden benefits – particularly consensus-building – have been exported to these other collaborative networks.



Stephen B. Weisberg, Ph.D.
Executive Director

TRACKING CONTAMINATION'S ECOSYSTEM IMPACTS

Shared responsibility, mutual trust fuel Bight '13's signature Contaminant Impact Assessment element

Southern California's environmental management community has invested hundreds of millions of dollars in recent decades into understanding how human contamination is impacting coastal ecosystems.

In a region that is home to some 22 million people, it's easy to understand why: The influence humans can have on aquatic systems is as varied as it is pervasive – from land-based runoff and treated wastewater

The Southern California Bight is defined by a concave bend in the coastline that stretches from Point Conception in Santa Barbara County to Punta Colonet in Mexico. In the Bight, cold waters from the north mix with warm waters from the south, making possible rich ecosystem diversity.

Storm drain systems transport land-based contaminants to Southern California's coastal waters, where they can settle in sediment and exert long-term toxic effects.

effluent discharges to coastal development that spans the industrial, military, commercial, residential and recreational sectors.

Most of the ecosystem monitoring developed to track coastal health has historically been focused at the site level: A concern or problem is identified, and a site-specific solution is designed to track that issue over the long term.

Site-specific monitoring, consequently, has enabled environmental managers to track the effectiveness of an array of actions designed to reduce and mitigate ecological impacts.

But site-specific monitoring does not allow managers to compare data from disparate monitoring programs to understand whether some areas are better off than others, nor to aggregate data to pick up on regional patterns and cumulative environmental forces.

Site-specific monitoring also doesn't shed insights on the health of the Southern California Bight as a whole: Are sensitive coastal ecosystems being adequately protected? Should humans be concerned about consuming the sportfish they catch? Can beachgoers safely swim in coastal waters?

That's where regional monitoring adds value. Regional monitoring brings together diverse stakeholders to analyze the wide range of cumulative impacts humans can have on their environment.

In 1994, SCCWRP and its member agencies established the Southern California Bight Regional Monitoring Program, the premier program for comprehensively monitoring 1,539 square miles of Southern California's coastal waters. Via this ongoing partnership that runs in five-year cycles, nearly 100 participating organizations come together to speak with a common voice about the condition of Bight ecosystems across time and space.

Indeed, much of what Southern California environmental managers know about how contamination has impacted Bight ecosystems over the past two decades comes from the findings of the Bight program's Contaminant Impact Assessment element.

"The Bight program really has changed how we think about our responsibility to protect the health of our coastal ecosystems," said Greg Gearheart, Deputy Director for the Office of Information Management and Analysis for the State Water Resources Control Board. "It has been fantastic to see all of the Bight efforts result in increased collective knowledge and better interventions. Each time we do this, we get more data, more buy-in and confirmation of how much we can get done when we pool our resources and collaborate."

Documenting Bight health

Over the years, the Bight program has taken on numerous studies aimed at exploring different facets of Bight health. Among the focal points of Bight '13 – the most recent cycle of the program initiated in 2013 – are studies that track the spread of trash across aquatic environments, that document changing Bight seawater chemistry in response to ocean acidification and that quantify human sources of microbial contamination at beaches.

The heart of the Bight program, however, remains the Contaminant Impact Assessment element, which focuses on analyzing the quality of seafloor sediment and the animals that live in and on

sediment. The Contaminant Impact Assessment is the foundational element of the Bight program and the only program element to be conducted consistently since the Bight program was conceived.

The quality of sediment, which covers the vast majority of the Bight seafloor, is a particularly effective indicator of how contaminants have holistically impacted ecosystems. While ocean currents can quickly disperse contaminants in the water column, many chemical contaminants stick to suspended particles and settle to the ocean floor, forming a layer of sediment that can exert adverse impacts on ecosystems for decades to come.

Over time, contaminants that have stuck to sediment particles are ingested and absorbed by bottom-dwelling organisms. As these organisms are consumed by predators, the contaminants build up – or bioaccumulate – in each successive predator that consumes its prey. In this way, chemical contaminants can be transferred through marine food webs, putting wildlife and humans at risk of exposure to contaminated seafood.

The Contaminant Impact Assessment element consists of five main types of sediment quality studies, each generating results that are analyzed and interpreted by independent workgroups. Afterward, the findings of all five studies are synthesized using a multiple-lines-of-evidence

A sieve is used to isolate worms, mollusks and other organisms from sediment. The types and numbers of these organisms are analyzed to gain insights into the health of sediment-dwelling biological communities.

Multiple lines of evidence

The Contaminant Impact Assessment element relies on five main lines of evidence to conduct a scientifically robust evaluation of 1,539 square miles of the Bight. Three of the lines of evidence – sediment chemistry, sediment toxicity and sediment-dwelling biological communities – feed into the sediment quality triad, which is an integrative tool co-developed by SCCWRP to quantitatively score sediment condition. The other two lines of evidence – large, bottom-dwelling fish/invertebrates and contaminant bioaccumulation – add to the overall narrative about how contamination has impacted the environment.

- Sediment chemistry
- Sediment toxicity
- Sediment-dwelling biological communities
- Large, bottom-dwellling fish/ inverebrate communities
- Contaminant bioaccumulation

Sediment quality triad

Narrative assessment

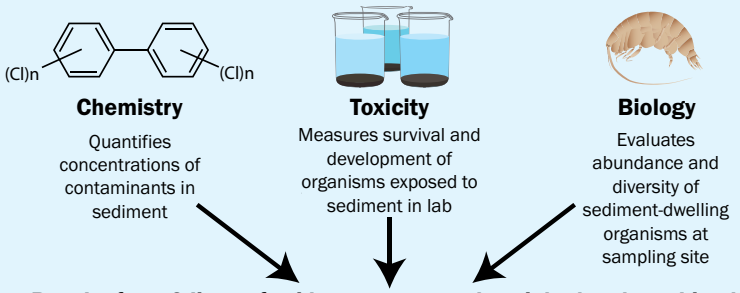
Courtesy of Amec Foster Wheeler

Bottom-dwelling fish and other invertebrates are caught using trawl nets, then sorted and analyzed as part of the Bight program's Contaminant Impact Assessment element.

Seafloor sediment is placed in bottles in preparation for taking it to a lab for analysis. Sediment quality is evaluated using a multiple-lines-of-evidence approach to increase confidence in the findings.

Sediment quality triad scoring tool

Because of the key role that sediment plays in illuminating the condition of marine environments, SCCWRP has co-developed a quantitative scoring tool to provide consistency when interpreting and synthesizing three lines of evidence. This scoring tool is the gold standard for conducting sediment evaluations. The Contaminant Impact Assessment element uses this tool to score sediment samples collected at depths of 650 feet or less. In 2009, the State Water Board adopted it to score sediment quality in embayments statewide.



Stratified sampling design

Sampling locations for the Bight program's Contaminant Impact Assessment element are selected via a stratified, random sampling design pioneered by SCCWRP that removes possible bias and ensures findings are statistically representative. Sampling starts at depths of just 3 feet along the shore and extends more than 20 miles offshore, to depths of nearly 3,000 feet. More than 1,400 sites have been sampled since the program was launched in 1994.

approach that provides greater confidence in the results and enables voluminous data to be distilled into cohesive, easy-to-understand conclusions.

Bight coastal managers use the knowledge and insight from the Contaminant Impact Assessment element to maintain focus and direct resources to areas where contamination impacts are particularly acute. Sites are able to be compared to one another, and trends are able to be tracked over time.

"This approach enables us to spot problems early on, which means we maintain a maximum number of options for taking action to remedy and mitigate the problem," said Don Cadien, Research Scientist for the Technical Services Division of the Sanitation Districts of Los Angeles County. "This is the most efficient, cost-effective way for us to deploy our resources."

Illuminating regional ecosystem condition

The primary big-picture finding of Bight '13 is that sediment contamination levels are so low across the vast majority of the Bight seafloor that these areas are considered unimpacted by sediment contamination. Sediment quality analyses reveal that only about 6% of the 1,539 square miles assessed for Bight '13 has sediment contamination levels that are considered possibly or likely impacted.

Bight '13 found, however, that

Courtesy of Amec Foster Wheeler

Participants of the Bight '13 Contaminant Impact Assessment drop a grab sampler off the back of a research vessel in San Diego Bay to collect sediment samples. The condition of these sediment samples was analyzed and scored using the sediment quality triad scoring tool, co-developed by SCCWRP.

embayments, particularly marinas and estuaries, remain disproportionately impacted by sediment contamination. About one-half of the assessed area of marina seafloors, and one-third of the assessed area of estuary seafloors, are possibly or likely impacted, according to a Bight '13 analysis using the sediment quality triad scoring tool.

While Bight embayments were found to be impacted, the impact to these areas has lessened over time. The total area of embayment seafloors impacted by sediment contamination has decreased by nearly 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.

During Bight '13, participants also expanded their analyses of how contamination is spreading through Bight marine food webs. While the Contaminant Impact Assessment element previously focused on documenting contaminants that have bioaccumulated in fish, the Bight '13 cycle instead focused on contaminant bioaccumulation in the eggs of Bight seabirds.

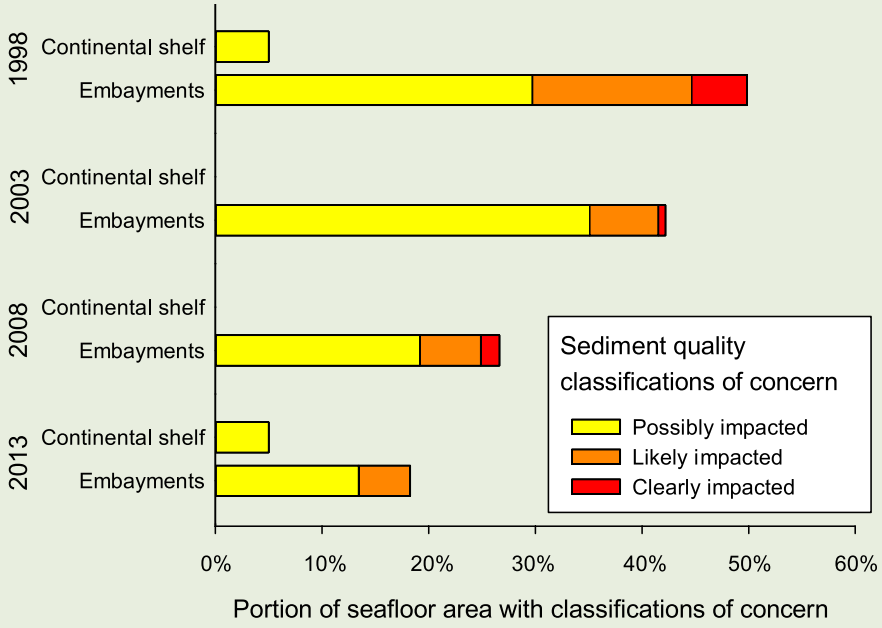
The bioaccumulation study found that almost all of the 101 abandoned seabird eggs collected contained detectable contamination levels for a majority of the contaminants tested, indicating that

Key Bight '13 findings

- About 94% of the assessed area of the Bight is unimpacted or likely unimpacted by sediment contamination.
- About one-half of the assessed area of marina seafloors, and one-third of the assessed area of estuary seafloors, are possibly or likely impacted by sediment contamination.
- The total area of embayment seafloors impacted by sediment contamination has decreased by nearly two-thirds since the late 1990s, from nearly 50% of the area in 1998 to 18% of area in 2013.

Trend toward improved sediment quality

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



Courtesy of Lea Squires

A researcher collects an abandoned tern egg in South San Diego Bay. The Bight '13 Contaminant Impact Assessment element found that contaminants have bioaccumulated in some of the highest-level predators, albeit at almost uniformly low levels.

contamination is traveling through food webs and bioaccumulating in some of the highest-level predators. Contaminant levels, however, were almost uniformly below the thresholds at which adverse health effects may start to occur.

The continuing improvements to Bight ecosystem condition documented by Bight '13 could be a consequence of any number of factors – both natural changes to ecosystem condition and those triggered by management actions. Indeed, it remains a challenge to disentangle these factors in an environment as dynamic and complex as the Bight.

However, it is clear that at least some management actions are having a positive effect on ecosystem integrity. For example, the Contaminant Impact Assessment element looked for the presence of a now-banned class of flame retardant chemicals known as PBDEs (polybrominated diphenyl ethers) during Bight '08 and Bight '13. Average PBDE concentrations fell by 92% between 2008 – the year the ban was enacted – and 2013.

"Regional monitoring is not intended to discern the cause – or causes – of changes

Expanding monitoring to submarine canyons

Through the Contaminant Impact Assessment element, participants are able to continually expand the scope of their monitoring to answer additional questions of mutual interest. For Bight '13, participants looked at toxicity in submarine canyons for the first time, finding that 17% of the area in submarine canyons contains sediment that is toxic to bottom-dwelling organisms. The finding suggests that submarine canyons, which connect the continental shelf to deeper areas farther from shore, may be funneling toxic contaminants. However, only one line of evidence – sediment toxicity – is available to support this conclusion, as the sediment quality triad scoring tool has not been adapted to score sediment condition in areas as deep as submarine canyons.

in conditions in our water bodies," said Chris Crompton, Manager of Water Quality Compliance for Orange County Public Works. "What it does is give us the data to focus follow-up investigations and to assess potential corrective actions, if needed."

Expansive benefits of partnership

The Contaminant Impact Assessment has withstood the test of time because it involves almost no money trading hands; instead, each participant provides in-kind resources and shares in the program's governance.

"If someone had to write a multi-million-dollar check for every Bight cycle, this program never would have gotten off the ground, much less been able to flourish and actually expand in size over time," said SCCWRP Deputy Director Ken Schiff, the Bight program's lead coordinator. "The Bight program works because everyone devotes a small piece of their in-house resources to working on this."

And participating agencies get more out of the Bight program than just insightful answers they need.

Courtesy of Orange County Public Works

The installation of pervious pavers, such as this effort by Orange County Public Works, can help reduce runoff to storm drain systems and lower the volume of contaminants being transported to the coastal zone.

Courtesy of Hal Beral

Seabirds like the tern, above, are exposed to chemical contaminants via the fish they eat. Such contamination originates in seafloor sediment and is transferred through marine food webs.

Among other benefits, the Bight program provides a platform for standardizing data collection and analysis methodologies used by environmental laboratories across the region. Over the years, labs have voluntarily committed to numerous quality-assurance and quality-control studies as part of Bight data collection, ensuring all data coming out of the labs – not just Bight program data – are comparable and of high quality.

The Bight program also serves as a testing ground for participants to explore newer technologies and different methods across a wide spectrum of habitat conditions and environmental stressors. Numerous lab analytical techniques for measuring contaminants of emerging concern in sediment, for example, have been developed, refined and transferred into routine use via the Bight program.

Finally, participation in the Bight program helps environmental managers build collegiality and trust, especially when they have disparate priorities and agendas. Before Bight participants can begin data collection, they must come to agreement on what questions they most want to answer, as well as commit to taking certain courses of action depending on outcomes. When findings are surprising or unexpected, they can collaborate on follow-up studies and site-specific monitoring.

Above all, though, the Bight program gives participants a credible platform through which to communicate key scientific findings and recommendations to policymakers and other decision-makers.

"Because we're speaking with a unified voice, our message gets amplified and really gets heard," Schiff said. "This is why the regional monitoring model we've developed is now emulated by other groups all around the world."

Planning for Bight '18

As Bight program participants gear up for Bight '18, they are particularly interested in examining whether the improvements in ecosystem condition observed during Bight '13 continue their upward trajectory.

Other priorities include laying a scientific foundation to investigate the effectiveness of various management actions in improving the quality of Southern California Bight ecosystems, and examining whether the health risks associated with eating contaminated seafood from the Bight are rising or falling.

OVERHAULING TRASH MANAGEMENT

As California shifts its strategy for combating trash in aquatic environments, Bight '13 is paving the way to assess long-term effectiveness

Southern California's storm drain system can transport trash from across hundreds of square miles to the coastal zone.

For generations, trash in Southern California's aquatic environments has been as ubiquitous as it has been vexing to control.

Unlike toxic chemicals or harmful emissions that can be manageably controlled at the source, trash is generated by millions of individual people and businesses. As trash accumulates in aquatic environments,

Top 10 types of trash found in Southern California streams

Litter in and along streambeds across coastal Southern California was collected and counted as part of a Bight '13 trash study. The top 10 items found make up about 75% of all trash in streambeds.

1. Plastic wrappers
2. Plastic bags
3. Persistent plastic pieces
4. Polystyrene foam pieces
5. Glass pieces
6. Sports balls
7. Cigarette butts
8. Paper and cardboard
9. Plastic bottles
10. Concrete/asphalt material

Courtesy of the NOAA Marine Debris Program

Litter often covers beaches after heavy rains.

Background photo courtesy of Heal the Bay

it degrades aesthetics, reduces the recreational potential of water bodies, and can harm vulnerable wildlife and delicate ecosystems.

Historically, Southern California's environmental management community has focused its attention on eliminating trash generated by those who frequent the coastal zone and other water bodies. Beachgoers, boaters, anglers and businesses have been targeted with strict anti-littering laws, public education initiatives and outreach campaigns.

Still, trash has continued to accumulate in Southern California's aquatic environments.

In the mid-1990s, the Los Angeles Regional Water Quality Control Board led the state in dramatically rethinking how water-quality managers combat trash entering waterways. Instead of taking a site-specific trash management approach, the agency's water-quality regulators embraced a more holistic, regional focus.

Supporting this fundamental shift in strategy was research conducted by SCCWRP and others showing that coastal activities such as beach-going, shipping and fishing are not generating the majority of litter along the coastline.

Rather, the predominant source of coastal trash is land-based runoff. Indeed, the storm drain systems built to move water quickly off the land to prevent flooding also serve to funnel trash from across hundreds of square miles of densely populated landscapes – and deposit it in the coastal zone.

"Over the past two decades, we've really come to view trash as a regional problem that demands collective action," said Karen Larsen, Deputy Director of the State Water Board's Division of Water Quality. "The most effective way to control trash in our waterways is to capture it as close to its source as possible, even when those sources are many miles inland."

This evolution in thinking has ushered in an ambitious new strategy for trash management in California, one that ultimately will call on municipalities and others that discharge into storm drain systems to retrofit tens of thousands of storm drain entry points with

California milestones in reducing ubiquitous sources of trash

2005: Malibu becomes one of the first California coastal cities to ban the use of polystyrene foam, commonly referred to as Styrofoam, for food packaging. Dozens of other cities have since followed suit.

2008: California enacts strict regulations on facilities that manufacture, handle and transport pre-production plastic pellets. The tiny particles, which serve as the raw materials for plastic production, can spill and become lost during transport.

2014: California voters approve a statewide ban on carry-out plastic bags at grocery stores and pharmacies. The law goes into effect two years later, following an unsuccessful referendum to overturn the ban.

2015: California approves a ban on the sale of personal care products that contain plastic microbeads; a similar federal law is passed later that year.

How trash harms aquatic environments

In almost all water bodies, trash can be found floating at the surface, suspended in the water column, and at the bottom. Over time, trash is gradually broken down into smaller and smaller pieces. And it is much more than just an aesthetic problem.

- Marine life can become entangled, strangled and smothered by trash.
- Trash can impair the recreational and economic potential of water bodies.
- Trash can interfere with the traditional and cultural rights of indigenous people and subsistence fishers.
- Wildlife can mistake trash for food.
- When aquatic organisms ingest plastic particles – the most prevalent type of trash – they also can ingest toxic contaminants that attach to plastic, which introduces chemical contaminants to food webs.

Courtesy of Bill Macdonald, Algalita Marine Research and Education

Trash booms have been installed at the mouths of several Southern California rivers, including Ballona Creek in Los Angeles County, to capture floating debris before it reaches the coastal zone.

custom-designed mesh screens to deflect trash. More aggressive street sweeping and other source control measures also will be part of this trash management paradigm.

As municipalities across the state implement these costly new measures, there will be a demand to know whether they're working as intended, and whether they're ultimately extending greater protections to aquatic ecosystems.

The Southern California Bight Regional Monitoring Program is laying the groundwork to answer these critical management questions, completing a comprehensive regional survey of trash on land and at sea for Bight '13 that will serve as a baseline for tracking future improvements over time.

"For us to be able to say that trash-reduction measures are effective, we need a baseline against which to judge success going forward," said Shelly Moore, an aquatic scientist who leads SCCWRP's marine debris research program. "Bight '13 has given us that baseline for Southern California."

Documenting trash in the environment

Perhaps the biggest challenge for aquatic trash management in densely populated Southern California is the ease with which litter can be transported through storm drain systems and spread across water bodies.

This flood control infrastructure was not designed to filter or remove debris prior to its discharge, which means that as Southern California has become increasingly urbanized, storm drain systems have been transformed into efficient funnels of trash from across vast landscapes.

Studies over the past two decades have demonstrated that an estimated 60% to 80% of human-created debris in marine environments comes from land-based sources.

SCCWRP's contributions to this body of research date back to the late 1990s and early 2000s, when the agency co-authored a series of studies documenting how inland-based sources of trash are accumulating along Southern California's coastline.

In 1998, SCCWRP and its research partners found that an estimated 106 million discarded items weighing 13 tons had accumulated along Orange County's shoreline.

The study noted that the most abundant source of trash found on Orange County beaches isn't litter from beachgoers. Rather, the main culprit is tiny plastic particles known as pre-production pellets, which are manufactured in the early stages of plastic production and presumably are being spilled and lost during transport.

A follow-up study found that these pre-production plastic pellets had accumulated on more than half of the Los Angeles County coastline and on nearly three-fourths of the Orange County coastline.

Courtesy of Orange County Public Works

Bottles and other non-biodegradable plastic material in Southern California's waterways are gradually broken down into smaller and smaller pieces. They can persist in aquatic environments indefinitely.

Further from shore, SCCWRP and its partners documented the prevalence of tiny plastic debris in the open ocean – the size that filter feeders are most likely to confuse with plankton. These studies showed that the proportion of plastic to plankton – as well as the density of plastic – was greater in the Bight than in the North Pacific central gyre, the area of the Pacific Ocean that subsequently was christened the "Great Pacific garbage patch."

"We now know that trash from land is making its way into our coastal waters at levels that are causing harm to our environment," said SCCWRP's Dr. Martha Sutula, Chair of the Bight '13 Trash and Marine Debris Committee. "And our

A SCCWRP field crew uses a sifter to isolate tiny plastic trash particles that have accumulated in beach sand. The most abundant source of trash found on Southern California beaches is pre-production plastic pellets, manufactured in the early stages of plastic production.

Economic costs of dirty beaches

Southern California residents spend millions of dollars each year traveling to beaches farther away from home that they perceive as cleaner, according to a 2014 study commissioned by the National Oceanic and Atmospheric Administration. The study found that reducing marine debris by just 25% at beaches perceived as dirty could save Orange County residents roughly $32 million every summer. Reducing marine debris by 50% would save residents $67 million.

diffuse storm drain network is a major conduit."

Charting a new trash management paradigm

As SCCWRP and other researchers have documented the accumulation of trash in aquatic environments, environmental managers have used these insights to improve and expand their approaches to trash management.

Street sweepers have been dispatched to remove accumulated trash from curbs and gutters with greater frequency. State and local governments have enacted strict anti-dumping ordinances. Municipalities have invested in solid waste facilities and enhanced curbside recycling.

Water-quality regulators at the Los Angeles Regional Water Quality Control Board, meanwhile, have pursued a more holistic strategy for reducing trash entering aquatic environments.

In 1996, the agency began using data collected from its inland trash monitoring program to add L.A.-area waterways to a federal list of water bodies with known water-quality impairments. Called the 303(d) listing process, the move enabled the L.A. regional board to develop total maximum daily load (TMDL) regulatory plans to compel municipalities and other entities that discharge into the region's storm drain systems to reduce trash loading.

The trash TMDLs marked the first time that the 303(d) listing process had been used to regulate trash levels in a U.S. water body. TMDLs are policy vehicles through which water-quality regulators use their enforcement powers under the federal Clean Water Act to cap pollutant loading levels.

"In the '90s, trash TMDLs were a novel concept," said Deborah Smith, Chief Deputy Executive Officer for the Los Angeles Regional Water Quality Control Board. "After listing several water bodies as being impaired by trash, we had to develop a regulatory framework to address this serious water-quality issue. Evidence was mounting that many types and sizes of trash had the potential to harm aquatic environments."

The L.A.-area trash TMDLs specified that stormwater dischargers reduce trash entering waterways in two main ways:

» **Option 1**: Metal mesh screens are installed at storm drain inlets, typically just below street level in catch basins. The custom-designed screens trap and hold back trash particles larger than 5 millimeters in diameter; then, maintenance crews manually go in and remove the accumulated trash at regular intervals. Tens of thousands of these devices are expected to be installed in the coming years.

» **Option 2**: Stormwater dischargers that prefer not to install these full-capture devices, or that cannot because of the physical configuration of their storm drain systems, can instead develop a plan for capturing trash at levels equivalent to full-capture devices. Option 2 typically includes a mix of improved source control, more intensive street sweeping and installation of bioswales and other multi-benefit projects.

Today there are 15 trash TMDLs for various rivers and other water bodies across the Los Angeles region.

Municipalities have responded to these trash TMDLs with ambitious trash-reduction initiatives. The City of Los Angeles is running a program to retrofit more than 38,000 catch basins with full-capture devices, as well as install 13 netting systems and four hydrodynamic devices.

Meanwhile, the Los Angeles County Department of Public Works, which chose Option 1 for all county unincorporated areas, is on track to retrofit about 5,700 catch basins with full-capture devices by 2020. Nearly 90% have already been installed.

"We've learned a lot over the past seven or eight years about how to optimize the design of these devices, and reduce installation and maintenance costs," said Genevieve Osmeña, a civil engineer in the Watershed Management Division of the L.A. County Department of Public Works. "Because we were among the first to install full-capture devices, we're now able to offer advice and guidance to others."

Stormwater pours out of a drain that terminates at the coastal zone. Southern California's storm drain system transports litter to coastal waters from across hundreds of square miles.

Regulating trash through TMDLs

In 1998, the Los Angeles Regional Water Quality Control Board enacted the first TMDL (total maximum daily load) regulatory policy in the nation to reduce trash in waterways. Today there are 15 trash TMDLs in the Los Angeles region, the densest concentration of TMDLs of any area in the nation.

Courtesy of Los Angeles County Department of Public Works

Trash-capture devices known as automatic retractable screens can be installed to reduce trash entering storm drain inlets. The screens open automatically when they become obstructed by debris to prevent street flooding.

Rolling out California's trash reduction initiative

Around 2010, as stormwater dischargers across the L.A. region began coming into compliance with the trash TMDLs, the State Water Board examined the feasibility of developing a statewide trash-reduction program.

Instead of trying to address trash impairments one water body at a time, as is done via the trash TMDL process, the state wanted a program that could immediately apply to all water bodies across California impacted by high trash-generation rates. The State Water Board achieved this by amending the state's master plans governing management of California's coastal ocean and freshwater systems; the trash amendments became effective in early 2016.

Similar to the Los Angeles trash TMDLs, the state's trash reduction program centers around two compliance options: installation of full-capture devices at storm drain inlets, or development of a plan to capture trash at equivalent rates. The state program applies to areas with high trash-generating rates only.

In the coming years, the new trash-reduction requirements will be codified in stormwater discharge permits. Responsible parties then will be tasked with developing compliance plans and implementing their plans over a 10- to 15-year period.

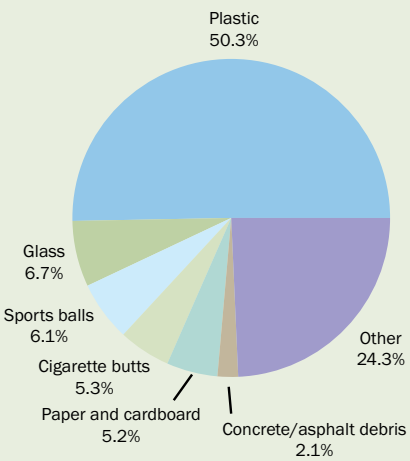
"We recognize there are differences in municipal resources across the state, so

Courtesy of Los Angeles County Department of Public Works

In storm drain catch basins just beneath street level, metal mesh screens known as connector pipe screens block debris from entering storm drain pipes. The Los Angeles County Department of Public Works is on track to retrofit about 5,700 catch basins by 2020 to comply with the L.A. region's trash-reduction requirements.

Trash in Southern California streams

Plastic was the dominant type of trash found in Southern California streams during the Bight '13 survey.



More frequent street sweeping is one trash-reduction strategy being employed by Southern California municipalities and other entities whose runoff ends up in storm drains. The Los Angeles Regional Water Quality Control Board has enacted trash-reduction regulations that call for a target of zero trash entering waterways.

Cost of trash-reduction measures

$428 million: Estimated annual spending by California communities to prevent trash from entering state waters

$10.71: Spending per California resident to prevent trash from entering state waters

$5.30: Average additional spending per resident of the Los Angeles region to comply with trash TMDLs

Source: California State Water Resources Control Board 2014 analysis

California trash reduction regulations

New statewide regulations intended to reduce trash entering California's waterways took effect in early 2016. Municipalities and other entities whose runoff ends up in storm drains and waterways must adopt one of two management approaches for areas with high trash-generation rates.

	Track 1	Track 2
Approach	Use trash-catching devices to capture all litter entering storm drains	Create a plan that achieves equivalent results
Compliance options	Install full-capture systems in catch basins, etc. (30+ approved devices to choose from)	Do more source control, street sweeping, multi-benefit projects (i.e., bioswales), etc.
Requirements for compliance	Annual report on maintenance and operation of installed systems	Study that demonstrates trash is being captured at levels equivalent to Track 1
What's not required	Demonstration of effectiveness not required	Installation of trash-catching devices not required
Timeline	18 months to be codified in discharge permits 3 months to select track 10-15 years to comply	18 months to be codified in discharge permits 3 months to select track 18 months to prepare equivalency plan 10-15 years to comply

we've focused the trash amendments on just high trash-generation areas," said Paul Hann, Watershed and Wetlands Section Chief for the State Water Board. "We think there's an opportunity to make a significant difference in these areas."

Tracking trash via Bight monitoring

As California's new trash-control measures are rolled out in the coming years, environmental managers and the public will need a way to measure effectiveness over time and determine whether the approaches are achieving their stated goals.

To answer these critical questions, managers rely on science – specifically, regional assessments of how far trash and debris have spread across coastal Southern California's aquatic environments – to benchmark their progress.

Hence, Bight '13 participants created a separate element of Bight regional monitoring devoted to establishing a regional baseline for trash.

This study involved tracking trash and marine debris across three habitats: Bight seafloor sediment, the surface of the seafloor, and freshwater streams.

On land, field crews surveyed 273 wadeable stream sites over a three-year period, counting and classifying every visible trash particle along a 100-foot-long swath. This effort marked the first comprehensive trash survey of streams in the region; it involved method standardization among a range of participating organizations, enabling all parties to benefit from the establishment of a regional baseline.

At sea, field crews counted and classified trash particles captured by fish trawl nets that had been dragged along the Bight seafloor. Although these large mesh nets only capture larger particles, debris has been quantified in this manner for every Bight cycle since 1994, enabling researchers to track trends over time.

Finally, researchers for the first time quantified micro-plastic particles that have accumulated in Bight seafloor sediment. Micro-plastics are particles of 1 to 5 millimeters in diameter that slip through trash-capture devices installed in storm drain systems.

Although SCCWRP had previously tracked micro-plastics in the water column, the Bight '13 survey marked the first such effort to quantify micro-debris in seafloor sediment. Researchers used the same sediment samples that were collected for the Bight '13 Contaminant Impact Assessment element, creating a cost-effective, leveraged way to collect samples and repeat the analysis in future Bight cycles.

Bight '13 found that trash had accumulated in more than three-fourths of Southern California's 4,600 miles of wadeable streams, and micro-plastics had accumulated in more than one-third of Bight seafloor sediment.

Meanwhile, the Bight '13 trash tracking study using fish trawl nets showed that trash has spread to more areas of the Bight seafloor over time. The portion of trawling areas where debris was found has roughly doubled between 1994 – when the Bight program was first launched – and Bight '13.

The findings of the Bight '13 trash survey have underscored the need for a multi-pronged approach to trash

Combatting micro-trash

While trash-capture devices and other measures can significantly reduce the amount of trash entering storm drain systems, micro-trash – defined as particles less than 5 millimeters in diameter – elude capture with metal mesh screens. Environmental managers recognize that there's no viable way to capture these particles and still enable storm drain systems to do their primary job, which is to prevent flooding. Thus, source-control measures are the most viable solution. In California, these measures include:

Plastic microbeads ban: In 2015, California passed a law prohibiting the manufacture and sale of exfoliating body washes and other personal care products containing tiny plastic microbeads. Microbeads, typically less than 1 millimeter in diameter, can evade capture even during the wastewater treatment process. Congress followed up a few months later with a nationwide ban; it goes into effect in summer 2017.

Pre-production plastic pellet regulations: California enacted tougher regulations in 2008 on facilities that manufacture, handle and transport pre-production plastic pellets, which are the 1- to 5-millimeter-diameter raw materials used to manufacture plastic products. Regulators are performing on-site inspections, requiring environmental clean-ups, and issuing fines to facilities that spill pellets or lose them in transit.

Pre-production plastic pellets, which are tiny pellets used in the early stages of plastic production, are ubiquitous in the environment, presumably spilled and lost during transport.

A Bight '13 field crew counts and classifies trash particles in the Los Angeles River. Researchers surveyed wadeable streams across Southern California to create the first regional assessment of trash in aquatic environments.

management – one that not only reduces trash in waterways but also takes advantage of source-control strategies to curb trash's many points of entry into the environment. Bight '13 also has highlighted the need for robust trash surveying methodologies to track long-term effectiveness of these trash-reduction strategies.

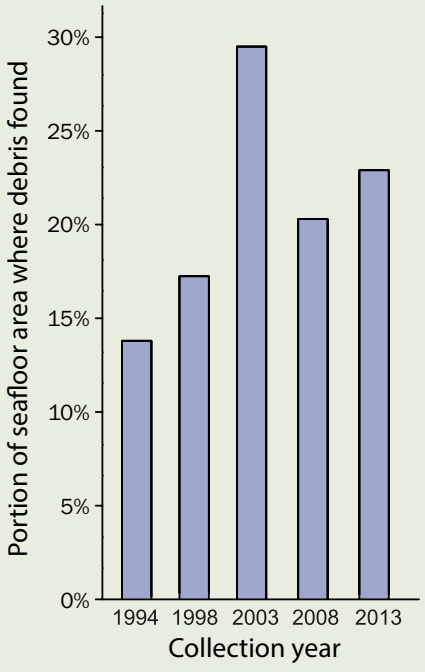
Although the Bight program developed the methods necessary to create a regional baseline, environmental managers still need additional methods for quantifying trash levels in various specific habitats, as well as for linking the trash found on land to debris found in the marine environment.

SCCWRP already is in discussions with the California Ocean Protection Council, State Water Board, California Ocean Science Trust and San Francisco Estuary Institute about how to develop these additional trash surveying methodologies. Bight program participants likely will begin test-driving these methodologies for Bight '18.

"This focus on improving trash monitoring is really going to guide management decisions going into the future," said Holly Wyer, Program Manager for the Ocean Protection Council. "We're really excited about developing methodologies to improve the assessments of trash throughout California."

Trash on the Bight continental shelf

For more than two decades, the Southern California Bight Regional Monitoring Program has been tracking the spread of marine debris along the Bight seafloor. The analysis methods are crude and approximate, as the program is highly leveraged. Still, since monitoring began in 1994, researchers have been able to document an increase in the area of the Bight continental shelf where debris has accumulated.



CORROSIVE WATERS' CREEP

Bight '13 documents vulnerability of Southern California's marine ecosystems to ocean acidification

When the Pacific Northwest shellfish industry began to experience mass die-offs of millions of fledgling oyster larvae in 2007, hatcheries initially assumed the culprit was bacteria in the seawater. The die-offs, however, persisted even after disinfection.

Shellfish farmers soon learned they had a far more troubling, pervasive problem on their hands: Corrosive seawater was circulating at their coastal doorstep.

Brought to the surface and toward the shore by ocean mixing, the corrosive waters ultimately

Photos courtesy of Occidental College Vantuna Research Group and Sanitation Districts of Los Angeles County

Bight '13 field samplers from the Orange County Sanitation District lower a CTD (conductivity, temperature depth) rosette into the ocean to take a variety of measurements, including seawater pH. The study enabled researchers to get a comprehensive look at ocean acidification conditions across the Southern California Bight continental shelf.

cost Pacific Northwest oyster hatcheries as much as 80% of their larvae in 2007 and 2008. Tens of millions of dollars were lost.

The unanticipated disruption caught the scientific community off-guard. Oceanographers had long been aware that the North American West Coast would be especially vulnerable to a global phenomenon called ocean acidification, in which the world's oceans are absorbing about a quarter of atmospheric carbon dioxide emissions and becoming more acidic. But they didn't realize the ecological and economic consequences would hit so soon and be felt so acutely.

"This really was the turning point, the event that caused environmental managers on the West Coast to take notice," said Jennifer Phillips, Program Manager for the California Ocean Protection Council. "Before the shellfish industry disruptions, we did not know we would be so vulnerable so soon."

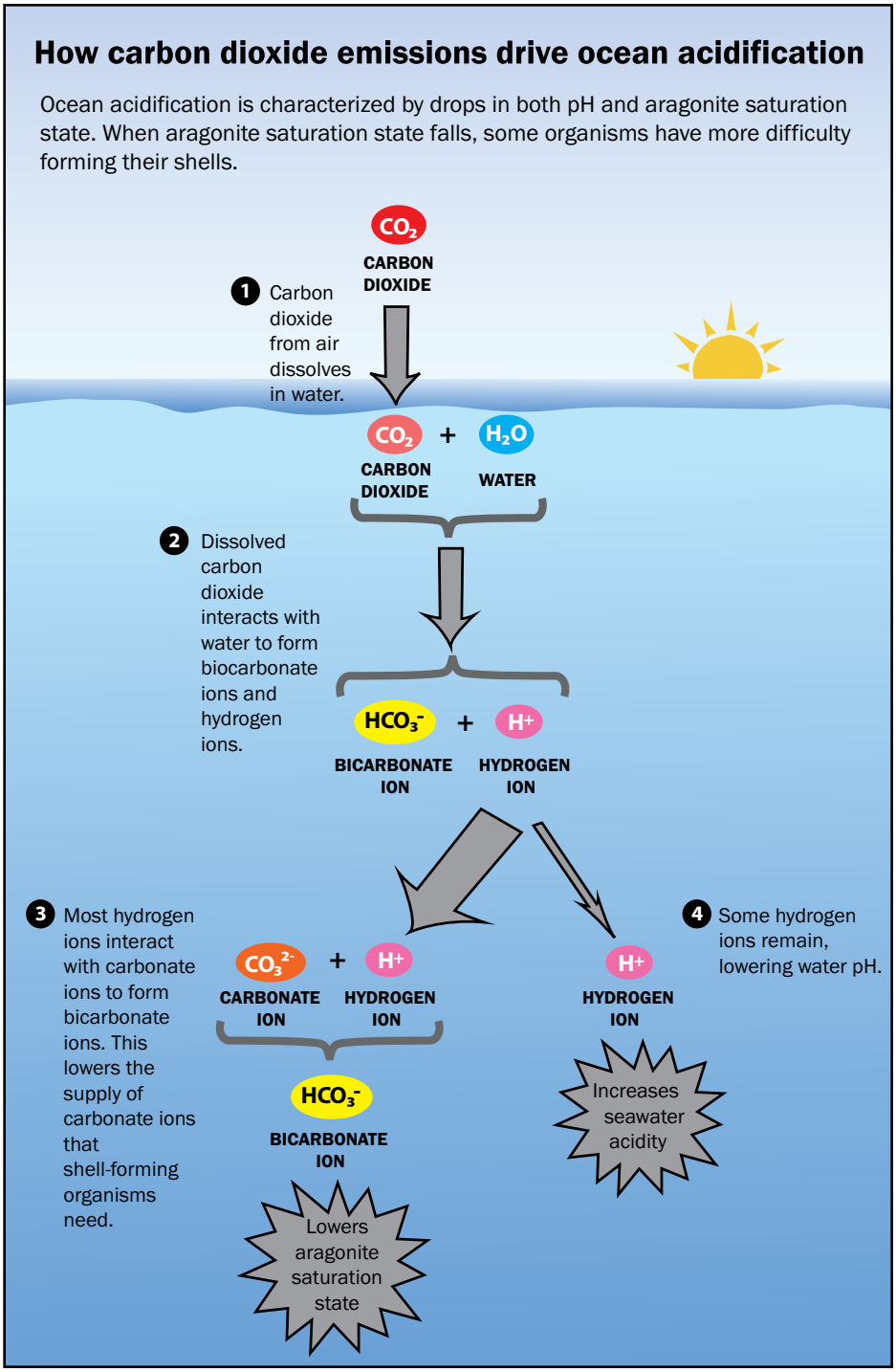
As West Coast environmental managers and scientists raced to get to the bottom of what was happening in the Pacific Northwest, the Southern California Bight Regional Monitoring Program began questioning the region's own vulnerability to ocean acidification.

Bight participants recognized that if corrosive waters were infiltrating into areas close to shore, especially for extended periods of time, they could be wreaking havoc on vulnerable marine species and potentially disrupting entire ecosystems.

Thus, the Bight '13 Water Quality element decided to build upon prior West Coast acidification monitoring efforts by designing a survey to measure ocean chemistry along the Bight continental shelf, the zone closest to shore. Only limited acidification data had been collected there, and the continental shelf would be particularly vulnerable to ecological damage from corrosive waters.

A SCCWRP researcher gathers mussels attached to rocks. The supply of seawater minerals that mussels rely on to form their protective outer shells is falling in response to ocean acidification.

A purple sea urchin, shown here surrounded by starfish, is among the marine organisms that will experience greater difficulty forming and maintaining their spiny outer shells in response to ocean acidification.



What Bight '13 participants learned during this comprehensive survey is that corrosive conditions already can be found along the Bight continental shelf, and that Southern California isn't far behind the Pacific Northwest at all.

In fact, the survey's findings have renewed the sense of urgency among Southern California's environmental managers to gain a stronger scientific grasp on ocean acidification's impacts, and to understand if and what they should be proactively doing in response.

"We know what happened in the Pacific Northwest, and we can see our own future there," said Dr. Karen McLaughlin, a SCCWRP Senior Scientist who facilitated the Bight '13 acidification study. "This acidification survey has really helped us start to get in front of this enormous global problem."

Harbinger of widespread ecological harm

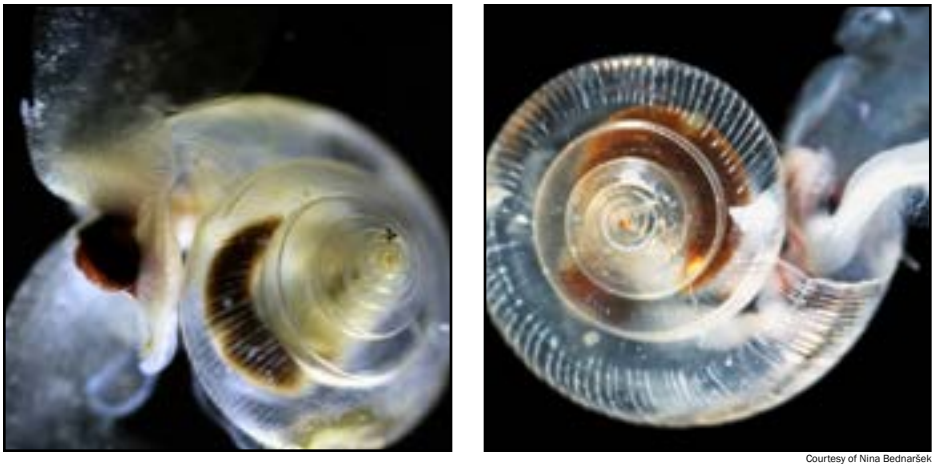
The reason the Pacific Northwest shellfish industry's woes are so alarming to environmental managers is because they portend potentially devastating impacts of global ocean acidification.

Although Southern California's shellfish industry is not nearly as big as the Pacific Northwest's, fundamental changes to seawater chemistry are reducing the supply of minerals that all shell-forming organisms depend on. Marine life ranging from calcareous phytoplankton to tiny sea snails to oysters and urchins will be impacted by these changes.

Furthermore, if organisms at the base of marine food webs are harmed by these chemical changes, it could trigger a chain reaction of ecological damage.

Changing seawater chemistry also could affect behavior, reproduction and growth in a variety of marine species. Early experiments with fish, for example, have shown that the changing ocean chemistry can affect their navigation, leading to increased difficulty finding food, distinguishing predators from prey, and identifying safe habitats.

The North American West Coast is uniquely vulnerable to ocean acidification because of a confluence of ocean mixing



Courtesy of Nina Bednaršek

Sea snails, or pteoropods, already are showing signs of shell dissolution on the West Coast in response to changing ocean chemistry. The shell of a healthy sea snail, left, looks visibly different than that of a stressed sea snail, right, with pit marks on its shell. Pteropods form the base of marine food webs.

phenomena that determine when and for how long the most acidic of these waters lingers, especially in ecologically sensitive nearshore areas.

The dominant force bringing corrosive seawater to the surface and toward West Coast shorelines is a phenomenon called upwelling. Triggered by seasonal winds off the coast of North America, upwelling forces water to the surface that has been trapped at the bottom of the Pacific Ocean for decades.

When an upwelling event is particularly strong, typically in the spring months, so much corrosive water can come to the surface that that it begins to adversely impact sensitive marine species. Especially in areas where water mixes relatively slowly, such as bays and estuaries, corrosive waters that linger are particularly worrisome.

The deep waters upwelled along the West Coast are made corrosive by excess levels of carbon dioxide, the water-soluble

Partnering with XPRIZE to test pH sensor prototypes

During Bight '13, researchers evaluated the accuracy of a widely used pH sensor known as a potentiometric glass electrode. The study concluded that this decades-old profiling instrument isn't accurate enough to precisely track changes to seawater pH over time. The finding paved the way for SCCWRP and its four wastewater treatment member agencies to partner with the XPRIZE Foundation to test promising, next-generation pH monitoring technologies.

SCCWRP and its member agencies tested four prototype instruments in 2015 and 2016 that were developed through an international XPRIZE competition. Although the evaluation didn't identify any viable successors to glass electrodes, the field testing enabled the developers of these technologies to recognize their commercial potential – and how to redesign them to be more useful for regulatory monitoring.

Staff from SCCWRP's wastewater treatment member agencies receive training on how to use a pH sensor prototype developed through an international XPRIZE competition. SCCWRP and its member agencies tested four such prototype technologies in an effort to identify a viable replacement for potentiometric glass-electrode pH sensors.

gas that gives soda its slightly acidic bite. As humans release more and more carbon dioxide into the atmosphere, the world's oceans have been absorbing more and more of it.

Much of the carbon dioxide in Southern California's upwelled waters was originally absorbed when this water was at the ocean surface 30 to 50 years ago. Then, along the water's multi-decade journey to Southern California, anaerobic bacteria living deep in the ocean added more carbon dioxide as they broke down dead organic matter through natural respiratory processes.

In 2016, an expert panel of leading West Coast ocean scientists unanimously concluded that the entire West Coast is vulnerable to pervasive ecosystem damage from ocean acidification. The 20-member West Coast Ocean Acidification and Hypoxia Science Panel, which included participation by two SCCWRP scientists, urged scientists and environmental managers to work together to develop coordinated strategies for monitoring acidification and modeling how it will impact vulnerable ecosystems.

"Ocean acidification is likely to become one of the defining challenges for West Coast water-quality managers in the coming decades," said Dr. Richard Feely, Senior Scientist at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle. "This is why it is very encouraging to see Bight '13 being particularly proactive on this topic, and really helping Bight managers to understand our changing ocean."

Documenting acidification Bight-wide

Although oceanographers have methodically documented ocean acidification conditions along the West Coast over the past two decades, their measurements have focused on continental basins and other areas farther from shore.

Thus, by targeting the continental shelf for acidification monitoring, Bight '13 was able to elucidate conditions in a zone where the ecological and economic impacts of ocean acidification are likely to be felt first.

Using moorings to monitor pH

Courtesy of Sanitation Districts of Los Angeles County

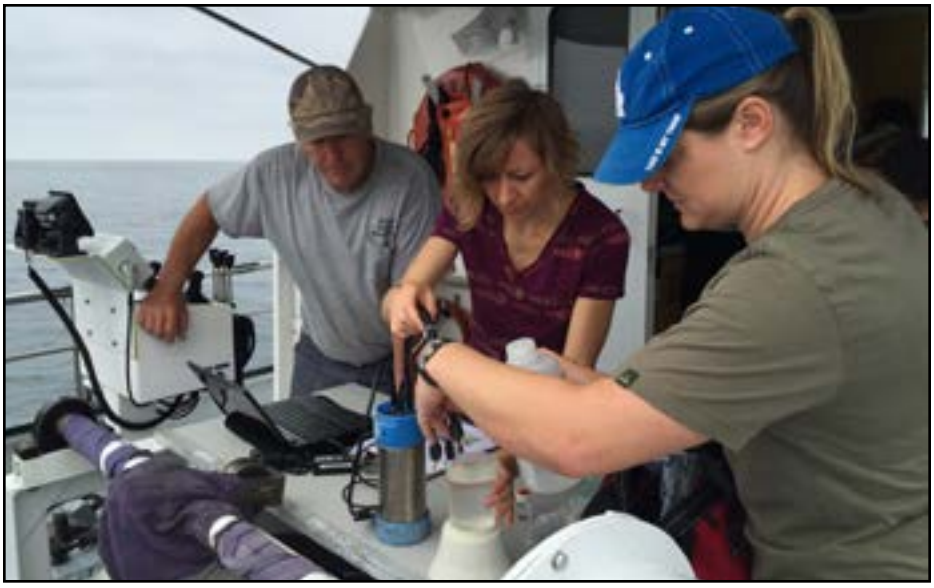
A field crew from the Sanitation Districts of Los Angeles County lowers a pH sensor into the ocean near Santa Monica Bay for attachment to a mooring line. The pH sensor measures pH conditions in real time.

Although Bight '13 provided a comprehensive overview of acidification conditions across the Southern California Bight, the findings are based on measurements taken just four times during the year. Stationary platforms known as moorings, by contrast, can provide a continuous stream of real-time pH data for a specific location and depth.

In recent years, at least eight pH moorings have been installed in high-priority, nearshore areas of the Bight, including by SCCWRP member agencies. These moorings can monitor swings in pH and aragonite saturation state that occur in relatively short timespans. For example, tides can bring corrosive waters into and out of an area in a matter of hours. And in kelp forests, underwater plants can respire so much carbon dioxide at night that they briefly send seawater into corrosive territory.

Courtesy of Sanitation Districts of Los Angeles County

Terra Petry of the Sanitation Districts of Los Angeles County attaches a seawater pH sensor to a mooring line. Unlike the Bight '13 acidification study that involved collecting seawater samples at discrete locations, depths and times, pH moorings provide a continuous stream of pH data for a single location and depth.



Field staff from SCCWRP's wastewater treatment member agencies prepare to deploy a pH sensor prototype to evaluate its utility as a seawater pH profiling device.

For the Bight '13 acidification study, participants analyzed 1,403 samples of seawater collected from 72 locations across the Bight. Participants measured seawater pH and total alkalinity for each bottle sample, enabling them to calculate aragonite saturation state, a measure of ocean acidification that is particularly relevant to shell-forming organisms.

Aragonite is a form of the seawater mineral calcium carbonate; shelled organisms draw aragonite from the ocean to form and maintain their shells. As aragonite saturation state drops, shell-forming organisms experience increasing difficulty with normal shell formation.

When aragonite saturation state drops below 1.0, shells can dissolve spontaneously, and seawater is deemed "corrosive."

Overall, Bight '13 found that aragonite saturation states averaged 2.0, well above the critical 1.0 threshold. But during the spring months – when upwelling brings carbon dioxide-rich waters close to shore – average aragonite saturation state dropped as low as 0.5 in relatively shallow depths of around 20 meters.

Meanwhile, the average annual Bight depth at which corrosive waters were documented was just 120 meters. And during the spring upwelling season, the average depth of corrosive waters crept up to 80 meters.

"Results from Bight '13 replicate previous findings taken offshore and better our understanding of the extent of corrosive waters in the Bight nearer to the coast and our discharges," said George Robertson, Senior Scientist for the Orange County Sanitation District. "It confirms the collective need to understand the drivers involved and their potential impact on managing discharges to the ocean."

Exploring the limits of pH sensors

Because the Bight '13 acidification survey involved such an intensive data collection effort, participants used the opportunity to investigate the accuracy of another, more widely used technology for measuring seawater pH.

Known as a potentiometric glass electrode sensor, the field instrument is typically attached to a profiling rosette that is lowered into the water from the deck of a research vessel. As the glass electrode descends through the water column, the instrument measures pH at various depths in real time.

Bight environmental managers routinely use glass electrodes to collect pH data for monitoring programs. Glass electrodes offer a cost-effective alternative to the gold-standard measurement method, which involves collecting seawater samples in bottles at various depths and taking them to a lab for analysis.

Although glass electrodes are advantageous because they can capture a continuous stream of pH data, these sensors have never had a reputation for being particularly accurate or stable.

By comparing the glass-electrode pH data to data obtained via lab analyses of the 1,403 bottle samples, Bight '13 showed that glass electrodes are not tracking potential pH changes within ±0.2 pH units, which is the standard mandated by state water-quality regulators.

However, Bight '13 also concluded that for profiling purposes, glass electrodes remain the only viable way to measure pH.

To improve the accuracy of glass-electrode measurements going forward, researchers developed a method that allows field crews to "correct" the glass-electrode probes by periodically collecting a bottle sample. Known as an ***in situ*** calibration, the method improves the accuracy of glass-electrode pH

Courtesy of Sanitation Districts of Los Angeles County

Potentiometric glass-electrode pH sensors have been used for decades to monitor pH in the Southern California Bight. Bight '13 found that they are not accurate enough to reliably track pH changes to the level of precision required by state water-quality regulators.

Calculating aragonite saturation state

Aragonite saturation state is a way to express the concentration of a dissolved mineral called aragonite in seawater. To calculate aragonite saturation state, researchers measure two properties of the seawater sample -- pH and total alkalinity – and then plug the data into a chemical equation. When aragonite saturation state drops below 1.0, seawater is considered to be corrosive.

measurements, albeit not sufficiently for use in an ocean acidification survey that meets regulatory standards.

"We recognize that it's not feasible for Bight managers to do bottle sampling for all of their pH monitoring," McLaughlin said. "The *in situ* calibration enables us to get more accurate pH data with glass electrodes, even as we continue to investigate alternative technologies to replace it."

Modeling West Coast acidification

Although ocean acidification is driven primarily by factors playing out at a global scale, researchers have the ability to model at a regional scale how it is expected to unfold in the coming decades.

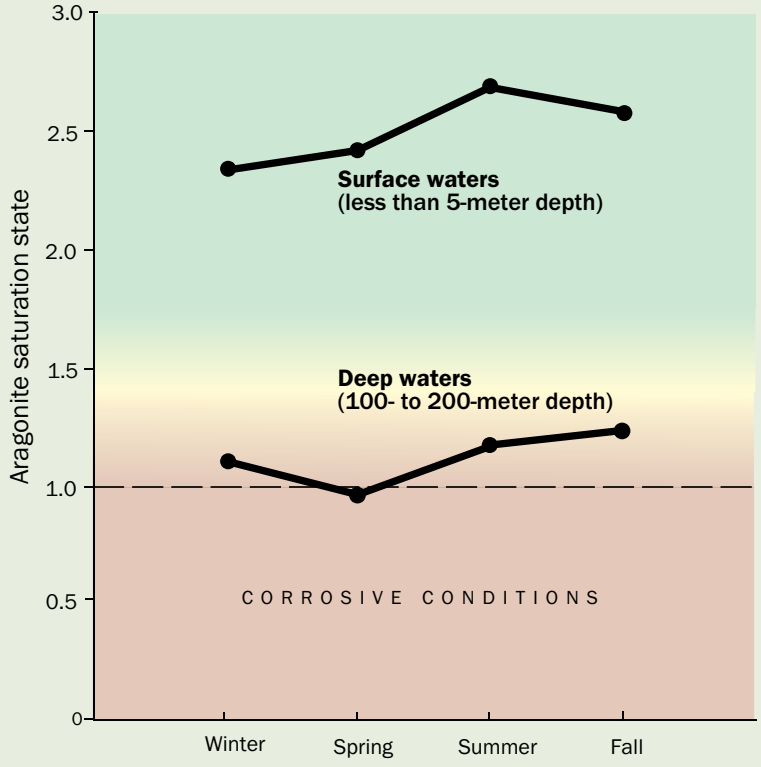
Thus, SCCWRP has joined forces with a group of ocean modelers to begin predicting which habitats and marine communities will be most vulnerable to the impacts of corrosive conditions along the West Coast. The ambitious project involves building a powerful computer model that will capture the interplay of two main factors:

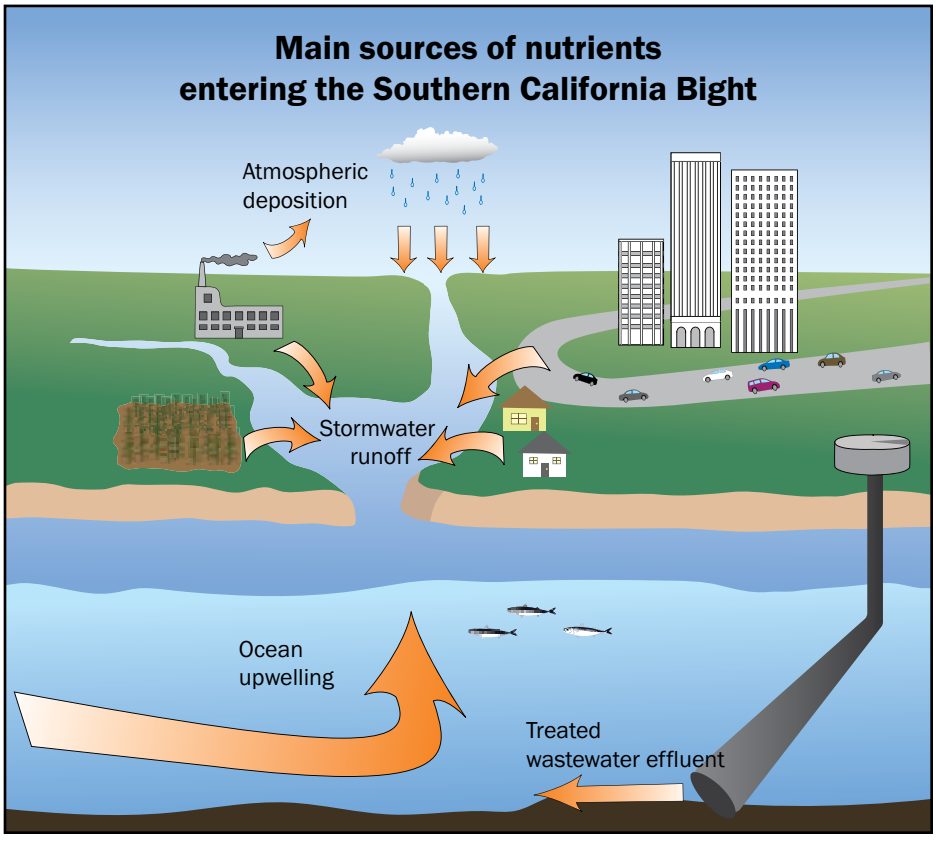
» The physical movement and mixing of water up and down the West Coast, including within the Southern California Bight.

» The biogeochemical pathways that alter carbon dioxide levels in seawater, including via the localized introduction of nutrients like nitrogen and phosphorous from land-based sources.

Critical aragonite saturation state levels

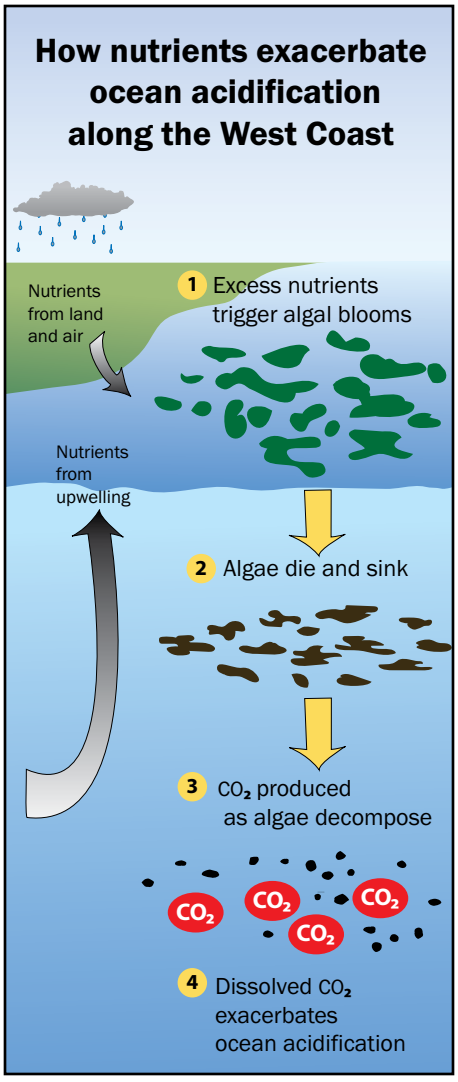
In the spring, when upwelling brings carbon dioxide-rich water close to shore, Bight '13 found that average aragonite saturation state in deep waters drops below the critical 1.0 threshold. Average aragonite saturation state in surface waters remains well above 2.0, but surface waters also could be impacted as ocean acidification intensifies in the coming decades.





Courtesy of Occidental College Vantuna Research Group

Rocky reefs, the shallow Southern California Bight ecosystems known for their rich biological diversity, could be harmed if corrosive waters linger for extended periods of time.



With the model, coastal managers will gain an understanding of the relative sensitivity of various marine habitats and areas to corrosive conditions, as well as what times of year these sites will be most at risk. Understanding such patterns can help managers develop solutions to protect vulnerable areas during critical periods.

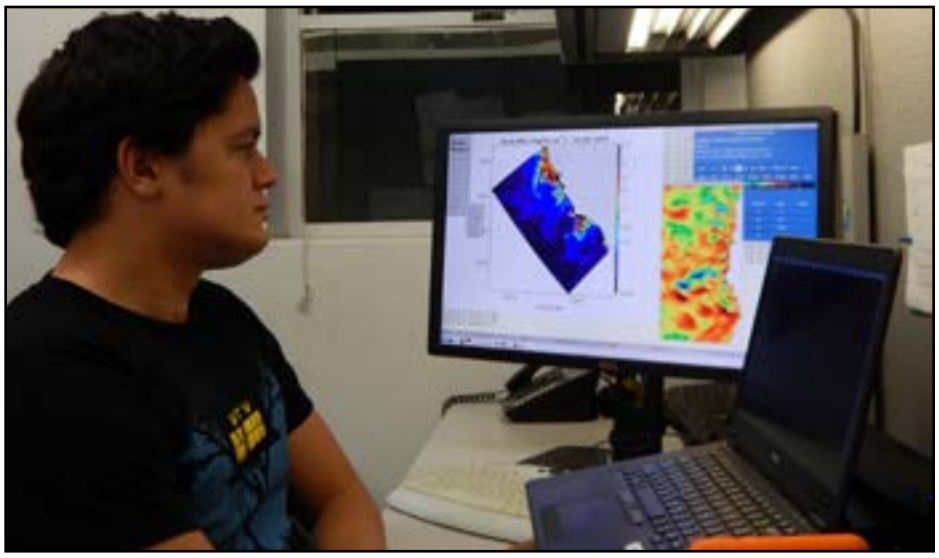
The model also will analyze whether land-based sources of nutrients, including wastewater effluent and stormwater discharge, are exacerbating ocean acidification conditions in ecologically sensitive areas.

If the nutrients in wastewater effluent, for example, are meaningfully contributing to acidification, environmental managers could explore removing the nutrients prior to discharge and/or diverting the discharges to alternate locations.

The acidification data collected during Bight '13 will play a key role in the West Coast modeling project, which is a joint collaboration of SCCWRP, the National Oceanic and Atmospheric Administration, the University of Washington, and the University of California, Los Angeles.

Modelers are using the Bight '13 data to help them validate whether the model is accurately capturing real-world conditions, as well as to help them characterize the level of uncertainty associated with model predictions. These steps are critical for giving environmental managers the confidence they need to rely on the model for resource management and spatial planning.

"The Bight '13 acidification study is really the foundation of a lot of the research that's going to be happening going forward," said Dr. Steve Weisberg, SCCWRP's Executive Director. "We're looking forward to seeing a lot of progress on ocean acidification in the coming years, and getting a better handle on this enormous global challenge."



SCCWRP's Dr. Fayçal Kessouri works on developing an ocean acidification model for the West Coast. The computerized model will predict which West Coast habitats and marine communities will be most vulnerable to corrosive seawater conditions in the coming decades.

Accomplishments

SCCWRP is a national leader in aquatic sciences research, with a comprehensive research agenda that spans a diverse array of water-quality issues confronting the environmental management community.

SCCWRP mission

To enhance the scientific foundation for management of Southern California's ocean and coastal watershed resources

Research themes

SCCWRP research agenda is organized around nine major thematic areas

44 Number of peer-reviewed journal articles and book chapters co-authored by SCCWRP that appear in this Annual Report

18 Number of technical reports co-authored by SCCWRP that appear in this Annual Report

115 Number of leadership roles that SCCWRP scientists hold with professional societies, advisory committees and editorial boards of scientific journals **Page 63**

Information Technology and Visualization

With an ever-present need to improve the technology used to monitor and assess the health of aquatic ecosystems, SCCWRP is working to build next-generation tools that enhance environmental managers' ability to collect, store, standardize, share and visualize data.

Bioassessment

As environmental managers increasingly turn to measuring the health of aquatic systems through biological assessments – or bioassessment – SCCWRP is developing next-generation approaches that use benthic invertebrates, algae and other organisms to evaluate ecological condition across a variety of environments, from streams to the coastal ocean.

Ecohydrology

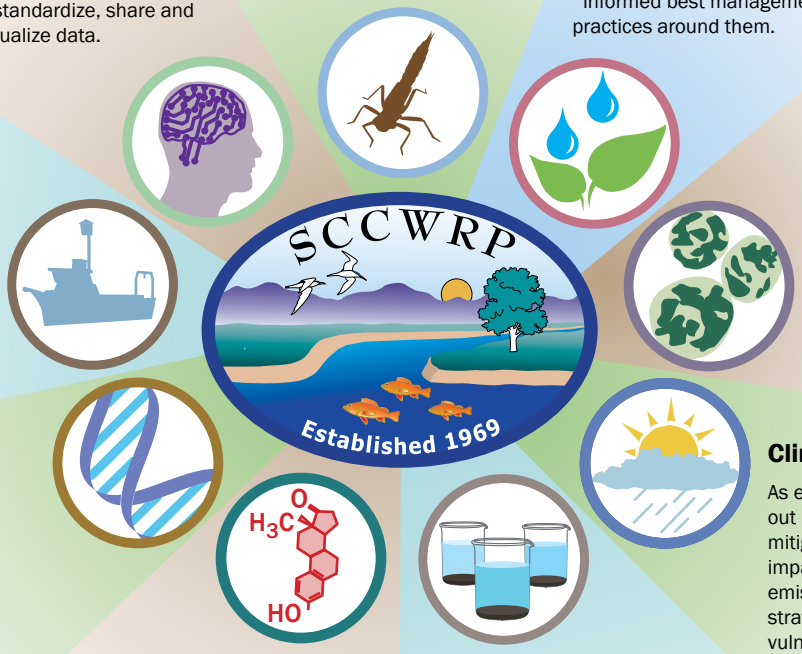
As environmental managers work to protect aquatic systems and the biological communities they support from human-induced alterations to hydrological flow patterns, SCCWRP is working to better understand these ecohydrological relationships and how to develop science-informed best management practices around them.

Regional Monitoring

To give environmental managers comprehensive, big-picture snapshots of the condition of aquatic systems and how they are changing over time, SCCWRP facilitates the design and execution of multi-agency regional monitoring – notably, the Southern California Bight Regional Monitoring Program and the Southern California Stormwater Monitoring Coalition Regional Watershed Monitoring Program.

Eutrophication

With anthropogenic nutrient inputs a leading cause of eutrophication – or accelerated accumulation of organic matter from overgrowth of aquatic plants and algae – SCCWRP is working to help environmental managers understand the deleterious impacts of excessive nutrients and how they can more effectively manage nutrient loading to water bodies.



Microbial Water Quality

With runoff and discharge introducing potentially pathogenic waterborne microbes into coastal waters, especially at populated beaches, SCCWRP is working to more rapidly and effectively detect this microbial contamination, identify the source(s) of the contamination, and understand the risk of illness from water contact.

Climate Change

As environmental managers seek out next-generation solutions for mitigating and offsetting the local impacts of global carbon dioxide emissions, SCCWRP is developing strategies to optimally position vulnerable aquatic systems – and the biological communities they support – to cope with and adapt to climate change.

Contaminants of Emerging Concern

To help environmental managers identify which of the tens of thousands of largely unmonitored CECs in aquatic systems pose the greatest potential health risks to wildlife and humans, SCCWRP is developing novel approaches to rapidly and cost-effectively screen water bodies for CECs, connect screening-level monitoring data to higher-level biological responses, and understand exposure routes.

Sediment Quality

To help environmental managers extend greater protections to marine communities affected by contaminated seafloor sediment, SCCWRP is working to understand how this contamination enters food webs and bioaccumulates in fish and wildlife, and how to effectively clean up and remediate its toxic effects.

DNA methods being evaluated to monitor ecosystem condition

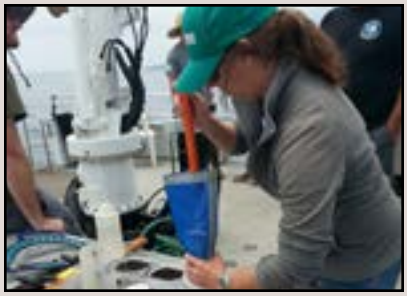
SCCWRP and its partners have launched a pair of studies exploring the feasibility of assessing ecosystem condition by using DNA-based methods to identify stream algal species and marine larval fish communities.

Researchers in 2016 developed sampling protocols that enable DNA barcoding technology to be used to identify the composition of the biological community at a given site. The protocols are designed to integrate seamlessly with existing monitoring programs.

Organisms such as fish larvae and algae are traditionally analyzed under a microscope by trained taxonomists, which can be time-consuming and costly. DNA-based identification methods show promise as a cost-effective alternative for tracking community composition, with results available in weeks instead of months.

Understanding community composition is key to understanding overall ecological health of a habitat.

Already, researchers have obtained preliminary data showing that using DNA barcoding methods to identify ichthyoplankton – which are the eggs and larvae of fish – generates results that are comparable to those obtained with traditional taxonomic methods.



The eggs and larvae of fish are extracted from a collection bag that was towed through Los Angeles County coastal waters. Researchers have begun assessing whether DNA-based methods can be used to identify the species present.

For the algal DNA study, researchers already have paired more than 200 algal DNA samples to samples obtained during previous statewide field surveys.

The twin DNA sampling efforts were made possible through numerous collaborations, including with the National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center, the state's Surface Water Ambient Monitoring Program and the Southern California Stormwater Monitoring Coalition.

Initial pair of bioindicators under development for intermittent streams

SCCWRP and its partners have initiated field sampling for a study that seeks to use terrestrial arthropods and bryophytes to assess the biological condition of streams that run dry for much of the year.

Field researchers in 2016 collected data from 39 stream sites across the San Diego area representing a range of conditions and environmental settings. Intermittent and ephemeral streams make up about 60% of all streams in Southern California.

The goal is to develop terrestrial arthropods and bryophytes (i.e., mosses) as bioindicators of stream condition, which would pave the way for creation of a regional scoring tool to assess the condition of intermittent streams across California at the drier end of the hydrologic spectrum.

These two bioindicators would be the first to be developed specifically for intermittent and ephemeral streams.

Researchers already have developed scoring tools to assess the condition of perennial streams, including the California Stream Condition Index.

Causal assessment study integrated with routine monitoring of San Diego Creek

SCCWRP and its partners are nearing completion of a two-year pilot study examining the feasibility of incorporating causal assessment studies into routine monitoring programs for San Diego Creek in Orange County.

The project brought together a broad cross-section of regulatory and regulated partners to evaluate six possible causes of the low benthic-invertebrate-based bioassessment scores observed in the Orange County creek: sediment accumulation, channel engineering, pesticides, elevated nutrients, altered temperature and elevated conductivity.

The causal assessment analysis found that the creek's poor ecological condition scores likely resulted, at least in part, from accumulation of excessive fine-grained sediment, much of which contains high concentrations of pyrethroid pesticides and buries complex habitat features that provide refuge from elevated temperatures.

The pilot study represents an important step forward for stream causal assessments, demonstrating that this work can be integrated with routine stream monitoring initiatives, completed largely with existing resources, and conducted at the reach scale instead of doing traditional site-specific analyses.

San Diego Creek in Orange County is the focus of a two-year pilot study examining how to incorporate a causal assessment study into routine stream monitoring.

Microbes as engines of ecosystem function: When does community structure enhance predictions of ecosystem processes?

Emily B. Graham[1,2], Joseph E. Knelman[1,3], Andreas Schindlbacher[4], Steven Siciliano[5], Marc Breulmann[6], Anthony Yannarell[7], J. M. Beman[8], Guy Abell[9], Laurent Philippot[10], James Prosser[11], Arnaud Foulquier[12], Jorge C. Yuste[13], Helen C. Glanville[14], Davey L. Jones[14], Roey Angel[15], Janne Salminen[16], Ryan J. Newton[17], Helmut Bürgmann[18], Lachlan J. Ingram[19], Ute Hamer[20], Henri M. P. Siljanen[21], Krista Peltoniemi[22], Karin Potthast[23], Lluís Bañeras[24], Martin Hartmann[25], Samiran Banerjee[26], Ri-Qing Yu[27], Geraldine Nogaro[28], Andreas Richter[29], Marianne Koranda[30], Sarah C. Castle[31], Marta Goberna[32], Bongkeun Song[33], Amitava Chatterjee[34], Olga C. Nunes[35], Ana R. Lopes[35], Yiping Cao[36], Aurore Kaisermann[37], Sara Hallin[38], Michael S. Strickland[39], Jordi Garcia-Pausas[40], Josep Barba[41], Hojeong Kang[42], Kazuo Isobe[43], Sokratis Papaspyrou[44], Roberta Pastorelli[45], Alessandra Lagomarsino[45], Eva S. Lindström[46], Nathan Basiliko[47], Diana R. Nemergut[1,48]

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Abstract

Microorganisms are vital in mediating the earth's biogeochemical cycles; yet, despite our rapidly increasing ability to explore complex environmental microbial communities, the relationship between microbial community structure and ecosystem processes remains poorly understood. Here, we address a fundamental and unanswered question in microbial ecology: 'When do we need to understand microbial community structure to accurately predict function?' We present a statistical analysis investigating the value of environmental data and microbial community structure independently and in combination for explaining rates of carbon and nitrogen cycling processes within 82 global datasets. Environmental variables were the strongest predictors of process rates but left 44% of variation unexplained on average, suggesting the potential for microbial data to increase model accuracy. Although only 29% of our datasets were significantly improved by adding information on microbial community structure, we observed improvement in models of processes mediated by narrow phylogenetic guilds via functional gene data, and conversely, improvement in models of facultative microbial processes via community diversity metrics. Our results also suggest that microbial diversity can strengthen predictions of respiration rates beyond microbial biomass parameters, as 53% of models were improved by incorporating both sets of predictors compared to 35% by microbial biomass alone. Our analysis represents the first comprehensive analysis of research examining links between microbial community structure and ecosystem function. Taken together, our results indicate that a greater understanding of microbial communities informed by ecological principles may enhance our ability to predict ecosystem process rates relative to assessments based on environmental variables and microbial physiology.

CITATION

Graham, E.B., J.E. Knelman, A .Schindlbacher, S. Siciliano, M. Breulmann, A. Yannarell, J.M. Beman, G. Abell, L. Philippot, J. Prosser, A. Foulquier, J.C. Yuste, H.C. Glanville, D. Jones, R. Angel, J. Salminen, R.J. Newton, H. Bürgmann, L.J. Ingram, U. Hamer, H.M. Siljanen, K. Peltoniemi, K. Potthast, L. Bañeras, M. Hartmann, S. Banerjee, R.-Q. Yu, G. Nogaro, A. Richter, M. Koranda, S. Castle, M. Goberna, B. Song, A. Chatterjee, O.C. Nunes, A.R. Lopes, Y. Cao, A. Kaisermann, S. Hallin, M.S. Strickland, J. Garcia-Pausas, J. Barba, H. Kang, K. Isobe, S. Papaspyrou, R. Pastorelli, A. Lagomarsino, E. Lindström, N. Basiliko, D.R. Nemergut. 2016. Microbes as engines of ecosystem function: when does community structure enhance predictions of ecosystem processes? *Frontiers in Microbiology* http://dx.doi.org/10.3389/fmicb.2016.00214.

SCCWRP Journal Article #0915
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/915_MicrobesEnginesEcosystemFunction.pdf

Habitat conditions: Coastal wetlands

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ABSTRACT

Coastal wetlands are low-lying areas of land that are frequently and regularly inundated with fresh and/or ocean water. They are habitats that can be perennially open to the ocean (e.g., Ballona Creek) or function instead as barbuilt lagoons that only have an intermittent connection to the ocean (e.g., Malibu Lagoon). Coastal wetlands often include habitats such as salt marsh wetlands and adjacent brackish and freshwater wetlands that do not necessarily have a direct connection to the ocean. The largest set of coastal wetland habitats in the Santa Monica Bay watershed is within the approximately 600-acre Ballona Wetland Ecological Reserve ("Reserve"). The Reserve contains wetlands, adjacent salt flats, freshwater, and upland habitats that were primarily former salt marsh habitats. For the purposes of this report, the entire former Ballona Wetland Complex is evaluated for the area and loss assessment scores, but the current, existing delineated wetland habitats at the Reserve (approximately 150 acres) are used for the condition scores ("Ballona wetlands"). Located in the eastern portion of the Bay at the mouth of Ballona Creek and situated between Los Angeles International Airport and Marina del Rey, this area is part of a historic and large wetland complex of approximately 2,100 acres that included Lower Ballona Creek, Marina del Rey, Ballona Lagoon, Del Rey Lagoon, Oxford Flood Control Basin, portions of Venice Beach and the Venice Canal system, and other adjacent subtidal and freshwater marsh habitats. These remaining pieces of the former complex still exist as hydrologically distinct separate systems, and in some cases (e.g., Marina del Rey) have been completely converted to other habitat types (e.g., subtidal). In the north region of the Bay, several smaller wetlands are present. Largest among these is Malibu Lagoon, followed by Zuma Lagoon, Lower Topanga Creek and Lagoon, and Lower Trancas Creek. All of these smaller systems are periodically or permanently closed to the ocean.

CITATION

Ambrose, R.F., J.H. Dorsey, K. Johnston, E.D. Stein. 2015. Habitat Conditions: Coastal Wetlands. *Urban Coast* 5(1):59-68.

SCCWRP Journal Article #0910
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/910_CoastalWetlands.pdf

Assessment of the condition of Southern California depressional wetlands: Application of macroinvertebrate, diatom and overall condition indices for assessing Southern California depressional wetlands

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CITATION

Brown, J.S., E.D. Stein, C. Solek, A.E. Fetscher. 2016. Assessment of the Condition of Southern California Depressional Wetlands: Application of Macroinvertebrate, Diatom and Overall Condition Indices for Assessing Southern California Depressional Wetlands. Technical Report 921. State Water Resources Control Board Surface Water Ambient Monitoring Program. Sacramento, CA.

SCCWRP Technical Report #0921
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/921_AssessmentConditionSoCalWetlands.pdf

Standard operating procedures (SOP) for the collection of field data for bioassessments of California Wadeable Streams: Benthic macroinvertebrates, algae, and physical habitat

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CITATION

Ode, P.R., A.E. Fetscher, L.B. Busse. 2016. Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat. Technical Report 835. State Water Resources Control Board Surface Water Ambient Monitoring Program. Sacramento, CA.

SCCWRP Technical Report #0835
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/835_SOPCollectionFieldData.pdf

Framework developed for setting stream flow targets

SCCWRP and its partners in 2016 completed development of a framework that can be used to establish ecologically relevant flow targets for stream sites across Southern California.

The framework, which relates flow alterations to biological indicators of stream condition, was the final stage of a three-year study aimed at developing tools for incorporating flow-ecology principles into water resources management.

The study, conducted in partnership with Colorado State University and the U.S. Geological Survey, used a scientific approach known as the Ecological Limits of Hydrologic Alteration (ELOHA) to evaluate minimum environmental flow requirements at more than 800 ungauged stream sites across Southern California.

The study involved establishing preliminary thresholds for each of seven flow metrics identified as having the most influence on biological condition; flow alterations beyond these thresholds are expected to be associated with declines in in-stream biological condition.

With these flow-ecology relationships, watershed managers will be able to make better-informed decisions regarding how to optimally balance in-stream flows across a watershed, as well as how to prioritize ongoing stream restoration and protection efforts.

Researchers analyzed more than 800 ungauged stream sites, including Green Valley in San Diego County, above, to create a framework for establishing ecologically relevant flow targets for Southern California streams.

Study shows watershed managers how to apply new flow-ecology modeling tools

SCCWRP and its partners in the San Diego River watershed have completed a demonstration study showing how to use a newly developed suite of flow-ecology modeling tools to optimally manage flows across a watershed.

The modeling tools, which explain how hydrological flow alterations affect biological indicators of stream condition, were co-developed by SCCWRP to help watershed managers balance the often-conflicting goals of maintaining flows, providing flood control, improving water quality and supporting in-stream biological health.

SCCWRP and its partners ran the San Diego River watershed demonstration study as part of a broader study that involved developing a scientific framework to guide setting ecologically relevant flow targets for streams across Southern California. This regional framework is based on the Ecological Limits of Hydrologic Alteration (ELOHA) framework.

The San Diego River watershed is the focus of a SCCWRP-led demonstration study showing how to use a newly developed suite of flow-ecology modeling tools to optimally manage flows across a watershed.

SCCWRP also began offering training to watershed managers on how to use the flow-ecology modeling tools, which take into account projected changes in land use, installation of runoff controls, and other variables.

Hydrologic classification system aids in setting flow targets for Southern California streams

SCCWRP and its partners have developed a seven-category system for classifying California streams based on their hydrologic characteristics, an effort that has paved the way for development of ecologically relevant flow management targets for Southern California streams.

Streams were sorted into classes based on differences in winter precipitation, geology, soil characteristics, and mean watershed elevation. Then, flow data from a subset of stream sites with reference gauge information were used to determine which hydrologic variables distinguish the seven classes.

The classification exercise showed that the vast majority of stream miles in Southern California fall into just three hydrologic classes, a finding that helped inform the development of appropriate flow targets for streams across the region.

Water resources: Water supply and use from a water quality perspective

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ABSTRACT

In our urbanized watershed, water can come from a variety of sources. It can come from rainfall and snowmelt that is captured, imported, and stored for use in our drinking water systems. It can be runoff captured for irrigation, mostly lost to the ocean via storm drains. It can be potable water discharged to the ocean as effluent from wastewater treatment plants after being used in our homes and industry, or as runoff after being used outdoors for landscaping. Each of these sources of water in the Santa Monica Bay Watershed is managed separately by different agencies. For example, in the City of Los Angeles, the Los Angeles Department of Water and Power (DWP) manages potable water, the Department of Public Works is responsible for managing runoff, wastewater treatment, and flood control, and the state's Los Angeles Regional Water Quality Control Board regulates the water quality of discharge to the receiving waters. Despite this separation, one agency's management action can be affected by the decisions of a different agency. For example, reclaiming wastewater can reduce demand for potable water and decrease the amount discharged into receiving waters. Reducing outdoor water use can decrease runoff, and capturing runoff and using it onsite can also decrease demand for potable water. Conversely, one agency's activities can also create challenges for other agencies, such as when development and flood control efforts convert pervious surfaces into impervious ones, preventing rainwater from recharging underground aquifers, or when conservation efforts successfully reduce the volume of water disposed into the sewer system, but simultaneously increase the concentration of said wastewater, making it more challenging and expensive to treat. Four years of drought in California have increased the focus on water supply and the urgency for agencies to work together to forge solutions that meet all of their collective mandates. Pressure to solve water shortages with traditional, single-minded solutions is still high. A better approach, however, would be to coordinate efforts across the different agencies. Australia provides an example of such collaboration. During the Millennium Drought in southeastern Australia, the city of Melbourne succeeded in reducing water consumption and rebuilding its water reserves, due in part to having one water management agency that oversees all aspects of water supply, use, and disposal.

CITATION

Cox, H., E.D. Stein, L. Protopapadakis, M. Dojiri. 2015. Water Resources: Water Supply and Use from a Water Quality Perspective. *Urban Coast* 5(1):3-10.

SCCWRP Journal Article #0904
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/904_WaterSupplyUse.pdf

Habitat conditions: Freshwater aquatic and riparian habitats

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ABSTRACT

There are 28 distinct drainage basins in the Santa Monica Bay watershed, with more located in the north part of the Bay watershed than the south. In the north, Malibu Creek is the largest un-channelized creek in the Bay watershed. Smaller drainage basins are present throughout the Santa Monica Mountains. Many in the eastern Santa Monica Mountains are confined to concrete channels for at least parts of their lengths. In the south, the Ballona Creek drainage basin dominates. At 130 square miles, it is the largest sub-watershed draining into Santa Monica Bay. Ballona Creek drains portions of west central Los Angeles and several other cities, as well as the southeastern portion of the Santa Monica Mountains. Most of Ballona Creek was channelized in the 1930s for flood control purposes, and consequently, little riparian habitat remains. Smaller drainage basins can be found throughout the South Bay and the Palos Verdes Peninsula. Most of these have been buried or replaced with storm drains.

CITATION

Dagit, R., F. Federico, L. Kats, E.D. Stein. 2015. Habitat Conditions: Freshwater Aquatic and Riparian Habitats. *Urban Coast* 5(1):48-58.

SCCWRP Journal Article #0908
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/908_FreshwaterAquaticRiparianHabitats.pdf

Application of regional flow-ecology to inform management decision in the San Diego River Watershed

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CITATION

Stein, E.D., A. Sengupta, R. Mazor, and K. McCune. 2016. Application of Regional Flow-ecology to Inform Management Decision in the San Diego River Watershed. Technical Report 948. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0948
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/948_ApplOfSanDiegoRivWatershedFlowEcolToInformMangDec.pdf

Macroalgal work informs proposed nutrient TMDL

A SCCWRP-led investigation into how to set scientifically defensible macroalgal biomass and nutrient loading targets in the Santa Margarita River Estuary has served as the basis of a proposed alternative nutrient TMDL (total maximum daily load) for the estuary.

San Diego Regional Water Quality Control Board staff likely will recommend board approval in 2017 for a set of numeric nutrient targets designed to reduce the proliferation of macroalgal blooms in the northern San Diego County estuary. The macroalgae numeric endpoints and related nutrient loading targets are based on work conducted by SCCWRP and its partners over the past few years; they would replace outdated total nitrogen (TN) and total phosphorous (TP) numeric targets for the estuary.

The Santa Margarita River Estuary alternative nutrient TMDL represents the first application of SCCWRP's macroalgal assessment framework to a California coastal estuary dominated by macroalgal blooms. Previous SCCWRP eutrophication research in other estuaries helped build the foundation for the Santa Margarita River Estuary TMDL.

Because macroalgae are the most abundant type of algae in Southern California estuaries, the example set by the Santa Margarita TMDL is expected to influence how nutrient management is approached in other macroalgae-dominated estuaries going forward.

A field crew collects samples of algal blooms in the Santa Margarita River as part of a study to set targets for macroalgal biomass and nutrient loading.

Ongoing work in the Santa Margarita River upstream of the estuary will provide opportunities to test-drive elements of a proposed State Water Board stream biointegrity and biostimulatory policy that would govern the health of wadeable streams statewide.

Framework developed to assess nutrient over-enrichment in San Francisco Bay

A group of researchers working to protect San Francisco Bay from the ecological effects of eutrophication has created a scientific framework for assessing nutrient over-enrichment.

The framework, co-developed by SCCWRP, is intended to support management decisions regarding how to set thresholds for three key indicators of eutrophication: phytoplankton biomass (expressed as chlorophyll-a concentration), abundance and toxin concentrations of harmful algal blooms, and dissolved oxygen levels.

Although the Bay historically has avoided adverse eutrophication symptoms, toxic HABs and increasing chlorophyll-a concentrations have been documented in recent years.

During the framework's development, ecologists analyzed 20 years of U.S. Geological Survey data alongside international experts in assessment framework development and nutrient criteria.

Researchers are testing and continuing to refine the framework.

HAB experts develop state strategy for responding to toxic cyanobacterial blooms

A group of scientific experts on harmful algal blooms (HABs) in California has developed a statewide strategy for responding to these events and mitigating their impacts in water bodies across California.

The strategy, co-authored by SCCWRP and published in early 2016 by the State Water Board's Surface Water Ambient Monitoring Program (SWAMP), provides a roadmap that California's aquatic resource agencies can use to build capacity for monitoring HABs, assessing a water body's susceptibility to these toxic blooms, and coordinating management responses.

HABs are events that trigger production of algal toxins that can impair water quality and recreational uses, as well as threaten the health of humans, wildlife, and pets that come into contact with these toxins. Multiple water bodies in California already have been placed on the state's 303(d) listing of impaired water bodies due to the toxins produced by HABs.

This strategy report serves as a conversation starter that various aquatic resource agencies can use to coordinate and implement management approaches. SWAMP already has begun implementing the report's recommendations with support from SCCWRP and others.

California water bodies such as Pinto Lake in Santa Cruz County, tainted green by toxic cyanobacteria, are the focus of a new statewide strategy for managing harmful algal blooms.

Are harmful algal blooms becoming the greatest inland water quality threat to public health and aquatic ecosystems?

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ABSTRACT

In this Focus article, the authors ask a seemingly simple question: Are harmful algal blooms (HABs) becoming the greatest inland water quality threat to public health and aquatic ecosystems? When HAB events require restrictions on fisheries, recreation, and drinking water uses of inland water bodies significant economic consequences result. Unfortunately, the magnitude, frequency, and duration of HABs in inland waters are poorly understood across spatiotemporal scales and differentially engaged among states, tribes, and territories. Harmful algal bloom impacts are not as predictable as those from conventional chemical contaminants, for which water quality assessment and management programs were primarily developed, because interactions among multiple natural and anthropogenic factors determine the likelihood and severity to which a HAB will occur in a specific water body. These forcing factors can also affect toxin production. Beyond site-specific water quality degradation caused directly by HABs, the presence of HAB toxins can negatively influence routine surface water quality monitoring, assessment, and management practices. Harmful algal blooms present significant challenges for achieving water quality protection and restoration goals when these toxins confound interpretation of monitoring results and environmental quality standards implementation efforts for other chemicals and stressors. Whether HABs presently represent the greatest threat to inland water quality is debatable, though in inland waters of developed countries they typically cause more severe acute impacts to environmental quality than conventional chemical contamination events. The authors identify several timely research needs. Environmental toxicology, environmental chemistry, and risk-assessment expertise must interface with ecologists, engineers, and public health practitioners to engage the complexities of HAB assessment and management, to address the forcing factors for HAB formation, and to reduce the threats posed to inland surface water quality.

CITATION

Brooks, B.W., J.M. Lazorchak, M.D.A. Howard, M.V.V. Johnson, S.L. Morton, D.A.K. Perkins, E.D. Reavie, G.I. Scott, S.A. Smith, J.A. Steevens. 2016. Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems. *Environmental Toxicology and Chemistry* 35(1):6-13.

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New insights into impacts of anthropogenic nutrients on urban ecosystem processes on the Southern California coastal shelf: Introduction and synthesis

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ABSTRACT

Anthropogenic nutrients inputs are one of the most important factors contributing to eutrophication of coastal waters. Coastal upwelling regions are naturally highly variable, exhibiting faster flushing and lower retention times than estuarine systems. As such, these regions are considered more resilient to anthropogenic influences than other coastal waters. Recent studies have shown our perception of the sustainability of these systems may be flawed and that anthropogenic nutrients can have an impact at local and regional spatial scales within these larger upwelling ecosystems. Maintenance of an outfall pipe discharging wastewater effluent to the Southern California Bight (SCB) provided an opportunity to study effects of anthropogenic nutrients inputs on a near-shore coastal ecosystem. The diversion of wastewater effluent from a primary, offshore outfall to a secondary, near-shore outfall set up a large-scale, *in situ* experiment allowing researchers to track the fate of wastewater plumes as they were "turned off" in one area and "turned on" in another. In this introduction to a special issue, we synthesize results of one such wasterwater diversion conducted by the Orange County Sanitation District (OCSD) during fall 2012. Anthropogenic nitrogen (N) from point-source discharges altered biogeochemical cycling and the community composition of bacteria and phytoplankton. Nitrification of ammonium to nitrate in wastewater effluent close to outfalls constituted a significant source of N utilized by the biological community that should be considered in quantifying "new" production. The microbial-loop component of the plankton community played a significant role, exemplified by a large response of heterotrophic bacteria to wastewater effluent that resulted in nutrient immobilization within the bacterial food web. This response, combined with the photosynthetic inhibition of phytoplankton due to disinfection byproducts, suppressed phytoplankton responses. Our findings have ramifications for future studies and regulatory monitoring, emphasizing the need to consider chemical and biological responses to wastewater effluent in assessing effects of anthropogenic nutrient inputs on urbanized coastal ecosystems.

CITATION

Howard, M.D.A., R.M. Kudela, K. McLaughlin. New insights into impacts of anthropogenic nutrients on urban ecosystem processes on the Southern California coastal shelf: Introduction and synthesis. *Estuarine, Coastal and Shelf Science*, in press.

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Rapid nitrification of wastewater ammonium near coastal ocean outfalls, Southern California, USA

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ABSTRACT

In the southern California Bight (SCB), there has been a longstanding hypothesis that anthropogenic nutrient loading is insignificant compared to the nutrient loading from upwelling. However, recent studies have demonstrated that, in the nearshore environment, nitrogen (N) flux from wastewater effluent is equivalent to the N flux from upwelling. The composition of the N pool and N:P ratios of wastewater and upwelled water are very different and the environmental effects of wastewater discharges on coastal systems are not well characterized. Capitalizing on routine maintenance of the Orange County Sanitation District's ocean outfall, wherein a wastewater point source was "turned off" in one area and "turned on" in another for 23 days, we were able to document changes in coastal N cycling, specifically nitrification, related to wastewater effluent. A "hotspot" of ammonium (NH_4+) and nitrite (NO_2-) occurred over the ocean outfall under normal operations and nitrification rates were significantly higher offshore when the deeper outfall pipe was operating. These rates were sufficiently high to transform all effluent NH_4+ to nitrate (NO_3-). The dual isotopic composition of dissolved NO_3- ($\delta\ ^{15}N_{NO3}$ and $\delta\ ^{18}O_{NO3}$) indicated that Nassimilation and denitrification were low relative to nitrification, consistent with the relatively low chlorophyll and high dissolved oxygen levels in the region during the study. The isotopic composition of suspended particulate organic matter (POM) recorded low $\delta\ ^{15}N_{PN}$ and $\delta\ ^{13}C_{PN}$ values around the outfall under normal operations suggesting the incorporation of "nitrified" NO_3- and wastewater dissolved organic carbon into POM. Our results demonstrate the critical role of nitrification in nitrogen cycling in the nearshore environment of urban oceans.

CITATION

McLaughlin, K., N. Nezlin, M.D.A. Howard, C.D.A. Beck, R.M. Kudela, M.L. Mengel, G.L. Robertson. 2016. Rapid nitrification of wastewater ammonium near coastal ocean outfalls, Southern California, USA. *Estuarine Coastal and Shelf Science* DOI: 10.1016/j.ecss.2016.05.013.

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Assessment of wastewater impact on dissolved oxygen around southern California's submerged ocean outfalls

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ABSTRACT

Ocean wastewater dischargers in southern California maintain extensive water quality monitoring programs to assess their effects on coastal receiving waters, but there is no shared protocol to analyze these measurements for compliance with California Ocean Plan standards. Here we present an assessment methodology that we apply regionally to determine discharge effects on dissolved oxygen (DO). The methodology was developed using an optimization algorithm to determine the following: (1) the most appropriate number of reference sites to capture natural variability among sites without moving so far from the potentially affected site to confound the comparison with natural latitudinal and offshore gradients; (2) the thickness of depth slices for comparing profiles between reference and potentially affected sites that minimizes false positives from natural vertical variability while not being so large as to average out plume-caused deviations; and (3) an allowable difference from the reference mean associated with variability among reference profiles. The algorithm was based on maximizing the chance of detecting DO outranges in the effluent plume, while simultaneously minimizing the chance to falsely identify outranges at reference sites outside of the plume zone. The assessment methodology also differentiates DO outranges resulting from physical upward entrainment of deep, low-oxygen water by rising of lower density plume water, as opposed to outranges resulting from low-oxygen relationships as a tracer of water masses. When the algorithm was applied to a ten year monitoring record from four discharge monitoring programs along the southern California coast, 11% of effluent sites were found to contain DO outranges, with about half of them resulting from deep water entrainment.

CITATION

Nezlin, N.P., J.A.T. Booth, C. Beegan, C.L. Cash, J.R. Gully, M.J. Mengel, G.L. Robertson, A. Steele and S.B. Weisberg. 2016. Assessment of wastewater impact on dissolved oxygen around southern California's submerged ocean outfalls. *Regional Studies in Marine Science* 7:177–184.

SCCWRP Journal Article #0945
Full text available by request: pubrequest@sccwrp.org

Looking ahead: Preliminary examination of stream cyanotoxins in Santa Monica Bay and California watersheds

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ABSTRACT

Cyanobacteria ("blue-green algae") are photosynthetic prokaryotes that are nearly ubiquitous in freshwater and brackish habitats. Nuisance cyanobacterial blooms occur commonly, and are problematic because they can impede the recreational use of water bodies, reduce aesthetics, lower dissolved-oxygen concentrations, cause drinking water taste and odor problems, and sometimes produce toxins (cyanotoxins), the most common of which are microcystins. Microcystins are powerful hepatotoxins associated with wildlife mortality and liver tumors/cancer in humans. They have also been implicated in impairment of benthic macroinvertebrate communities, as they can depress bioassessment scores. Freshwater harmful algal blooms (HABs, blooms of cyanotoxin-producing cyanobacteria) have been increasing in geographic range, frequency, duration, and severity as a result of various anthropogenic factors, including nutrient enrichment and changes in temperature. Although little data are available on cyanotoxins in the Santa Monica Bay Watershed, based on what data exist, there is currently no indication of a persistent cyanotoxin problem in SMB streams. Nonetheless, toxic cyanobacterial blooms are an emerging issue throughout California, and merit our attention.

CITATION

Fetscher, A.E., E.D. Stein, and M.D.A. Howard. 2015. Looking Ahead: Preliminary Examination of Stream Cyanotoxins in Santa Monica Bay and California Watersheds. *Urban Coast* 5(1): 198-200.

SCCWRP Journal Article #0913
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/913_StreamCyanotoxins.pdf

Factors affecting growth of submersed and floating macrophytes in the Sacramento-San Joaquin Delta

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CITATION

Boyer, K., M. Sutula. 2015. Factors Affecting Growth of Submersed and Floating Macrophytes in the Sacramento-San Joaquin Delta. Technical Report 870. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0870
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/870_FactorsControllingSubmersedAndFloatingMacrophytesInSac-SanJoaquinDelta.pdf

California freshwater harmful algal blooms assessment and support strategy

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[3]*San Francisco Regional Water Quality Control Board, Oakland, CA*
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CITATION

Anderson-Abbs, B., M. Howard, K. Taberski, K. Worcester. 2016. California Freshwater Harmful Algal Blooms Assessment and Support Strategy. Technical Report 925. State Water Resources Control Board Surface Water Ambient Monitoring Program. Sacramento, CA.

SCCWRP Technical Report #0925
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/925_CaliforniaFreshwaterHABAssessment.pdf

Application of watershed loading and estuary water quality models to inform nutrient management in the Santa Margarita River Watershed

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[2]*Tetra Tech, Inc., Pasadena, CA*

CITATION

Sutula, M., J. Butcher, J. Boschen, M. Molina. 2016. Application of Watershed Loading and Estuary Water Quality Models to Inform Nutrient Management in the Santa Margarita River Watershed. Technical Report 933. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0933
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/933_AppOfWatershedLoading.pdf

The prevalence of cyanotoxins in Southern California waterbodies based on screen assessment and regional monitoring programs

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[2]*San Diego Regional Water Quality Control Board, San Diego, CA*

CITATION

Howard, M., B. Fetscher, C. Nagoda. 2016. The prevalence of cyanotoxins in Southern California waterbodies based on screen assessment and regional monitoring programs. Technical Report 930. State Water Resources Control Board Surface Water Ambient Monitoring Program. Sacramento, CA.

SCCWRP Technical Report #0930
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/930_CyanotoxinsInSouthernCaliforniaWaterbodies.pdf

First phase wraps up for acidification model development

West Coast researchers working to develop a computer model that predicts how the region's coastal waters will be affected by ocean acidification and hypoxia have successfully completed the first phase of model development.

The first phase, completed in fall 2016, involved conducting a preliminary analysis to confirm the model is accurately capturing large-scale forcing at the scale of the Pacific Ocean basin. This preliminary validation step gives modelers confidence that when they downscale the model to a resolution of 1 square kilometer and move closer to shore, they are accurately capturing key characteristics of dynamic oceanic forces.

The modeling project is a three-year initiative to help West Coast managers understand which coastal marine habitats are most vulnerable to ocean acidification and to what extent local, land-based sources of nutrients are exacerbating acidification conditions. The modeling work involves coupling West Coast physical and biogeochemical ocean models together to understand the relative contributions of global carbon dioxide emissions, natural upwelling processes, and nutrients.

SCCWRP and its partners at UCLA and the University of Washington are developing a downscaled South Coast model that spans San Francisco to Baja California and has a resolution of 1 square kilometer. The large-scale Pacific basin model serves to establish boundary conditions for the downscaled model.

A field crew lowers a CTD (conductivity, temperature, depth) rosette into Southern California's coastal ocean to take a variety of measurements. Researchers are using this data to help validate a West Coast ocean acidification model.

New sea level rise model applied to predict impacts to coastal wetlands

SCCWRP and its partners have developed a model that predicts how Southern California coastal wetlands of all types and sizes will be impacted by sea level rise.

The model, which was applied to 104 low-lying coastal wetland areas in 2016, found that if sea levels rise an average of 0.6 meters, as they are projected to do by 2050, impacts will be moderate. However, if sea levels rise 1.6 meters, as they are projected to do by 2100, impacts will be severe.

The analysis found that the most vulnerable systems are large river valley estuaries, where a combination of sediment input changes and sea level rise will likely cause intertidal flats and marshes to become subtidal habitat. The effect is expected to be particularly pronounced in currently fragmented river valley systems.

The modeling work shows that by 2100, small creeks and small lagoons will be among the most vulnerable systems, with the highest portion in Santa Barbara County.

The sea level rise model also is being used to assess the projected effectiveness of proposed management actions aimed at protecting coastal wetlands.

Regional planning objectives will be developed based on this modeling work.

Courtesy of Sean Baumgarten, San Francisco Estuary Institute

Researchers have developed a model to predict how low-lying coastal wetlands across Southern California, including Los Peñasquitos Lagoon in San Diego, will be impacted by sea level rise over the next century.

Researchers analyze El Niño's impacts on coastal lagoons for climate change study

SCCWRP and its partners have completed a study analyzing how El Niño-fueled storm surges during winter 2015-16 impacted the geomorphology and hydrology of low-lying coastal lagoon areas.

The project, which involved assessing 10 vulnerable coastal estuaries across Southern California, is intended to offer insights into how more intense storm surges triggered by climate change could alter and disrupt biological habitats.

The analysis, completed in 2016, found that extreme ocean conditions were associated with substantial loss of sensitive habitats and fish die-offs triggered by anoxic conditions following mouth closures.

Researchers also compared the impacts of storm surge on more ecologically unaltered estuaries vs. more developed and managed estuaries. The study found that more managed estuaries were more susceptible to the effects of extreme ocean conditions than more natural ones.

Habitat compression and expansion of sea urchins in response to changing climate conditions on the California continental shelf and slope (1994-2013)

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Abstract

Echinoid sea urchins with distributions along the continental shelf and slope of the eastern Pacific often dominate the megafauna community. This occurs despite their exposure to naturally low dissolved oxygen (DO) waters (< 60 µmol kg^{-1}) associated with the Oxygen Limited Zone and low-pH waters undersaturated with respect to calcium carbonate (Ω_{CaCO3}<1). Here we present vertical depth distribution and density analyses of historical otter trawl data collected in the Southern California Bight (SCB) from 1994 to 2013 to address the question: Do changes in echinoid density and species' depth distributions along the continental margin in the SCB reflect observed secular or interannual changes in climate? Deepdwelling burrowing urchins (*Brissopsis* pacifica, *Brisaster* spp. and *Spatangus californicus*), which are adapted to low-DO, low-pH conditions appeared to have expanded their vertical distributions and populations upslope over the past decade (2003-2013), and densities of the deep pink urchin, *Strongylocentrotus fragilis*, increased significantly in the upper 500 m of the SCB. Conversely, the shallower urchin, *Lytechinus pictus*, exhibited depth shoaling and density decreases within the upper 200 m of the SCB from 1994 to 2013. Oxygen and pH in the SCB also vary inter-annually due to varying strengths of the El Niño Southern Oscillation (ENSO). Changes in depth distributions and densities were correlated with bi-monthly ENSO climate indices in the region. Our results suggest that both a secular trend in ocean deoxygenation and acidification and varying strength of ENSO may be linked to echinoid species distributions and densities, creating habitat compression in some and habitat expansion in others. Potential life-history mechanisms underlying depth and density changes observed over these time periods include migration, mortality, and recruitment. These types of analyses are needed for a broad suite of benthic species in order to identify and manage climate-sensitive species on the margin.

Citation

Sato, K.N., L.A. Levin, K. Schiff. 2016. Habitat compression and expansion of sea urchins in response to changing climate conditions on the California continental shelf and slope (1994-2013). *Deep-Sea Research II* DOI: 10.1016/j.dsr2.2016.08.012.

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Water quality criteria for an acidifying ocean: Challenges and opportunities for improvement

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Abstract

Acidification has sparked discussion about whether regulatory agencies should place coastal waters on the CleanWater Act 303(d) impaired water bodies list. Here we describe scientific challenges in assessing impairment with existing data, exploring use of both pH and biological criteria. Application of pH criteria is challenging because present coastal pH levels fall within the allowable criteria range, but the existing criteria allow for pH levels that are known to cause extensive biological damage. Moreover, some states express their water quality criteria as change from natural conditions, but the spatio-temporal distribution and quality of existing coastal pH data are insufficient to define natural condition. Biological criteria require that waters be of sufficient quality to support resident biological communities and are relevant because a number of biological communities have declined over the last several decades. However, the scientific challenge is differentiating those declines from natural population cycles and positively associating them with acidification-related water quality stress. We present two case studies, one for pteropods and one for oysters, which illustrate the opportunities, challenges and uncertainties associated with implementing biological criteria. The biggest challenge associated with these biological assessments is lack of co-location between long-term biological and chemical monitoring, which inhibits the ability to connect biological response with an acidification stressor. Developing new, ecologically relevant water quality criteria for acidification and augmenting coastal water monitoring at spatiotemporal scales appropriate to those criteria would enhance opportunities for effective use of water quality regulations.

Citation

Weisberg, S.B., N. Bednarsek, R.A. Feely, F. Chan, T.S. Fleming, A.B. Boehm, M. Sutula, J.L. Ruesink, B. Hales, J.L. Largier, and J.A. Newton. 2016. Water quality criteria for an acidifying ocean: Challenges and opportunities for improvement. *Ocean and Coastal Management* 126:31–41.

SCCWRP Journal Article #0924
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Intermittent estuaries: Linking hydro-geomorphic context to climate change resilience

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ABSTRACT

Intermittent estuaries are temporarily open to exchange with the open ocean, and the influence of their entrance opening regime on hydrological and ecological function has received considerable attention. Here we consider the influence of tectonic, climatic and geomorphic controls on the distribution of estuarine habitats by contrasting two settings: the south coasts of New South Wales, Australia, and California USA. The combination of tectonic uplift and semi-arid, variable hydrology in southern California provides a stronger sediment yield to estuaries than in the tectonically stable temperate setting of southern Australia. This reflects in a greater proportional area of intertidal vegetation and a higher elevation capital than encountered in SE Australia. The implications for estuary management in the context of sea-level rise and urbanization are discussed.

CITATION

Saintilan, N., K. Rogers, C. Toms, E.D. Stein, and D. Jacobs. 2016. Intermittent Estuaries: Linking Hydro-geomorphic Context to Climate Change Resilience. *Journal of Coastal Research* 75:133-137.

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The West Coast Ocean Acidification and Hypoxia Science Panel: Major findings, recommendations, and actions

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CITATION

Boehm, A., F. Chan, J. Barth, E. Chornesky, A. Dickson, R. Feely, B. Hales, T. Hill, G. Hofmann, D. Ianson, T. Klinger, J. Largier, J. Newton, T. Pedersen, G. Somero, M. Sutula, W. Wakefield, G. Waldbusser, S. Weisberg, E. Whiteman. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust. Oakland, CA.

SCCWRP Technical Report #0926
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/926_WestCoastOAHSciencePanel.pdf

Ocean acidification: Setting water quality goals

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CITATION

Aminzadeh, S., M. Armsby, N. Bednarsek, J. Bishop, A. Boehm, C. Braby, F. Chan, R. Dunbar, R. Feely, B. Gaylord, L. Jewett, C. Krembs, K. Kroeker, R. Labiosa, T. Maloney, J. Phillips, B. Rappoli, M. Sakashita, D. Sivas, G. Somero, M. Sutula, D. Thomas, G. Waldbusser, S. Weisberg. 2016. Ocean Acidification: Setting Water Quality Goals. Stanford University. Stanford, CA.

SCCWRP Technical Report #0961
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/961_OceanAcidificationSettingWaterQualityGoals.pdf

Health framework evaluates sediment contaminants' impacts

SCCWRP and its partners have completed development of an assessment framework for evaluating how sediment contamination affects the health of humans who consume fish caught in enclosed bays and estuaries.

The sediment quality human health framework uses contamination data obtained through fish tissue sampling to estimate the level of chemical exposure to humans as a result of eating fish from enclosed bays and estuaries. A bioaccumulation model that explains how contaminants travel through food webs is used to estimate what role sediment contamination played in contaminating the fish.

The draft framework, submitted in early 2017 for consideration by the State Water Board, is the second sediment quality assessment framework co-developed by SCCWRP for enclosed bays and estuaries. The State Water Board adopted the first assessment framework, which focuses on the protection of sediment-dwelling aquatic life, in 2009.

The human health framework consists of a tiered assessment process for analyzing fish contamination data that becomes progressively more complex and costly to execute. At the end of the analysis, each site is classified into a final condition category, ranging from "unimpacted" to "clearly impacted."

Researchers have developed an assessment framework to evaluate how sediment contamination affects the health of humans who eat fish caught in California emabayments, including San Diego Bay, above.

Given the framework's intended applicability across the state, the framework was designed to accommodate data from a variety of fish species, as well as features a decision support tool to simplify data analysis by a wide range of users.

This framework is being considered for formal adoption in 2017.

Bioaccumulation study informs health risks from contaminated sediment

SCCWRP and its partners have completed a comprehensive investigation into how sediment contamination is transferred through Southern California marine food webs, enabling scientists to close key data gaps and build more accurate models for estimating health risks to wildlife and humans across coastal California.

The three-year study, completed in fall 2016, was conducted in San Diego Bay. It already has been used to refine a standardized sediment assessment framework under development for California's coastal embayments that focuses on how sediment contamination affects human health.

The study involved linking contaminants found in San Diego Bay sediment – including PCBs, pesticides and trace metals – to the contaminants that were found to be bioaccumulating in organisms throughout the marine food web, from sediment-dwelling organisms to seabirds.

San Diego Bay environmental managers can use the study's findings to inform more effective, targeted actions as they continue to improve the bay's sediment quality.

Marina del Rey sediment study demonstrates stressor identification methods

SCCWRP and its partners have completed a stressor identification study in Marina del Rey Harbor to shed insights into why bottom-dwelling marine communities are showing evidence of adverse health impacts.

The toxicity identification evaluation (TIE) study, conducted as part of the harbor's toxics TMDL (total maximum daily load), marked the first formal demonstration of the stressor identification process required under the state's water quality control plan for sediment quality, and one of the first attempts to characterize the cause of impacts to bottom-dwelling marine communities.

Researchers sampled sediment in the Los Angeles County boat harbor in winter and summer 2016, then explored whether a number of toxic chemicals – including trace metals, PAHs and chlorinated hydrocarbons – could be responsible for degraded sediment quality. Marina del Rey Harbor has a TMDL (total maximum daily load) for these toxics.

Researchers ruled out all of the toxics listed in the TMDL as possible causes of sediment toxicity, and theorized that other types of toxic chemicals that enter Marina del Rey Harbor via stormwater runoff could be responsible for the toxicity observed during the lab tests.

A field crew collects sediment samples from Marina del Rey Harbor for a stressor identification study focused on the boat harbor's sediment quality.

Trophic transfer and effects of DDT in male hornyhead turbot (Pleuronichthys verticalis) from Palos Verdes Superfund site, CA (USA) and comparisons to field monitoring

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[3]*Southern California Coastal Water Research Project, Costa Mesa, CA*

ABSTRACT

High concentrations of DDT and metabolites (ΣDDT) have been detected in sediment and the demersal flatfish hornyhead turbot (*Pleuronichtys verticalis*) collected from Palos Verdes (PV), California, USA, a site contaminated with over 100 metric tons of DDT throughout 1960–70s. This study was conducted to assess the transfer of ΣDDT from PV-sediment into polychaetes (*Neanthes arenaceodentata*) and hornyhead turbot, and to investigate if the responses in turbots from two different laboratory exposures mimic those in turbots caught in PV (PV-turbot). Turbot fed PV-sediment-contaminated polychaete for 7 days had liver concentrations of ΣDDT similar to PV-turbot. After 28 days, ΣDDT also accumulated in livers of turbot gavaged with a ΣDDT mixture. *In vitro* cell bioassays indicated significant increases of 17bestradiol equivalents (EEQ) in turbot bile extracts as compared to the control in the 7-day study. These responses corresponded to those measured in PV-fish. Glucocorticoid receptor (GR), anti-androgen receptor (anti-AR), estrogen receptor (ER) or aryl hydrocarbon receptor (AhR) activities were also observed in extracts of PV-sediment, and PV-sediment-exposed worm. Anti-AR, AhR and GR activities were significantly higher in PV-sediment than reference sediment (San Diego, SD). Higher transcripts of hepatic VTG, ERα and ERβ were found in PV-turbot than SD-turbot, but were unaltered in fish exposed to sediment-contaminated worms for the 7-day study. In contrast, liver extracts from the 28-day treatment of ΣDDT showed lower EEQ but similar hepatic VTG and ERβ transcripts relative to those of PV-turbot. These data indicated that trophic transfer of sediment-associated DDT in 7-day exposures corresponded to field measurements of DDT residues and *in vitro* ER bioactivities, but failed to mimic *in vivo* biological effects observed in field fish. In contrast, treatment with ΣDDT alone for 28 days mimicked *in vivo* biological effects of DDTs in PV fish, but did not correspond to liver concentrations or *in vitro* bioactivities.

CITATION

Crago, J., E.G. Xu, A. Kupsco, F. Jia, A.C. Mehinto, W. Lao, K.A. Maruya, J. Gan, D. Schenk. 2016. Trophic transfer and effects of DDT in male hornyhead turbot (Pleuronichthys verticalis) from Palos Verdes Superfund site, CA (USA) and comparisons to field monitoring. *Environmental Pollution* 213:940-948.

SCCWRP Journal Article #0923
Full text available by request: pubrequest@sccwrp.org

Water resources: Toxic TMDLs

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ABSTRACT

The Clean Water Act (CWA) requires that each state "shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality objective applicable to such waters." The CWA also requires states to establish a priority ranking and TMDLs (Total Maximum Daily Loads) for these impaired waters. Multiple water bodies within Santa Monica Bay and its watershed are listed as impaired due to various constituents such as trash, bacteria, nutrients, and toxic pollutants in water or sediment. Recent monitoring data and analyses have been conducted that provide an update on the impacts from toxics on Santa Monica Bay seafood contamination and aquatic life. As a result of this information, TMDLs for toxics and metals in sediment and/or water have been established or updated for four water bodies: Santa Monica Bay (offshore), Ballona Creek, Ballona Creek Estuary, and Marina del Rey Harbor. These activities provide an opportunity to evaluate the current impact from toxics and assess recent progress towards improving water and sediment quality.

CITATION

Bay, S. 2015. Water Resources: Toxics TMDLs. *Urban Coast* 5(1): 22- 28.

SCCWRP Journal Article #0905
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/905_ToxicsTMDLs.pdf

Habitat conditions: Soft-bottom benthos

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[3]*Sanitation Districts of Los Angeles County, Whittier, CA*

ABSTRACT

Soft sediments composed of sand, silt, and clay make up the majority of the bottom habitat in the Bay. These are found throughout the Bay, with exceptions in the deep-water canyon off Point Dume; on Short Bank in the middle of the Bay; on the shelf off Rocky Point; and along the coast from the county line to Lechuza Point, from Point Dume to Malibu Point, and off the Palos Verdes Peninsula. Soft sediments provide both shelter and foraging grounds for thousands of benthic invertebrate species, ranging from tiny worms, shrimps, and crabs to sea stars, clams, and sea slugs. These bottom organisms are near the base of the food web that supports an abundant and diverse assemblage of bottom-dwelling fishes. Soft-bottom fish found in the Bay include flatfishes, rockfishes, sculpins, combfishes, and eelpouts. Some of these fish, such as California halibut (*Paralichthys californicus*), California scorpionfish (*Scorpaena guttata*), barred sand bass (*Paralabrax nebulifer*), and white croaker (*Genyonemus lineatus*), also account for a significant percentage of

recreational fish catches from piers and boats. Soft sediments are also a major reservoir of chemical contaminants in the Bay. Many chemical contaminants bind to organic material on sediment particles, where they can accumulate to high levels and provide an ongoing source of exposure to marine life. Chemical contaminants have been introduced to this habitat primarily through historical wastewater discharges at outfalls offshore from Hyperion Treatment Plant (Hyperion) near Los Angeles International Airport and the Joint Water Pollution Control Plant (JWPCP) near White Point on the Palos Verdes Peninsula. Other significant contributors are dry and wet weather runoff from rivers and creeks and industrial discharges to the Bay.

CITATION

Bay, S., M. Dojiri, and J. Gully. 2015. Habitat Conditions: Soft-Bottom Benthos. *Urban Coast* 5(1): 108-115.

SCCWRP Journal Article #0909
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/909_Soft-BottomBenthos.pdf

Assessment of bioaccumulation in San Diego Bay

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CITATION

Bay, S.M., D.J. Greenstein, A.N. Parks, C.Q.T. Zeeman. 2016. Assessment of bioaccumulation in San Diego Bay. Technical Report 953. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0953
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/953_SDBay_Bioaccum.pdf

Bioassays show potential to screen fish for CEC exposure

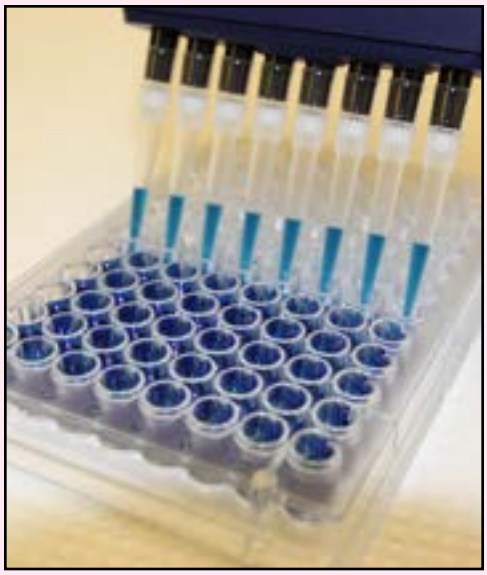
SCCWRP and its partners at the University of Florida have obtained preliminary evidence that biological assays built with engineered cell lines could be effective at screening for potential biological changes in fish exposed to estrogen-mimicking chemicals.

The proof-of-concept finding, obtained in spring 2016, found that there is a strong correlation between the way that engineered human cells respond to increasing levels of estrogenic chemical contaminants, and the way that inland silverside fish experience increasingly severe biological effects when exposed to this contamination.

The seminal study – the first of its kind in a coastal marine environment – offers early evidence that commercially available cell bioassays could be a viable technology for screening receiving waters for potentially harmful levels of CECs.

Traditional screening methods, such as targeted chemical analysis and whole-organism toxicity testing, tend to be more labor-intensive, costly and unable to detect all chemicals of concern.

SCCWRP and its partners are continuing to study the cell bioassay for estrogens, as well as replicate the study for a class of steroidal anti-inflammatory drugs called glucocorticoids.



Preliminary evidence indicates that using commercially available cell bioassays to screen receiving waters for CECs is an effective way to detect potential biological changes in fish.

Early results promising in evaluation of CEC monitoring framework

SCCWRP and its partners have completed the first year of a series of pilot studies being conducted across California to evaluate the utility of a new, multi-tiered framework for screening aquatic systems for CECs.

Initial data from the pilot studies indicate that cell bioassays – the first tier of the CEC screening framework – are working as they should. Researchers were able to identify water samples that should be advanced to nontargeted chemical analysis, which is part of the second screening tier.

The pilot studies, which run from 2015 to 2018, are being conducted in partnership with the Los Angeles Regional Water Quality Control Board, Southern California Stormwater Monitoring Coalition and North Coast Regional Water Quality Control Board in Santa Rosa.

The California CEC monitoring framework, co-developed by SCCWRP, is an adaptive management strategy for detecting and evaluating the risks of CECs in aquatic systems statewide. Each tier is progressively more complex, lengthy and costly to execute, giving water-quality managers an efficient, cost-effective way to zero in on the CECs that pose the greatest potential health risks to humans and ecosystems.

A SCCWRP crew collects water samples from the San Gabriel River Watershed near a wastewater treatment plant. Researchers want to know whether cell bioassays are effective at screening waterways for the presence of CECs.

Promising passive sampler developed to detect fipronil in receiving waters

SCCWRP and its partners have identified a promising, cost-effective passive sampling method for detecting the ubiquitous pesticide fipronil in receiving waters, the first breakthrough of its kind for a high-priority CEC.

The passive sampling method, described in a journal article published in 2016, was created by modifying a type of thin polymer film called polymethylmethacrylate (PMMA) to preferentially sorb fipronil and its degradation products. PMMA is commonly known as Plexiglas.

Fipronil and its degradation products are toxic to aquatic life at exceedingly low levels, making it a priority to develop an inexpensive, rapid fipronil monitoring method.

Fipronil is a pesticide used for flea control on domestic pets.

Passive sampling devices concentrate chemical contaminants from water and sediment samples, capturing "bioavailable" forms of CECs that could be harmful to aquatic life.

Newly identified DDT-related compounds accumulating in Southern California bottlenose dolphins

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[6]*Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, CA*

Abstract

Nontargeted GC×GC-TOF/MS analysis of blubber from 8 common bottlenose dolphins (*Tursiops truncatus*) inhabiting the Southern California Bight was performed to identify novel, bioaccumulative DDT-related compounds and to determine their abundance relative to the commonly studied DDT-related compounds. We identified 45 bioaccumulative DDT-related compounds of which the majority (80%) is not typically monitored in environmental media. Identified compounds include transformation products, technical mixture impurities such as tris(chlorophenyl)methane (TCPM), the presumed TCPM metabolite tris(chlorophenyl)- methanol (TCPMOH), and structurally related compounds with unknown sources, such as hexa- to octachlorinated diphenylethene. To investigate impurities in pesticide mixtures as possible sources of these compounds, we analyzed technical DDT, the primary source of historical contamination in the region, and technical Dicofol, a current use pesticide that contains DDT-related compounds. The technical mixtures contained only 33% of the compounds identified in the blubber, suggesting that transformation products contribute to the majority of the load of DDT-related contaminants in these sentinels of ocean health. Quantitative analysis revealed that TCPM was the second most abundant compound class detected in the blubber, following DDE, and TCPMOH loads were greater than DDT. QSPR estimates verified 4,4′,4″-TCPM and 4,4′4,″-TCPMOH are persistent and bioaccumulative.

Citation

Mackintosh, Susan A., N.G. Dodder, N.J. Shaul, L.I. Aluwihare, K.A. Maruya, S.J. Chivers, K. Danil, D.W. Weller, E. Hoh. 2016. Newly identified DDT-related compounds accumulating in Southern California Bottlenose Dolphins. *Environmental Science and Technology* doi: 10.1021/acs.est.6b03150.

SCCWRP Journal Article #0954
Full text available by request: pubrequest@sccwrp.org

A comprehensive non-targeted screening of halogenated organic compounds in dolphins from Brazil

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[2]*Aquatic Mammal and Bioindicator Laboratory, School of Oceanography, Rio de Janeiro State University, Rio de Janeiro, Brazil*
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Abstract

Typical environmental monitoring for persistent organic pollutants (POPs) reveals contamination by chemicals that are known in advance (e.g., PCBs, DDTs, chlordanes, PBDEs that are "routinely monitored"), but excludes new and unknown compounds that can bioaccumulate. The lack of knowledge about compounds that exist in the environment and which are not included in monitoring studies includes a range of halogenated organic compounds (HOCs) that may cause potential impacts on human health and wildlife. For many POPs, the original compound no longer plays the dominant role in the environment and their transformation products can become as or even more problematic. Naturally-produced can also bioaccumulate, as is found in cetaceans where they have been reported at similar and/or in some cases higher tissue concentrations compared to POPs targeted in monitoring. Cetaceans have long been used as sentinel species for assessment of contamination by POPs. The bottlenose dolphin (*Tursiops truncatus*) is a cosmopolitan species, distributed worldwide and has site fidelity in coastal regions. Due to its life history and presence in waters near densely populated areas, it is an excellent sentinel for the study of oceans and human health. A number of recent studies have suggested endocrine disruption, neurotoxicity, immunosuppression and reproductive toxicity associated with HOCs in mammals. The aim of this study was to identify and catalog bioaccumulative HOCs (both anthropogenic and natural) in *T. truncatus* stranded or incidentally caught along the Brazilian coast using a non-targeted analytical approach.

Citation

Alonso, M.B., J. Lailson-Brito, A. Azevedo, E. Santos-Neto, J.P.M. Torres, O. Malm, E. Hoh, N. Dodder, K. Maruya. 2015. A comprehensive non-targeted screening of halogenated organic compounds in dolphins from Brazil. *Organohalogen Compounds* 77:337-340.

SCCWRP Journal Article #0903
Full text available by request: pubrequest@sccwrp.org

Multi-media screening of contaminants of emerging concern (CECs) in coastal urban watersheds in southern California (USA)

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ABSTRACT

To examine the occurrence and fate of contaminants of emerging concern (CECs) and inform future monitoring of CECs in coastal urban waterways, water, sediment and fish tissue samples were collected and analyzed for a broad suite of pharmaceuticals and personal care products (PPCPs), commercial/household chemicals, current use pesticides and hormones in an effluent-dominated river and multiple embayments in southern California (USA). In the Santa Clara River (SCR), which receives treated wastewater from several facilities, aqueous phase CECs were detectable at stations nearest discharges from municipal wastewater treatment plants but were attenuated downstream. Sucralose and the chlorinated phosphate flame-retardants TCPP, TDCPP and TCEP were most abundant in water, with maximum concentrations of 35, 3.3, 1.4 and 0.81 ug/L, respectively. Triclocarban, an antimicrobial agent in use for decades, was more prevalent in water than triclosan or nonylphenol. Maximum concentrations of bifenthrin, permethrin, polybrominated diphenyl ethers (PBDEs) and degradates of fipronil exceeded CEC-specific monitoring trigger levels (MTLs) recently established for freshwater and estuarine sediments by factors of 10 to 1000, respectively. Maximum fish tissue concentrations of PBDEs varied widely (370 and 7.0 ng/g for the SCR and coastal embayments, respectively), with most species exhibiting concentrations at the lower end of this range. These results suggest that continued monitoring of pyrethroids, PBDEs and degradates of fipronil in sediment, is warranted in these systems. In contrast, aqueous pharmaceutical concentrations in the SCR were not close to exceeding current MTLs, suggesting a lower priority for targeted monitoring in this medium.

CITATION

Maruya, K.A., N.G. Dodder, A. Sengupta, D.J. Smith, J.M. Lyons, A.T. Heil, J.E. Drewes. Multi-media screening of contaminants of emerging concern (CECs) in coastal urban watersheds in southern California. *Environmental Toxicology and Chemistry* DOI 10.1002/etc.3348.

SCCWRP Journal Article #0902
Full text available by request: pubrequest@sccwrp.org

Screening for endocrine activity in water using commercially-available *in vitro* transactivation bioassays

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ABSTRACT

In vitro transactivation bioassays have shown promise as water quality monitoring tools, however their adoption and widespread application has been hindered partly due to a lack of standardized methods and availability of robust, user-friendly technology. In this study, commercially available, division-arrested cell lines were employed to quantitatively screen for endocrine activity of chemicals present in water samples of interest to environmental quality professionals. A single, standardized protocol that included comprehensive quality assurance/quality control (QA/QC) checks was developed for Estrogen and Glucocorticoid Receptor activity (ER and GR, respectively) using a cell-based Fluorescence Resonance Energy Transfer (FRET) assay. Samples of treated municipal wastewater effluent and surface water from freshwater systems in California (USA), were extracted using solid phase extraction and analyzed for endocrine activity using the standardized protocol. Background and dose-response for endpoint-specific reference chemicals met QA/QC guidelines deemed necessary for reliable measurement. The bioassay screening response for surface water samples was largely not detectable. In contrast, effluent samples from secondary treatment plants had the highest measurable activity, with estimated bioassay equivalent concentrations (BEQs) up to 392 ng dexamethasone/L for GR and 17 ng 17β-estradiol/L for ER. The bioassay response for a tertiary effluent sample was lower than that measured for secondary effluents, indicating a lower residual of endocrine active chemicals after advanced treatment. This protocol showed that *in vitro* transactivation bioassays that utilize commercially available, division-arrested cell "kits", can be adapted to screen for endocrine activity in water.

CITATION

Mehinto, A.C., B.S. Jayasinghe, D.R. Vandervort, N.D. Denslow, K.A. Maruya. 2016. Screening for endocrine activity in water using commercially available *in vitro* transactivation bioassays. *Journal of Visualized Experiments* DOI: 10.3791/54725.

SCCWRP Journal Article #0955
Full text available by request: pubrequest@sccwrp.org

Bioanalytical approaches in assessing transformation products

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[3]*Griffith School of Environment, Griffith University, Queensland, Australia*

Abstract

Transformation products (TPs), including disinfection byproducts (DBPs) produced from halogenenation of natural organic substances found in water, have been identified in disinfected waters at varying concentrations, depending on the source of the water. Normally for drinking water, the concentrations are very low, in the parts per trillion, but concentrations can be much higher in sewage treated waters. Methods for detecting these chemicals have improved over the past decade, but analytical chemistry methods generally lack the ability to detect new TPs and would work best if partnered with bioanalytical methods to evaluate genetoxicity, cytotoxicity and specific modes of action. The process of disinfection also destroys bioactivec chemicals which can also be followed through analytical through bioanalytical assays. Bioanalytical tools are beginning to be used to monitor and assess production of bioactive products in water quality.

Citation

Denslow, N.D., K.A. Maruya, F.D.L. Leusch. 2016. Bioanalytical approaches in assessing transformation products. pp. 73-87 in: J.E. Drewes, T. Letzel (eds.), *Assessing Transformation Products of Chemical by Non-Target and Suspect Screening – Strategies and Workflows Volume 2*. American Chemical Society. Washington, DC.

SCCWRP Journal Article #0957
Full text available by request: pubrequest@sccwrp.org

Antibiotics as CECs: An overview of the hazards posed by antibiotics and antibiotic resistance

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Abstract

Monitoring programs have traditionally monitored legacy contaminants but are shifting focus to Contaminants of Emerging Concern (CECs). CECs present many challenges for monitoring and assessment, because measurement methods don't always exist nor have toxicological studies been fully conducted to place results in proper context. Also some CECs affect metabolic pathways to produce adverse outcomes that are not assessed through traditional toxicological evaluations. Antibiotics are CECs that pose significant environmental risks including development of both toxic effects at high doses and antibiotic resistance at doses well below the Minimum Inhibitory Concentration (MIC) which kill bacteria and have been found in nearly half of all sites monitored in the US. Antimicrobial resistance has generally been attributed to the use of antibiotics in medicine for humans and livestock as well as aquaculture operations. The objective of this study was to assess the extent and magnitude of antibodies in the environment and estimate their potential hazards in the environment. Antibiotics concentrations were measured in a number of monitoring studies which included Waste Water Treatment Plants (WWTP) effluent, surface waters, sediments, and biota. A number of studies reported levels of Antibiotic Resistant Microbes (ARM) in surface waters and some studies found specific ARM genes (e.g., the bla_{M-1} gene) in *E. coli* which may pose additional environmental risk. High levels of this gene were found to survive WWTP disinfection and accumulated in sediment at levels 100-1000 times higher than in the sewerage effluent, posing potential risks for gene transfer to other bacteria in aquatic and marine ecosystems. Antibiotic risk assessment approaches were developed based on the use of MICs and MIC Ratios [High (Antibiotic Resistant)/ Low (Antibiotic Sensitive) MIC] for each antibiotic indicating the range of bacterial adaptability to each antibiotic to help define the No Observable Effect Concentration (NOEC) for each antibiotic which were compared to maximum Measured Exposure Concentrations (MEC) in the environment to predict individual environmental risks. Four antibiotics had high MEC/ NOEC and high MIC ratios and were identified as higher risks for concern based upon this approach, but on Triclosan had MEC/NOEC ratios > 1 and was recommended for monitoring in future studies.

Citation

Scott, G.I., D.E. Porter, G.T. Chandler, S. Norman, C.H. Scott, M. Uyaguari, K. Maruya, S.B. Weisberg, M.H. Fulton, E.F. Wirth, J. Moore, P.L. Pennington, D. Schlenk, N.D. Denslow, and G. Cobb. 2016. Antibiotics as CECs: An overview of the hazards posed by antibiotics and antibiotic resistance. *Frontiers in Marine Science* 3:24, DOI: 10.3389/fmars.2016.00024.

SCCWRP Journal Article #0939
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/939_OverviewOfHazardsPosedByAntibiotics.pdf

A new film-based passive sampler for moderately hydrophobic organic compounds

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ABSTRACT

Passive samplers for moderately hydrophobic organic compounds (MHOCs) (i.e., log K_{ow} ranging from 2 to 5) are under-developed compared to those that target polar or strongly hydrophobic compounds. The goal of this study was to identify a suitable polymer and develop a robust and sensitive film-based passive sampler for MHOCs in aquatic systems. Poly(methyl methacrylate) (PMMA) exhibited the highest affinity for fipronil and its three metabolites (i.e., fipronils) (log K_{ow} 2.4−4.8) as model MHOCs compared with polyethylene and nylon films. In addition, a 30−60 min treatment of PMMA in ethyl ether was found to increase its sorption capacity by a factor of 10. Fipronils and 108 additional compounds (log K_{ow} 2.4−8.5) reached equilibrium on solvent-treated PMMA within 120 h under mixing conditions and their uptake closely followed first-order kinetics. PMMA-water partition coefficients and K_{ow} revealed an inverse parabolic relationship, with vertex at log K_{ow} of 4.21 ± 0.19, suggesting that PMMA was ideal for MHOCs. The PMMA sampler was tested in an urban surface stream, and in spiked sediment. The results demonstrated that PMMA film, after a simple solvent swelling treatment, may be used as an effective passive sampler for determining C_{free} of MHOCs in aquatic environments.

CITATION

Lao, W., Y. Hong, D. Tsukada, K.A. Maruya, J. Gan. 2016. A new film-based passive sampler for moderately hydrophobic organic compounds. *Environmental Science and Technology* 50:13470-13476.

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Water resources: Contaminants of emerging concerns

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ABSTRACT

Contaminants of emerging concern (CECs) encompass a vast number of compounds that are largely unregulated in the U.S. and abroad, and have limited or no monitoring data available for environmental media (e.g., air, water, sediment, and biota). A wide variety of pharmaceuticals, flame retardants, contemporary use pesticides, and even food additives are considered CECs. Many of these compounds have likely been present in aquatic ecosystems for decades, but were not previously detectable using available chemical methods. However, recent advances in analysis have allowed for the detection of many CECs in coastal habitats around the world. Previous studies of CEC occurrence and fate in Santa Monica Bay and other coastal areas, summarized in the 2010 State of the Bay Report, identified the widespread occurrence of some CECs and the potential for exposure of coastal fish and manifestation of adverse effects. However, these studies also identified many knowledge gaps that limit our ability to make decisions on managing CECs that are based on sound science. In the last 5 years, steps have been taken by California agencies to fill these knowledge gaps and develop new strategies for CEC management and regulation. Several recent regional and statewide studies have been conducted that add significantly to our understanding of CEC contamination in southern California and suggest directions for future management efforts. The 2008 Southern California Bight Regional Monitoring Program analyzed sediments from bays and estuaries for polybrominated diphenyl ether (PBDE) flame retardants and pyrethroid pesticides. In 2009-10, the Mussel Watch California Pilot Study was conducted to determine the extent and magnitude of more than 150 CECs in mussels (*Mytilus* spp.), low trophic level sentinels for contaminant exposure, at 68 sites along the California coast. Water column concentrations of CECs were also measured at selected sites using passive sampling technology. The Stormwater Monitoring Coalition (SMC) has also conducted chemical analyses of water from perennial streams in southern California coastal watersheds.

CITATION

Bay, S., R. Hoenicke, and K. Maruya. 2015. Water Resources: Contaminants of Emerging Concern. *Urban Coast* 5(1): 35- 40.

SCCWRP Journal Article #0907
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/907_ContaminantsofEmergingConcern.pdf

Effects of a pesticide and a parasite on neurological, endocrine, and behavioral responses of an estuarine fish

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ABSTRACT

In coastal waters, pesticides and parasites are widespread stressors that may separately and interactively affect the physiology, behavior, and survival of resident organisms. We investigated the effects of the organophosphate pesticide chlorpyrifos and the trematode parasite *Euhaplorchis californiensis* on three important traits of California killifish (*Fundulus parvipinnis*): neurotransmitter activity, release of the

stress hormone cortisol, and behavior. Killifish were collected from a population without *E. californiensis*, and then half of the fish were experimentally infected. Following a 30 day period for parasite maturation, infected and uninfected groups were exposed to four concentrations of chlorpyrifos (solvent control, 1–3 ppb) prior to behavior trials to quantify activity, feeding behavior, and anti-predator responses. Water-borne cortisol release rates were measured non-invasively from each fish prior to infection, one-month post-infection, and following pesticide exposure. Killifish exposed to 3 ppb Chlorpyrifos exhibited a 74.6 ± 6.8% and 60.5 ± 8.3% reduction in brain and muscle acetylcholinesterase (AChE) activity relative to controls. The rate of cortisol release was suppressed by each chlorpyrifos level relative to controls. Killifish exposed to the medium (2 ppb) and high (3 ppb) pesticide concentrations exhibited reduced activity and a decrease in mean swimming speed following a simulated predator attack. Muscle AChE was positively related to swimming activity while brain AChE was positively related to foraging behavior. No effects of the parasite were observed, possibly because of low metacercariae densities achieved through controlled infections. We found that sublethal pesticide exposure has the potential to modify several organismal endpoints with consequences for reduced fitness, including neurological, endocrine, and behavioral responses in an ecologically abundant fish.

CITATION

Compton Renick, V., K. Weinersmith, D.E. Vidal-Dorsch, T.W. Anderson. 2015. Effects of a pesticide and a parasite on neurological, endocrine, and behavioral responses of an estuarine fish. *Aquatic Toxicology* http://dx.doi.org/10.1016/j.aquatox.2015.0 9.010.

SCCWRP Journal Article #0894
Full text available by request: pubrequest@sccwrp.org

Surfer rainfall study helps focus water-quality discussion

SCCWRP and its partners in 2016 published a three-year epidemiological study examining the health impacts of entering coastal waters during and shortly after rainfall, a study that has raised important public policy questions about whether existing water-quality standards are over-protective of beachgoer health during wet weather.

The Surfer Health Study, which tracked the illness rates of 654 San Diego-area surfers during the rainy winter season, found that surfers experienced increased rates of gastrointestinal illness and other symptoms when they surfed during rain events and/or in the three days that followed.

However, when the illness data were correlated with quantitative measurements of aquatic microbial contamination at two popular San Diego surfing spots, the rate at which surfers contracted gastrointestinal illness was lower than the illness rate predicted under federal guidelines. The guidelines, issued in 2012, predict the relationship between gastrointestinal illness rates and corresponding microbial contamination levels; they were developed using data from beaches known to be impacted by treated wastewater effluent.

Rainfall makes Southern California's coastal zone particularly susceptible to waterborne contamination, as the pathogens that can make people sick wash off the land and travel through storm drains to the beach.

Surfers paddle away from shore at Ocean Beach in San Diego. Researchers have documented the health risks associated with entering coastal waters during and shortly after rainfall events.

During the study, surfer volunteers were asked to use a smartphone app to confidentially report daily surfing activities and symptoms of illness.

Water-quality managers are now tasked with determining whether additional clean-up actions are needed at the San Diego beaches to lower the illness risk.

EPA health risk model applied to L.A. County beach with high microbe levels

SCCWRP has launched a first-of-its-kind study aimed at ascertaining whether high fecal indicator bacterial levels at Inner Cabrillo Beach in the Los Angeles Harbor area are indicative of a health threat to beachgoers who enter the water.

The study, launched in spring 2016, involves using a health risk model known as Quantitative Microbial Risk Assessment (QMRA), which was recently endorsed by the U.S. Environmental Protection Agency to quantify the risk of gastrointestinal illness from waterborne contamination at the beach.

Inner Cabrillo Beach is a popular swimming area that receives about half a million beachgoers annually. For the past 15 years, beach water-quality managers have worked without success to reduce the concentration of a type of fecal indicator bacteria called Enterococcus, which is periodically found at levels that exceed water-quality guidelines.

Pair of tools developed to aid in interpreting beach microbial contamination signals

SCCWRP and its partners have developed two mathematical predictive tools designed to improve beach water-quality managers' ability to accurately interpret microbial contamination signals detected during routine beach monitoring.

The three-year study, completed in summer 2016, investigated whether mathematical models could be developed to predict how much fecal contamination in a water sample is coming from a human source vs. nonhuman animal sources. Human sources of fecal contamination are much more likely to contain the pathogens that make people sick.

However, because water-quality managers measure indicator microbes instead of pathogens themselves, researchers first needed to measure the degradation rates of the pathogens in relation to the degradation rates of a variety of indicator microbes that serve as proxies for specific animal and human sources of contamination.

Managers can use the tools as they investigate sources of microbial contamination, prioritize remediation efforts and consider which beaches may be eligible for site-specific water-quality objectives.

Sealed bags of raw sewage are placed in a marsh to measure degradation rates of the microbes inside. The data were used to develop new contamination detection tools.

Acute gastroenteritis and recreational water: Highest burden among young US children

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Abstract

Objectives: To provide summary estimates of gastroenteritis risks and illness burden associated with recreational water exposure and determine whether children have higher risks and burden.

Methods: We combined individual participant data from 13 prospective cohorts at marine and freshwater beaches throughout the United States (n = 84 411). We measured incident outcomes within 10 days of exposure: diarrhea, gastrointestinal illness, missed daily activity (work, school, vacation), and medical visits. We estimated the relationship between outcomes and 2 exposures: body immersion swimming and Enterococcus spp. fecal indicator bacteria levels in the water. We also estimated the population-attributable risk associated with these exposures.

Results: Water exposure accounted for 21% of diarrhea episodes and 9% of missed daily activities but was unassociated with gastroenteritis leading to medical consultation. Children aged 0 to 4 and 5 to 10 years had the most water exposure, exhibited stronger associations between levels of water quality and illness, and accounted for the largest attributable illness burden.

Conclusions: The higher gastroenteritis risk and associated burden in young children presents important new information to inform future recreational water quality guidelines designed to protect public health

Citation

Arnold, B.F., T.J. Wade, J. Benjamin-Chung, K.C. Schiff, J.F. Griffith, A.P. Dufour, S.B. Weisberg, J.M. Colford, Jr. 2016. Acute gastroenteritis and recreational water: Highest burden among young US children. *American Journal of Public Health* 106:1690–1697.

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Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/937_AcuteGastroenteritisAmongYoungUSChildren.pdf

The next-generation PCR-based quantification method for ambient waters: Digital PCR

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Abstract

Real-time quantitative PCR (qPCR) is increasingly being used for ambient water monitoring, but development of digital polymerase chain reaction (digital PCR) has the potential to further advance the use of molecular techniques in such applications. Digital PCR refines qPCR by partitioning the sample into thousands to millions of miniature reactions that are examined individually for binary endpoint results, with DNA density calculated form the fraction of positives using Poisson statistics. This direct quantification removes the need for standard curves, eliminating the labor and materials associated with creating and running standards with each batch, and removing biases associated with standard variability and mismatching amplification efficiency between standards and samples. Confining reactions and binary endpoint measurements to small partitions also leads to other performance advantages, including reduced susceptibility to inhibition, increased repeatability and reproducibility, and increased capacity to measure multiple targets in one analysis. As such, digital PCR is well suited for ambient water monitoring applications and is particularly advantageous as molecular methods move toward autonomous field application.

Citation

Cao, Y., J.F. Griffith, and S.B. Weisberg. 2016. The next generation PCR-based quantification method for ambient waters: Digital PCR. in: S.J. Bourlat (ed.), Methods in Molecular Biology Series: Marine Genomics. Springer. New York, NY.

SCCWRP Journal Article #0951
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A duplex digital PCR assay for simultaneous quantification of the Enterococcus spp. and the human fecal-associated HF183 marker in waters

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Abstract

This manuscript describes a duplex digital PCR assay (EntHF183 dPCR) for simultaneous quantification of *Enterococcus spp*. and the human fecal-associated HF183 marker. The EntHF183 duplex dPCR (referred as EntHF183 dPCR hereon) assay uses the same primer and probe sequences as its published individual quantitative PCR (qPCR) counterparts. Likewise, the same water filtration and DNA extraction procedures as performed prior to qPCR are followed prior to running dPCR. However, the duplex dPCR assay has several advantages over the qPCR assays. Most important, the dPCR assay eliminates the need for running a standard curve and hence, the associated bias and variability, by direct quantification of its targets. In addition, while duplexing (i.e. simultaneous quantification) *Enterococcus* and HF183 in qPCR often leads to severe underestimation of the less abundant

target in a sample, dPCR provides consistent quantification of both targets, whether quantified individually or simultaneously in the same reaction. The dPCR assay is also able to tolerate PCR inhibitor concentrations that are one to two orders of magnitude higher than those tolerated by qPCR. These advantages make the EntHF183 dPCR assay particularly attractive because it simultaneously provides accurate and repeatable information on both general and human-associated fecal contamination in environmental waters without the need to run two separate qPCR assays. Despite its advantages over qPCR, the upper quantification limit of the dPCR assay with currently available instrumentation is approximately four orders of magnitude lower than that achievable by qPCR. Consequently, dilution is needed for measurement of high concentrations of target organisms such as those typically observed following sewage spills.

CITATION

Cao, Y., M.R. Raith, J.F. Griffith. 2016. A duplex digital PCR assay for simultaneous quantification of the Enterococcus spp. and the human Fecal-associated HF183 marker in waters. *Journal of Visualized Experiments* e53611, doi:10.3791/53611.

SCCWRP Journal Article #0916
Full text available by request: pubrequest@sccwrp.org

Enterococcus growth on eelgrass (Zostera marina); Implications for water quality

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ABSTRACT

Enterococci are fecal indicator bacteria used to monitor fecal pollution of recreational waters. When *enterococci* levels exceed health standards, fecal pollution is assumed as the cause. *Enterococci* growing on plants limit their usefulness as fecal indicator bacteria. Here we examined enterococcal growth on eelgrass in Mission Bay, CA where *enterococci* levels have exceeded water quality thresholds. A total of 69 eelgrass samples were collected from six sites, shaken to remove enterococci attached to plant surfaces and the eluant filtered onto culture media. Isolates were then identified to species using biochemical methods, and DNA typing by pulsed-field gel electrophoresis was done to assess clonality of strains. *Enterococci* concentrations among eelgrass ranged from 8 to 14 000 CFU g^{-1} dry weight. The most predominant enterococcal species found were *Enterococcus casseliflavus* and *E. hirae* followed by *E. faecalis*. Cluster analysis indicated a high level of clonality among isolates across all species, with clonal isolates consistently associated with individual eelgrass samples. Finding high densities of *E. casseliflavus*, *E. hirae* and *E. faecalis* on eelgrass that included clonal strains indicates the capability of enterococcal growth on eelgrass. Amplification of *enterococci* on eelgrass presents challenges for regulatory agencies that interpret elevated levels of these bacteria as an indication of fecal pollution.

CITATION

Ferguson, D.M., S.B. Weisberg, C. Hagedorn, K. De Leon, V. Mofidi, J. Wolfe, M. Zimmerman and J.A. Jay. 2016. Enterococcus growth on eelgrass (*Zostera marina*); Implications for water quality. *FEMS Microbiology Ecology* 92:1-7. doi: 10.1093/femsec/fiw047.

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Virulence genes among Enterococcus faecalis and Enterococcus faecium isolated from coastal beaches and human and nonhuman sources in Southern California and Puerto Rico

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ABSTRACT

Most *Enterococcus faecalis* and *E. faecium* are harmless to humans; however, strains harboring virulence genes, including *esp*, *gelE*, *cylA*, *asa1*, and *hyl*, have been associated with human infections. *E. faecalis* and *E. faecium* are present in beach waters worldwide, yet little is known about their virulence potential. Here, multiplex PCR was used to compare the distribution of virulence genes among *E. faecalis* and *E. faecium* isolated from beaches in Southern California and Puerto Rico to isolates from potential sources including humans, animals, birds, and plants. All five virulence genes were found in *E. faecalis* and *E. faecium* from beach water, mostly among *E. faecalis*. *gelE* was the most common among isolates from all source types. There was a lower incidence of *asa1*, *esp*, *cylA*, and *hyl* genes among isolates from beach water, sewage, septage, urban runoff, sea wrack, and eelgrass as compared to human isolates, indicating that virulent strains of *E. faecalis* and *E. faecium* may not be widely disseminated at beaches. A higher frequency of *asa1* and esp among *E. faecalis* from dogs and of *asa1* among birds (mostly seagull) suggests that further studies on the distribution and virulence potential of strains carrying these genes may be warranted.

CITATION

Ferguson, D.M. G.N. Talavera, L.R. Hernández, R.F. Ambrose, J.A. Jay and S.B. Weisberg. 2016. Virulence genes among *E. faecalis* and *E. faecium* isolated from coastal beaches and potential sources in southern California and Puerto Rico. *Journal of Pathogens* http://dx.doi.org/10.1155/2016/3437214.

SCCWRP Journal Article #0919
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/919_EnterococcusVirulenceGenes.pdf

Epidemiologic evaluation of multiple alternate microbial water quality monitoring indicators at three California beaches

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ABSTRACT

Introduction: Advances in molecular methods provide new opportunities for directly measuring pathogens or host-associated markers of fecal pollution instead of relying on fecal indicator bacteria (FIB) alone for beach water quality monitoring. Adoption of new indicators depends on identifying relationships between either the presence or concentration of the indicators and illness among swimmers. Here we present results from three epidemiologic studies in which a broad range of bacterial and viral indicators of fecal contamination were measured simultaneously by either culture or molecular methods along with Enterococcus to assess whether they provide better health risk prediction than current microbial indicators of recreational water quality.

Methods: We conducted prospective cohort studies at three California beaches – Avalon Bay (Avalon), Doheny State Beach (Doheny), Surfrider State Beach (Malibu) – during the summers of 2007, 2008 and 2009. The studies enrolled 10,785 swimmers across the beaches and recorded each swimmer's water exposure. Water and sand samples were collected several times per day at multiple locations at each beach and analyzed for up to 41 target indicators using 67 different methodologies. Interviewers contacted participants by phone 10 – 14 days later and recorded symptoms of gastrointestinal illness occurring after their beach visit. Regression models were used to evaluate the association between water quality indicators and gastrointestinal illness among swimmers at each beach.

Results: F+ coliphage (measured using EPA Method 1602) exhibited a stronger association with GI illness than did EPA Method 1600 at the two beaches where it was measured, while a molecular method, F+ RNA Coliphage Genotype II, was the only indicator significantly associated with GI illness at Malibu. MRSA, a known pathogen, had the strongest association with GI illness of any microbe measured at Avalon. There were two methods targeting human-associated fecal anaerobic bacteria that were more strongly associated with GI illness than EPA Method 1600, but only at Avalon. No indicator combinations consistently had a higher odds ratio than EPA Method 1600, but one composite indicator, based on the number of pathogens detected at a beach, was significantly associated with gastrointestinal illness at both Avalon and Doheny when freshwater flow was high.

Discussion: While EPA Method 1600 performed adequately at two beaches based on its consistency of association with gastrointestinal illness and the precision of its estimated associations, F+ coliphage measured by EPA Method 1602 had a stronger association with GI illness under high risk conditions at the two beaches where it was measured. One indicator, F+ Coliphage Genotype II was the only indicator significantly associated with GI illness at Malibu. Several indicators, particularly those targeting human associated bacteria, exhibited relationships with GI illness that were equal to or greater than that of EPA Method 1600 at Avalon, which has a focused human fecal source. Our results suggest that site-specific conditions at each beach determine which indicator or indicators best predict GI illness.

CITATION

Griffith, J.F., S.B. Weisberg, B.F. Arnold, Y. Cao, K.C. Schiff, and J.M. Colford Jr. 2016. Epidemiologic evaluation of multiple alternate microbial water quality monitoring indicators at three California beaches. *Water Research* 94, 371-381.

SCCWRP Journal Article #0918
Full text available by request: pubrequest@sccwrp.org

Multi-laboratory survey of qPCR enterococci analysis method performance in U.S. coastal and inland surface waters

Richard A. Haugland[1], Shawn Siefring[1], Manju Varma[1], Kevin H. Oshima[1], Mano Sivaganesan[2], Yiping Cao[3], Meredith Raith[3], John Griffith[3], Stephen B. Weisberg[3], Rachel T. Noble[4], A. Denene Blackwood[4], Julie Kinzelman[5], Tamara Anan'eva[5], Rebecca N. Bushon[6], Erin A. Stelzer[6], Valarie J. Harwood[7], Katrina V. Gordon[7], Christopher Sinigalliano[8]

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ABSTRACT

Quantitative polymerase chain reaction (qPCR) has become a frequently used technique for quantifying enterococci in recreational surface waters, but there are several methodological options. Here we evaluated how three method permutations, type of mastermix, sample extract dilution and use of controls in results calculation, affect

method reliability among multiple laboratories with respect to sample interference. Multiple samples from each of 22 sites representing an array of habitat types were analyzed using EPA Method 1611 and 1609 reagents with full strength and five-fold diluted extracts. The presence of interference was assessed three ways: using sample processing and PCR amplifications controls; consistency of results across extract dilutions; and relative recovery of target genes from spiked enterococci in water sample compared to control matrices with acceptable recovery defined as 50 to 200%. Method 1609, which is based on an environmental mastermix, was found to be superior to Method 1611, which is based on a universal mastermix. Method 1611 had over a 40% control assay failure rate with undiluted extracts and a 6% failure rate with diluted extracts. Method 1609 failed in only 11% and 3% of undiluted and diluted extracts analyses. Use of sample processing control assay results in the delta– delta Ct method for calculating relative target gene recoveries increased the number of acceptable recovery results. Delta–delta tended to bias recoveries from apparent partially inhibitory samples on the high side which could help in avoiding potential underestimates of enterococci — an important consideration in a public health context. Control assay and delta–delta recovery results were largely consistent across the range of habitats sampled, and among laboratories. The methodological option that best balanced acceptable estimated target gene recoveries with method sensitivity and avoidance of underestimated enterococci densities was Method 1609 without extract dilution and using the delta–delta calculation method. The applicability of this method can be extended by the analysis of diluted extracts to sites where interference is indicated but, particularly in these instances, should be confirmed by augmenting the control assays with analyses for target gene recoveries from spiked target organisms.

CITATION

Haugland, R.A., S. Siefring, M. Varma, K.H. Oshima, M. Sivaganesan, Y. Cao, M. Raith, J. Griffith, S.B. Weisberg, R.T. Noble, A.D. Blackwood, J. Kinzelman, T. Anan'eva, R.N. Bushon, E.A. Stelzer, V.J. Harwood, K.V. Gordon, C. Sinigalliano. 2016. Multi-laboratory survey of qPCR enterococci analysis method performance in U.S. Coastal and inland surface waters. *J. Microbiol. Methods* http://dx.doi.org/10.1016/j.mimet.2016.01.017.

SCCWRP Journal Article #0917
Full text available by request: pubrequest@sccwrp.org

Solar inactivation of enterococci and Escherichia coli in natural waters: Effects of water absorbance and depth

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ABSTRACT

The decay of sewage-sourced *Escherichia coli* and enterococci was measured at multiple depths in a freshwater marsh, a brackish water lagoon, and a marine site, all located in California. The marine site had very clear water, while the waters from the marsh and lagoon contained colored dissolved organic matter that not only blocked light but also produced reactive oxygen species. First order decay rate constants of both enterococci and *E. coli* were between 1 and 2 d^{-1} under low light conditions and as high as 6 d^{-1} under high light conditions. First order decay rate constants were well correlated to the daily average UVB light intensity corrected for light screening incorporating water absorbance and depth, suggesting endogenous photoinactivation is a major pathway for bacterial decay. Additional laboratory experiments demonstrated the presence of colored dissolved organic matter in marsh water enhanced photoinactivation of a laboratory strain of *Enterococcus faecalis*, but depressed photoinactivation of sewage-sourced enterococci and *E. coli* after correcting for UVB light screening, suggesting that although the exogenous indirect photoinactivation mechanism may be active against *Ent. faecalis*, it is not for the sewage-source organisms. A simple linear regression model based on UVB light intensity appears to be a useful tool for predicting inactivation rate constants in natural waters of any depth and absorbance.

CITATION

Maraccini, P.A., M.C. Mattioli, L.M. Sassoubre, Y. Cao, J. Griffith, J. Ervin, L.V. de Werfhorst and A.B. Boehm. 2016. Solar Inactivation of Enterococci and Escherichia coli in Natural Waters: Effects of Water Absorbance and Depth. *Environmental Science & Technology* 50:5068-5076.

SCCWRP Journal Article #0950
Full text available by request: pubrequest@sccwrp.org

Absolute quantification of enterococcal 23S rRNA gene using digital PCR

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ABSTRACT

We evaluated the ability of chip-based digital PCR (dPCR) to quantify enterococci, the fecal indicator recommended by the United States Environmental Protection Agency (USEPA) for water-quality monitoring. dPCR uses Poisson statistics to estimate the number of DNA fragments in a sample with a specific sequence. Underestimation may occur when a gene is redundantly encoded in the genome and multiple copies of that gene are on one DNA fragment. When genomic DNA (gDNA) was extracted using two commercial DNA extraction kits, we confirmed that dPCR could discern individual copies of the redundant 23s rRNA gene in the enterococcal genome. dPCR quantification was accurate when compared to the nominal concentration inferred from

fluorometer measurements (linear regression slope = 0.98, intercept = 0.03, R2 = 0.99, and p value <0.0001). dPCR quantification was also consistent with quantitative PCR (qPCR) measurements as well as cell counts for BioBall reference standard and 24 environmental water samples. qPCR and dPCR quantification of enterococci in the 24 environmental samples were significantly correlated (linear regression slope =1.08, R^2 of 0.96, and p value <0.0001); the group mean of the qPCR measurements was 0.19 log units higher than that of the dPCR measurements. At environmentally relevant concentrations, dPCR quantification was more precise (i.e., had narrower 95% confidence intervals than qPCR quantification). We observed that humic acid caused a similar level of inhibition in both dPCR and qPCR, but calcium inhibited dPCR to a lesser degree than qPCR. Inhibition of dPCR was partially relieved when the number of thermal cycles was increased. On the basis of these results, we conclude that dPCR is a viable option for enumerating enterococci in ambient water.

Citation

Wang, D., K.M. Yamahara, Y. Cao, and A.B. Boehm. 2016. Absolute Quantification of Enterococcal 23S rRNA Gene Using Digital PCR. *Environmental Science and Technology* doi: 10.1021/acs.est.5b05747.

SCCWRP Journal Article #0920
Full text available by request: pubrequest@sccwrp.org

Decay of coliphages in sewage-contaminated freshwater: Uncertainty of seasonal effects

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Abstract

Understanding the fate of enteric viruses in water is vital for protection of water quality. However, the decay of enteric viruses is not well characterized, and its uncertainty has not been examined yet. In this study, the decay of coliphages, an indicator for enteric viruses, was investigated *in situ* under both sunlit and shaded conditions as well as in summer and winter. The decay rates of coliphages and their uncertainties were analyzed using a Bayesian approach. The results from the summer experiments revealed that the decay rates of somatic coliphages were significantly higher in sunlight (1.29 ± 0.06 day^{-1}) than in shade (0.96 ± 0.04 day^{-1}), but the decay rates of male-specific (F+) coliphages were not significantly different between sunlight (1.09 ± 0.09 day^{-1}) and shaded treatments (1.11 ± 0.08 day^{-1}). The decay rates of both F+ coliphages (0.25 ± 0.02 day^{-1}) and somatic coliphages (0.12 ± 0.01 day^{-1}) in winter were considerably lower than those in summer. Temperature and chlorophyll a (chla) concentration varied significantly ($p < 0.001$) between the two seasons, suggesting that these parameters might be important contributors to the seasonal variation of coliphage decay. Additionally, the Bayesian approach provided full distributions of decay rates and reduced the uncertainty, offering useful information for comparing decay rates under different conditions.

Citation

Wu, J., Y. Cao, B. Young, Y. Yuen, S. Jiang, D. Melendez, J.F. Griffith, J.R. Stewart. 2016. Decay of Coliphages in Sewage-Contaminated Freshwater: Uncertainty and Seasonal Effects. *Environmental Science and Technology* DOI: 10.1021/acs.est.6b03916.

SCCWRP Journal Article #0949
Full text available by request: pubrequest@sccwrp.org

Indicator and pathogen removal by low impact development best management practices

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[4]*Department of Civil and Environmental Engineering, Stanford University, Stanford, CA*

Abstract

Microbial contamination in urban stormwater is one of the most widespread and challenging water quality issues in developed countries. Low impact development (LID) best management practices (BMPs) restore pre-urban hydrology by treating and/or harvesting urban runoff and stormwater, and can be designed to remove many contaminants including pathogens. One particular type of LID BMP, stormwater biofilters (i.e., vegetated media filters, also known as bioinfiltration, bioretention, or rain gardens), is becoming increasingly popular in urban environments due to its multiple co-benefits (e.g., improved hydrology, water quality, local climate and aesthetics). However, increased understanding of the factors influencing microbial removal in biofilters is needed to effectively design and implement biofilters for microbial water quality improvement. This paper aims to provide a holistic view of microbial removal in biofilter systems, and reviews the effects of various design choices such as filter media, vegetation, infauna, submerged zones, and hydraulic retention time on microbial removal. Limitations in current knowledge and recommendations for future research are also discussed.

Citation

Peng, J., Y. Cao, M.A. Rippy, A.R.M.N. Afrooz, S.B. Grant. 2016. Indicator and pathogen removal by low impact development best management practices. *Water* 8(600) doi: 10.3390/w8120600.

SCCWRP Journal Article #0958
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/958_IndicatorPathogenRemovalLowImpact.pdf

Looking ahead: New development in beach water quality monitoring and bacterial source identification

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ABSTRACT

California has the most comprehensive beach water quality monitoring program in the nation. Water quality at California beaches is typically assessed using growth-based measurements of fecal indicator bacteria (FIB) including total coliform, fecal coliform and enterococci. Despite their wide use, growth-based methods are too slow to protect beachgoers from exposure to contaminated water because they require an 18-24 hour incubation period to produce an answer, and most contamination events last less than one day. Thus, swimmers are exposed to contaminated water during the incubation period and oftentimes warned to stay out of the water after the risk has abated. New faster methods for measuring FIB are now available. In 2012, the United States Environmental Protection Agency (EPA) published new rapid molecular methods for measuring Enterococcus using quantitative polymerase chain reaction (qPCR). These methods do not rely on growth and can be performed in the laboratory in about 2 hours. Known as EPA Method 1609 and 1611, the methods detect and quantify specific gene sequences in bacteria, acceptable levels of which were determined through epidemiology studies.

CITATION

Griffith, J. 2015. Looking Ahead: New Development in Beach Water Quality Monitoring and Bacterial Source Identification. *Urban Coast* 5(1):180-184.

SCCWRP Journal Article #0912
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/912_BeachWaterQualityMonitoring.pdf

The Surfer Health Study: A three-year study examining illness rates associated with surfing during wet weather

Kenneth Schiff, John Griffith, Joshua Steele

Southern California Coastal Water Research Project, Costa Mesa, CA

CITATION

Schiff, K., J. Griffith, J. Steele, B. Arnold, A. Ercumen, J. Benjamin-Chung, J.M. Colford Jr., J. Soller, R. Wilson, C. McGee. 2016. The Surfer Health Study: A Three-Year Study Examining Illness Rates Associated with Surfing During Wet Weather. Technical Report 943. Southern California Coastal Water Research Project Authority. Costa Mesa, CA.

SCCWRP Technical Report #0943
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/943_SurferHealthStudy.pdf

Microbiological water quality at reference beaches and adjoining estuary in Southern California during a prolonged drought

Liesl Tiefenthaler, Martha Sutula, John F. Griffith, Meredith Raith

Southern California Coastal Water Research Project, Costa Mesa, CA

CITATION

Tiefenthaler, L., M. Sutula, J. Griffith, M. Raith. 2016. Microbiological Water Quality at Non-Human Impacted Reference Beaches in Southern California During Wet and Dry Weather: March 2014-2016. Technical Report 936. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0936
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/936_MicrobiologicalWQRefBeaches.pdf

Bioassessment scores for engineered channels analyzed

The Southern California Stormwater Monitoring Coalition has completed a comprehensive analysis of ecological condition scores for engineered channels across coastal Southern California.

The study, completed in 2016 and co-authored by SCCWRP, found that condition assessments based on multiple bioindicators are far more useful in engineered channels than assessments based on one indicator alone. Specifically, using a benthic macroinvertebrate-based scoring tool and algae-based scoring tools together provided a more complete picture of stream health than using either scoring tool alone.

The SMC also shed light on why some engineered channels score better than others – insights that could help stream managers understand how best to direct resources to improve channel health. The study showed that bioassessment scores are influenced by habitat factors, including microhabitat diversity and shading, as well as by water quality, including specific conductivity and temperature.

The SMC study was conducted as California moves toward developing a biointegrity policy setting goals for the condition of streams statewide. The SMC is evaluating the biological condition of engineered channels across California's South Coast region to understand how stream managers could be affected by this upcoming policy.

Researchers analyzed ecological condition scores for engineered channels, including the Los Angeles River, above, for a study shedding light on how a forthcoming stream biointegrity policy could affect stream management.

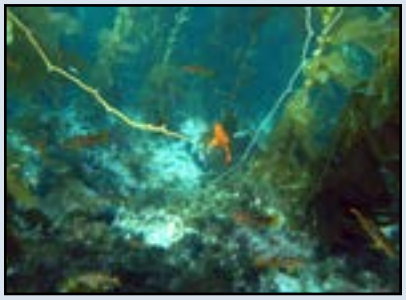
New scoring tools discern fishing vs. pollution impacts on rocky reefs

SCCWRP and its partners have developed a series of environmental scoring tools as part of the Southern California Bight 2013 Regional Monitoring Program to gain new insights into the relative impacts of fishing vs. pollutant discharges on Bight subtidal rocky reefs.

The Bight '13 Rocky Reefs element, which published its final assessment report in spring 2016, involved creating a fishing index to measure fish extraction, a plume exposure index to estimate pollutant loading and plume exposure, and a reef response index to measure biological community responses.

Subtidal rocky reefs make up about one-fourth of the Southern California Bight coastline and are home to among the most productive marine ecosystems on earth.

An overall analysis using the tools found that rocky reefs appear to be more sensitive to fishing than to pollution discharges, although these twin stressors tend to build upon one another to exert cumulative impacts.



Southern California's subtidal rocky reefs, home to among the most productive marine ecosystems on earth, are the focus of a study examining the relative impacts of fishing and pollutant discharges on rocky reef ecological health.

The Bight '13 Rocky Reefs element has recommended continued monitoring of rocky reefs as stormwater best management practices (BMPs) are implemented in the vicinity of rocky reefs, and as Marine Protected Areas curtail fishing practices.

Concentration of PBDEs falls dramatically across Bight following state ban

Concentrations of a class of flame retardant chemicals known as polybrominated diphenyl ethers (PBDEs) have dropped by 92% in Southern California Bight embayments over a five-year period, and by 50% offshore, according to the chemistry findings of the Southern California Bight 2013 Regional Monitoring Program.

PBDEs, which were banned in California in 2008, enter coastal waters primarily via land-based runoff and tend to settle in embayment sediment.

Researchers compared the levels of PBDEs measured in sediment in Bight '08 to the levels measured in Bight '13.

The declines are a source-control success story, indicating that management actions to halt the production of these chemicals have been effective.

Regional monitoring programs in the United States: Synthesis of four case studies from Pacific, Atlantic, and Gulf coasts

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ABSTRACT

Water quality monitoring is a cornerstone of environmental protection and ambient monitoring provides managers with the critical data they need to take informed action. Unlike site-specific monitoring that is at the heart of regulatory permit compliance, regional monitoring can provide an integrated, holistic view of the environment, allowing managers to obtain a more complete picture of natural variability and cumulative impacts, and more effectively prioritize management actions. By reviewing four long-standing regional monitoring programs that cover portions of all three coasts in the United States – Chesapeake Bay, Tampa Bay, Southern California Bight, and San Francisco Bay – important insights can be gleaned about the benefits that regional monitoring provides to managers. These insights include the underlying reasons that make regional monitoring programs successful, the challenges to maintain relevance and viability in the face of ever-changing technology, competing demands and shifting management priorities. The lessons learned can help other managers achieve similar successes as they seek to establish and reinvigorate their own monitoring programs.

CITATION

Schiff, K., P.R. Trowbridge, E.T. Sherwood, P. Tango, R.A. Batiuk. 2016. Regional Monitoring Programs in the United States: Synthesis of Four Case Studies from Pacific, Atlantic, and Gulf Coasts. *Regional Studies in Marine Science* 4:47-53.

SCCWRP Journal Article #0931
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/931_RegionalMonitoringPrograms.pdf

Hg concentrations in fish from coastal waters of California and Western North America

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ABSTRACT

The State of California conducted an extensive and systematic survey of mercury (Hg) in fish from the California coast in 2009 and 2010. The California survey sampled 3483 fish representing 46 species at 68 locations, and demonstrated that methylHg in fish presents a widespread exposure risk to fish consumers. Most of the locations sampled (37 of 68) had a species with an average concentration above 0.3µg/g wet weight (ww), and 10 locations an average about 1.0µg/g ww. The recent and robust dataset from California provided a basis for a broader examination of spatial and temporal patterns in fish Hg in coastal waters of Western North America. There is a striking lack of data in publicly accessible databases on Hg and other contaminants in coastal fish. An assessment of the raw data from these databases suggested the presence of relatively high concentrations along the California coast and in Puget Sound, and relatively low concentrations along the coasts of Alaska and Oregon, and the outer coast of Washington. The dataset suggests that Hg concentrations of public health concern can be observed at any location on the coast of Western North America where long-lived predator species are sampled. Output from a linear mixed-effects model resembled the spatial pattern observed for the raw data and suggested, based on the limited dataset, a lack of trend in fish Hg over the nearly 30-year period covered by the dataset. Expanded and continued monitoring, accompanied by rigorous data management procedures, would be of great value in characterizing methylHg exposure, and tracking changes in contamination of coastal fish in response to possible increases in atmospheric Hg emissions in Asia, climate change, and terrestrial Hg control efforts in coastal watersheds.

CITATION

Davis, J.A., J.R.M. Ross, S. Bezalel, L. Sim, A. Bonnema, G. Ichikawa, W.A. Heim, K. Schiff, C.A. Eagles-Smith, J.T. Ackerman. 2016. Hg concentrations in fish from coastal waters of California and Western North America. *Science of the Total Environment* 568:1146-1156.

SCCWRP Journal Article #0947
Full text available by request: pubrequest@sccwrp.org

The physical characteristics of nearshore rocky reefs in the Southern California Bight

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ABSTRACT

We present a GIS method for mapping and characterizing nearshore reef habitats. Utilizing this technique, we were able to successfully map all nearshore (<30 m depth) rocky reefs in the Southern California Bight and then quickly assess and characterize these data layers with expert opinion. The southern California coastline is 1198 km in length, with the eight Channel Islands and mainland comprising 503 km and 695 km of coastline, respectively. This is approximately the same amount of coastline as the rest of California. Within this region, we identified and characterized 122 natural

reefs comprising 49,055 hectares, which is 26.6% of the 184,439 ha of nearshore habitat in the bight, the remainder comprised of soft bottom. Reefs varied appreciably in size ranging from 6 – 2498 ha. We sampled a subset of these reefs using a generalized random tessellation stratified design and quantified their physical characteristics as measured by scuba surveys. The reefs also varied with respect to habitat type and five distinct subhabitat types varying from sheer oceanic pinnacle reefs to low-lying cobble were observed. The distribution of reef types varied between the mainland and islands. Island reefs were, in general, higher relief and had a greater percentage of rocky substrate. Mainland reefs generally had lower relief and a higher percentage of sand and cobble substrates.

Citation

Pondella II, D., J.P. Williams, J. Claisse, R. Schaffner, K. Ritter, K. Schiff. 2015. The Physical Characteristics of Nearshore Rocky Reefs in The Southern California Bight. *Bulletin of the Southern California Academy of Sciences* 114(3):105-122.

SCCWRP Journal Article #0942
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/942_PhysicalCharacteristicsOfNearshoreRockyReefs.pdf

Near-coastal water quality at reference sites following storm events

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[2]*ADH Environmental, Arcata, CA*
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Abstract

Stormwater is one of the more challenging sources of coastal pollution to abate, partly because stormwater also involves complex natural processes and differentiating these natural processes from anthropogenic excesses is difficult. The goal of this study was to identify what are the natural concentrations of stormwater constituents along the 1,377 km coastline of California, USA. Twenty-eight ocean reference sites, *a priori* defined by lack of human disturbance within its adjacent watershed, were sampled between 2008 and 2014. Samples were collected directly in front of flowing runoff following 78 site-events (combination of sampling sites and storm events), then measured for 57 constituents and toxicity to three endemic marine organisms. Results indicated a complete lack of toxicity and undetectable levels of anthropogenic constituents (i.e., current use pesticides) at ocean reference sites. The range of concentrations in ocean receiving waters adjacent to these undeveloped watersheds for naturally-occurring constituents (i.e., total suspended solids, nutrients, trace metals) typically ranged three to four orders of magnitude. With few exceptions, concentration ranges were comparable for different regions of the state, which vary in geology, rainfall, and oceanic currents. Storm characteristics (i.e., rainfall quantity, intensity, duration) did not explain these variations in concentration. The reference site information is now being used to establish targets for marine protected areas subject to runoff from developed watersheds.

Citation

Schiff, K., J. Brown, S. Trump, D. Hardin. 2016. Near-Coastal Water Quality at Reference Sites Following Storm Events. *Marine Pollution Bulletin* 103:294-300.

SCCWRP Journal Article #0914
Full text available by request: pubrequest@sccwrp.org

Effects of rainfall intensity and duration on the first flush from parking lots

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Abstract

Urban stormwater with large impervious (paved) areas often produces runoff with a variety of contaminants. Although southern California is among the most urbanized coastal areas in the United States, the effect of rainfall variations on washoff efficiency of contaminants from pervious and impervious surfaces is largely unknown. The goal of this study was to investigate the effect of varying rainfall intensities and duration on runoff composition from highly impervious parking lots. In order to control the tremendous natural variability in precipitation of the arid climate in southern California, rainfall simulators were used to generate and quantify pollutant washoff at changing intensities and durations. Washoff of suspended solids, total and dissolved trace metals, and polycyclic aromatic hydrocarbons was strongly inversely correlated with rainfall duration. Rainfall intensity only affected washoff at the smallest measured duration; higher intensities produced decreased concentrations. The effect of rainfall duration was a reflection of the first flush observed in pollutographs for every duration and intensity sampled. Peak concentrations, up to an order of magnitude higher than concentrations later in the event, occurred during the first 10 min after the onset of rainfall. Longer simulated storms effectively diluted the first flush.

Citation

Schiff, K.C., L.L. Tiefenthaler, S.M. Bay, D.J. Greenstein. 2016. Effects of Rainfall Intensity and Duration on the First Flush from Parking Lots. *Water* 8(320): DOI: 10.3390/w808032.

SCCWRP Journal Article #0941
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/941_EffectsOfRainfallIntensityFromParkingLots.pdf

Water resources: Trash and debris

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ABSTRACT

Marine debris has become one of the most recognized pollution problems in the world's oceans and watersheds today. About 80% of debris found in marine environments is generated from land-based sources of trash. Therefore, reduction of trash sources from watersheds is an important management action to reduce marine debris. To address marine debris, the Los Angeles Regional Water Quality Control Board (LARWQCB) established a Total Maximum Daily Load (TMDL) for trash for the Ballona Creek in 2002, for Malibu Creek in 2009, and for marine debris for Santa Monica Bay in 2012. Land-based trash also affects the condition of stream ecosystems, but in general there has been much less management focus on the impacts of trash on stream habitats in comparison to beaches and coastal environments. The implementation schedule for the Ballona Creek TMDLs requires a 10% progressive reduction from the baseline waste load allocation each year. It aimed to achieve a 50% reduction by 2009, followed by a target of zero trash by 2015. For Malibu Creek, the target of zero trash must be met by 2017. For Santa Monica Bay, the target of zero trash must be met by 2020, except for cities that pass ordinances banning plastic bags, smoking in public places, and single-use expanded polystyrene food packaging (Styrofoam), which have until 2023.

CITATION

Von Bitner, T., E.D. Stein, L. Protopapadakis, K. Thorsen. 2015. Water Resources: Trash and Debris. *Urban Coast* 5(1):29-34.

SCCWRP Journal Article #0906
Full text available online: ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/906_TrashDebris.pdf

Towards creating a national reference wetlands registry

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[3]U.S. Environmental Protection Agency, Washington D.C, DC
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[5]Southern California Coastal Water Research Project, Costa Mesa, CA
[6]New Jersey Natural Heritage Program, Trenton, NJ

ABSTRACT

Local and regional reference wetlands networks have proven to be extremely valuable in supporting wetland assessment, planning, and monitoring. By establishing a national Reference Wetlands Registry (RWR), we can leverage existing regional and national programs to provide broad access to information on reference wetlands around the country. Such a registry would facilitate data-sharing that is critical for evaluating national trends and policies. Large-scale assessments across broad (continental-scale) gradients are also important to help understand shifts in wetland conditions associated with impacts such as urban and energy development and climate change. Regions looking to develop or expand reference networks will benefit from being able to look at data and distributions from across the country to inform their decisions.

CITATION

Brooks, R.P., D. Faber-Langendoen, G. Serenbetz, J. Rocchio, E.D. Stein, K. Walz. 2016. Towards Creating a National Reference Wetlands Registry. *National Wetlands Newsletter* 38(3):7-11.

SCCWRP Journal Article #0927
Full text available by request: pubrequest@sccwrp.org

The bigeye scad, Selar crumenophthalmus (Bloch, 1973) (Family Carangidae), new to the California marine fauna, with a list to and keys for all California Carangids

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ABSTRACT

The anomalously warm waters of the northeast Pacific 2014–2015 brought with it a variety of subtropical and tropical fish species previously unusual or absent from California waters. On 1 February 2015, Mr. Keichi Yamamoto speared a fish that we have identified as *Selar crumenophthalmus*, the bigeye scad. The fish was captured in the midwaters of a kelp bed (bottom depth 8 m) off Rancho Palos Verdes (33°48'N, 118°24'W), southern California. This is the first time this species has been reported from off California. The fish he speared was one of approximately 10 conspecifics that were swimming with a school of juvenile jack mackerel, *Trachurus symmetricus*. This specimen is housed in the fish collection at the Natural History Museum of Los Angeles County, LACM 58288-1.

CITATION

Love, M.S., J.K. Passarelli, C. Okamoto, D.W. Diehl. 2015. The Bigeye Scad, Selar crumenophthalmus (Bloch, 1793) (Family Carangidae), New to the California Marine Fauna, with a List to and Keys for All California Carangids. *Bulletin of the Southern California Academy of Sciences* 114(3), pp. 141–148.

SCCWRP Journal Article #0901
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/901_BigeyeScadNewToCalifornia.pdf

Southern California Bight 2013 Regional Monitoring Program: Volume I. Sediment toxicity

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Citation

Bay, S.M., L. Wiborg, D.J. Greenstein, N. Haring, C. Pottios, C. Stransky, K. Schiff. 2015. Southern California Bight 2013 Regional Monitoring Program: Volume I - Sediment Toxicity Report. Technical Report 899. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0899
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/899_B13SedToxReport.pdf

Southern California Bight 2013 Regional Monitoring Program: Volume II. Rocky reefs

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[2]*Southern California Coastal Water Research Project, Costa Mesa, CA*
[3]*California Ocean Science Trust, Oakland, CA*

Citation

Pondella, D., K. Schiff, R. Schaffner, A. Zellmer, J. Coates. 2016. Southern California Bight 2013 Regional Monitoring Program: Volume II. Rocky Reefs. Technical Report 932. Southern California Coastal Water Research Project Authority. Costa Mesa, CA.

SCCWRP Technical Report #0932
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/932_Bight__13_RockyReefs.pdf

Southern California Bight 2013 Regional Monitoring Program: Volume III. Trash and marine debris

Shelly Moore[1], Martha Sutula[1], Ted Von Bitner[2], Gwen Lattin[3], Kenneth Schiff[1]

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[2]*AMEC Foster Wheeler, San Diego, CA*
[3]*Algalita Marine Research and Education, Long Beach, CA*

Citation

Moore, S., M. Sutula, T.V. Bitner, G. Lattin, K. Schiff. 2016. Southern California Bight 2013 Regional Monitoring Program: Volume III. Trash and Marine Debris. Technical Report 928. Southern California Coastal Water Research Project Authority. Costa Mesa, CA.

SCCWRP Technical Report #0928
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/928_B13_Debris.pdf

Southern California Bight 2013 Regional Monitoring Program: Volume IV. Sediment chemistry

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[2]*City of San Diego Ocean Monitoring Program, San Diego, CA*
[3]*Sanitation Districts of Los Angeles County, Whittier, CA*

Citation

Dodder, N., K. Schiff, A. Latker, C.L. Tang. 2016. Southern California Bight 2013 Regional Monitoring Program: Volume IV. Sediment Chemistry. Technical Report 922. Southern California Coastal Water Research Project Authority. Costa Mesa, CA.

SCCWRP Technical Report #0922
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/922_B13_SedChemReport.pdf

Southern California Bight 2013 Regional Monitoring Program: Volume V. Contaminant bioaccumulation in seabird eggs of the Southern California Bight

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Citation

Clatterbuck, C.A., R.A. Lewison, N. Dodder, C. Zeeman, K. Schiff. 2016. Southern California Bight 2013 Regional Monitoring Program: Volume V. Contaminant Bioaccumulation in Seabird Eggs of the Southern California Bight. Technical Report 944. Southern California Coastal Water Research Project Authority. Costa Mesa, CA.

SCCWRP Technical Report #0944
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/944_ContaminantBioaccInSeabirdEggs.pdf

Stormwater Monitoring Coalition toxicity testing laboratory guidance document

Kenneth C. Schiff, Darrin Greenstein

Southern California Coastal Water Research Project, Costa Mesa, CA

Citation

Schiff, K.C., D. Greenstein. 2016. Stormwater Monitoring Coalition Toxicity Testing Laboratory Guidance Document. Technical Report 956. Southern California Coastal Water Research Project. Costa Mesa, CA.

SCCWRP Technical Report #0956
Full text available online: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/956_StrmWtrMonitCoalitToxTestingLabGuid.pdf

UAS potential for environmental monitoring demonstrated

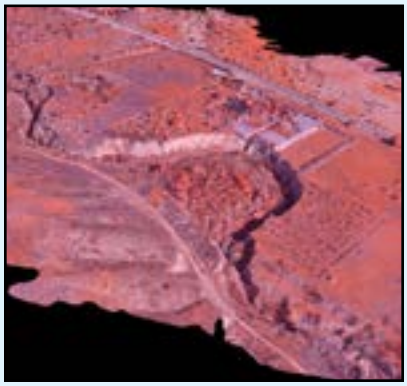
SCCWRP and its partners have demonstrated in a pilot study that traditional and multispectral cameras mounted to an unmanned aerial system (UAS) can be used to produce high-resolution, 3D mapping of waterways susceptible to hydromodification.

The 2016 project, which involved flying remote-controlled aircraft over stream channels in south Orange County, provides preliminary evidence that UAS aircraft can be adapted for environmental monitoring applications.

SCCWRP showed that the high-resolution aerial data obtained from the UAS can be used to develop runoff models, track changes to terrain over time, and zero in on a precise location retroactively to take more detailed measurements.

Data obtained from a visible spectrum camera and a multispectral infrared camera showed the most promise, while experimental data from a LiDAR (Light Detection and Ranging) laser profiling system did not initially prove useful.

SCCWRP is partnering with the San Francisco Estuary Institute in Richmond to explore how UAS could be used to map harmful algal bloom events, estuaries and wetlands, debris and discharge plumes, and other areas.



This high-resolution, 3D map of Oso Creek in Orange County demonstrates the potential of an unmanned aerial system (UAS) to be adapted for environmental monitoring applications.

Based in part on the success of the pilot study, SCCWRP and SFEI also are planning to invest in a shared UAS.

The pilot project was done in partnership with Orange County Public Works and PrecisionHawk, a Raleigh, N.C.-based manufacturer of professional-grade UAS that uses industry-standard imaging sensors to generate high-resolution location and elevation information.

Study shows CellScope images can be identified autonomously, accurately

SCCWRP and a team of master's students in statistics at California State University, Fullerton, have demonstrated that statistical classification methods can be used to correctly identify microscopic images of a marine diatom more than 90% of the time.

The student-led project, which wrapped up in spring 2016, provides an important proof of concept in SCCWRP's ongoing efforts to automate analysis and processing for images obtained with the CellScope Aquatic. The field-portable microscope prototype, co-developed by SCCWRP, uses a smartphone as the viewfinder.

The project involved testing six different statistical classification methods for distinguishing images that contain the toxin-producing *Pseudo-nitzschia* diatom from images that do not. All six statistical methods produced results that were at least 90% accurate, and three achieved accuracy of more than 95%.

The accuracy rates are comparable to the accuracy rates that taxonomists get when they evaluate and classify these images manually.

Virtual-reality simulation enables exploration of changes to Tijuana estuary

SCCWRP has teamed up with the geospatial software firm Esri to build a computer game-like re-creation of the Tijuana River estuary that will enable users to travel through the habitat and view pop-up information about past, present and future conditions.

The virtual reality demonstration project, initiated in 2016, is intended to showcase the power of geospatial software to explore an environment on a computer or tablet, and to understand how changing conditions – both human-induced and natural – have impacted and will continue to impact an ecologically sensitive site. The Tijuana River National Estuarine Research Reserve, which also is involved with the project, is located just north of the U.S.-Mexico border.

Through the estuary's virtual reality tour, users can view the state of its riparian forests before and after an invasive beetle infestation. Users also can view changes to water levels and sedimentation through 2100 as projected by U.S. Geological Survey modeling. Pop-up windows along the tour provide narrative information about changing environmental conditions.

A computer game-like re-creation of the Tijuana River estuary allows users to go on a virtual reality tour that explores past, present and future environmental conditions.

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