



SCCWRP Director's Report



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WINTER 2020 ISSUE

SMC develops roadmap to improve runoff water quality

The Southern California Stormwater Monitoring Coalition (SMC) has unveiled a comprehensive, multi-faceted research agenda that lays out a vision and roadmap for how the region's stormwater management community will collaborate to improve runoff water quality over the next five years.

The 2019-2024 Research Agenda spans multiple areas of stormwater science, from optimizing the performance of stormwater BMPs (best management practices) to modernizing data sharing and analysis capabilities. The SMC's governing board in January began discussing which projects to tackle first.

SCCWRP helped conceptualize and develop the research agenda, and the document will play a key role in shaping SCCWRP's own long-term research directions.

The 36-page SMC agenda is intended to unify the region's stormwater managers around a shared vision for conducting urgently needed research to advance the

science of stormwater management in Southern California.

The SMC is made up of 14 stormwater management agencies spanning the regulated and regulatory sectors. Other stormwater managers, including the co-permittees of SMC members, also routinely contribute resources and expertise to SMC projects.

Since its inception in 2001, the SMC has funded nearly 30 research projects valued at \$17 million. Half of that effort has come from in-kind resources from non-SMC member agencies, underscoring the value of a collaborative, regional approach to stormwater research.

The 2019-2024 research agenda builds off the SMC's previous five-year research agenda. Like the 2014-2019 research agenda, this agenda was developed by a 10-member advisory panel convened by the SMC to independently identify the region's most pressing research needs.

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Cover photo: Runoff flows into a bioswale in Marina del Rey in Los Angeles County. Southern California stormwater managers have developed a five-year research agenda to optimize the performance of bioswales and similar stormwater control measures. Photo courtesy of Los Angeles County Public Works

To subscribe: The SCCWRP Director's Report is published quarterly by the Southern California Coastal Water Research Project. To receive this newsletter by email, contact pubrequest@sccwrp.org.

Calendar

Thursday, February 6
CTAG quarterly meeting

Friday, February 7
Seminar: "R and teamwork for better science in less time"

Friday, March 6
Commission meeting

The panel included experts from seven science and engineering disciplines, plus three more representing a regulated stormwater agency, a regulatory agency and an environmental advocacy organization. SCCWRP facilitated the panel's deliberations.

After hearing testimony from SMC members about their research needs and priorities, the panel developed 64 initial project concepts, then refined them down to 24 priority projects organized into six thematic areas:

- » Microbiology and Human Health Risk
- » BMP Monitoring, Implementation and Effectiveness
- » Innovative Technology and Science Communication
- » Expanding the Utility of Biomonitoring
- » Improving Stormwater Monitoring Effectiveness
- » Emerging Challenges

Already, the SMC Steering Committee has begun a prioritization process to decide which projects to tackle in the 2020-21 fiscal year.



A 10-member expert panel convened by the Southern California Stormwater Monitoring Coalition (SMC) deliberates at SCCWRP last year. The panel developed the SMC's 2019-2024 research agenda, which offers a five-year roadmap for how the SMC will collaboratively pursue research to improve runoff water quality.

Over the next five years, SMC members will use the research agenda as they prioritize, design and execute regional stormwater research projects. The research agenda will help the SMC evaluate potential funding opportunities

and decide if, how and when to move forward with projects.

For more information, contact Dr. [Elizabeth Fassman-Beck](#).

Flow duration tool providing foundation for change in federal oversight of streams

A SCCWRP-developed approach for determining the flow duration patterns of streams in the U.S. Southwest is serving as the technical centerpiece in an ongoing effort to change how the federal government provides oversight of streams nationwide.

The stream flow duration tool, which can rapidly distinguish among intermittent, ephemeral and perennial streams, is being used by the U.S. Environmental Protection Agency to help determine which streams the government has jurisdiction to regulate under the federal Clean Water Act.

Under a rules change finalized in January by the Trump administration, entities that discharge into ephemeral streams will no longer be required to obtain discharge permits from the federal government.

Ephemeral streams, which are streams that only experience brief surface flows after rain events, have traditionally been difficult to distinguish from other stream types, including intermittent streams that experience sustained seasonal flows from snow melt and groundwater. Federal agencies will continue to provide oversight of intermittent streams.

Traditionally, distinguishing ephemeral streams from intermittent streams has required obtaining long-term records from gauges or rigorous hydrologic models – neither of which exists for most streams.

The EPA has been working for decades to improve the ability of regulatory agencies to distinguish among different stream types. SCCWRP's flow duration tool, which has been in development for the past two years, has the potential to help stream

managers rapidly develop clarity around complex jurisdictional issues nationwide.

The flow duration tool assesses stream flow duration using easily observed field indicators, including presence of wetland vegetation and specific types of aquatic insects. SCCWRP's tool combines elements of regional tools originally developed for use in the Pacific Northwest and New Mexico.

SCCWRP and its partners have been working to calibrate and test the tool for use in multiple U.S. regions, including the Arid Southwest, Western Mountains and Great Plains.

Along the way, SCCWRP has been leading local watershed managers in collaborative case studies, and proactively identifying opportunities to solve implementation challenges.



Dr. Raphael Mazor, right, leads a field training exercise in Denver, Colorado last year as part of an effort to develop a tool that can rapidly distinguish among streams with different flow types. The U.S. Environmental Protection Agency has requested the tool in multiple U.S. regions to help determine which streams the federal government has jurisdiction to regulate.

SCCWRP's managerially relevant implementation approach has resonated with the EPA, which has accelerated timelines for the tool's rollout in other regions of the U.S., including Alaska, Hawaii and overseas territories.

It remains unclear if or how California will be impacted by the new federal rule. Under the state's Porter-Cologne Water Quality Control Act of 1969, California does not distinguish ephemeral streams from streams with alternate flow regimes.

SCCWRP's work to date is chronicled in a pair of technical reports – a [literature review](#) and a newly published [pilot study](#) on flow duration indicators in the Southwest.

For more information, contact Dr. [Raphael Mazor](#).

DNA-based methods for identifying algae shown to be reliable, possibly more insightful

SCCWRP and its partners have shown in a proof-of-concept study that using DNA methods to conduct algae-based assessments of stream health offers a reliable, cost-effective alternative to traditional biological assessment methods and has the potential to provide richer insights into stream condition.

The three-year study, which will wrap up in February, compared traditional, morphology-based identifications of stream algae to DNA-based, or molecular, identifications of the same samples. Researchers showed that both methods could consistently distinguish among stream sites in poor vs. good ecological health.

The molecular approach, meanwhile, was able to identify hundreds more algal taxa than traditional microscopy-based taxonomic identification, underscoring its potential to provide a more detailed, nuanced understanding of the ecological

condition of algal communities in wadeable streams.

Finally, the molecular approach provided more consistent results more rapidly and more cost-effectively than traditional microscopy.

Stream managers rely on algal communities as a key indicator of ecological impacts to streams because of their sensitivity to even small environmental changes. For example, the [Algal Stream Condition Index](#) – an algae-based stream condition scoring tool co-developed by SCCWRP and unveiled in 2019 – is expected to help form the technical foundation for a proposed statewide stream biointegrity-biostimulatory policy.

Even so, algae-based assessments have traditionally been dependent on a limited number of trained taxonomists to identify samples under a microscope. This manual

identification process is costly, labor-intensive and prone to bottlenecks, underscoring the value of pursuing alternative, DNA-based approaches.

Over the past few sampling seasons, SCCWRP has partnered with stream bioassessment monitoring programs across California to collect and process stream algae samples using both traditional microscopy and molecular methods.

Based on the study's findings, researchers already have begun tackling priority next steps that will enable managers to begin using the molecular methods for routine algae-based bioassessment work.

In particular, researchers have begun exploring the possibility that existing algae-based scoring tools may need to be recalibrated.

Furthermore, because molecular methods are able to identify more algal taxa than traditional methods, researchers have begun working to develop more robust assessment tools to take advantage of the additional data.

Researchers already have begun a follow-up study exploring how to build more global DNA reference libraries to identify additional key algal taxa in California streams.

SCCWRP is working closely with the California Molecular Methods Workgroup – a technical workgroup of the California Water Quality Monitoring Council – to ensure the study's findings are used to inform standardized sampling and analytical protocol development.

A final study report is expected to be published this spring.

For more information, contact Dr. [Susanna Theroux](#).



A SCCWRP field crew collects algae samples from the Santa Margarita River that spans Riverside and San Diego Counties. Researchers have shown that using DNA methods to conduct algae-based assessments of stream health offers a reliable, cost-effective alternative to traditional biological assessment methods. Molecular methods also have the potential to provide richer insights into stream condition.

Non-targeted analysis to be tested in Ventura County source tracking study

SCCWRP has launched a study with Ventura County exploring how the unique chemical patterns inside storm drains might be used to identify and track sources of human fecal contamination in waterways, an approach that has the potential to complement existing, DNA-based source tracking methods.

The study, launched in December, will use non-targeted chemical analysis to analyze coastal storm drain infrastructure for potential human fecal contamination during wet weather.

Non-targeted chemical analysis is a novel approach for tracking sewage in waterways; it focuses on analyzing patterns in the overall chemical makeup of a water sample to create an overall chemical fingerprint – instead of focusing on identifying specific, individual

chemicals through traditional targeted chemical analysis.

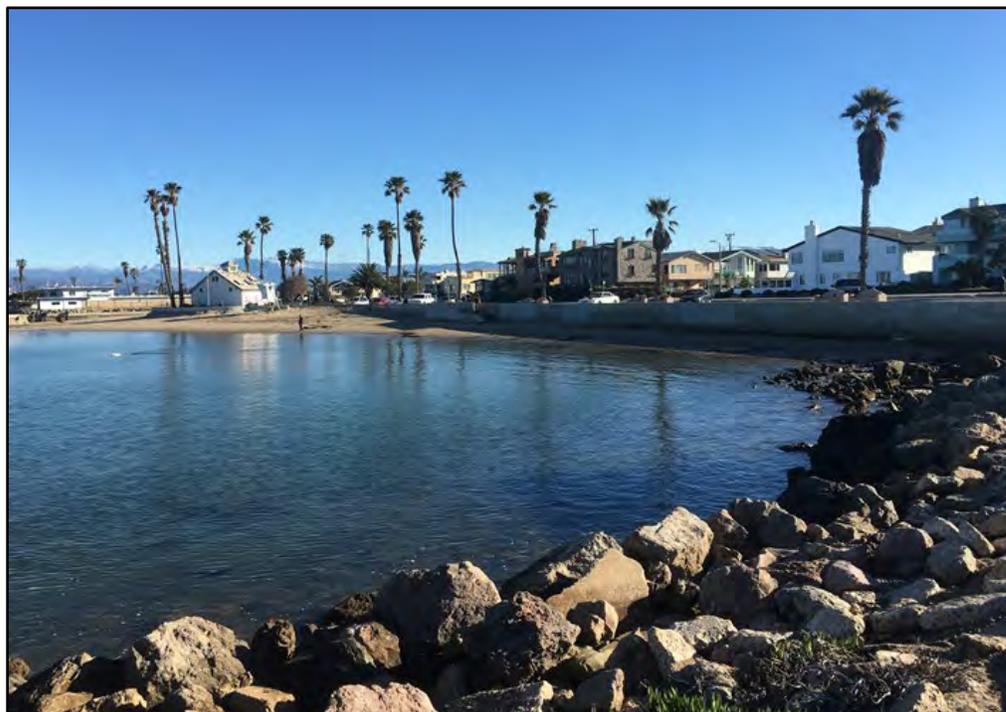
Last year, SCCWRP and its partners showed in a [proof-of-concept study](#) in San Diego that non-targeted chemical analysis can be used to distinguish sewer pipes from storm drain pipes – as well as one sewer pipe from another – during dry weather.

The Ventura County study, which spans just a few blocks of a beachfront residential neighborhood in Oxnard, is the first phase of a broader effort to pinpoint the source(s) of elevated human fecal contamination levels at Hobie Beach and Kiddie Beach Park in Channel Islands Harbor during wet weather; the side-by-side beaches have a TDML (total maximum daily load) for bacteria in wet weather.

During wet-weather events this winter, researchers will look for chemical indicators of sewage contamination in a storm drain that runs through the residential neighborhood. The storm drain is the largest of a handful that discharge into Channel Islands Harbor near the two beaches.

The non-targeted chemical analysis method will be tested alongside two more traditional source tracking approaches: targeted chemical analysis, which focuses on identifying specific chemicals associated with sewage, and microbial source tracking, which relies on a genetic marker known as HF183 to track human fecal contamination.

Having an additional, chemistry-based line of evidence would increase management confidence in the results of DNA-based



Channel Islands Harbor in Ventura County experiences elevated levels of fecal bacteria in wet weather. SCCWRP has launched a study examining whether non-targeted chemical analysis can be used to identify and track potential sources of human fecal contamination in nearby storm drains that discharge to the harbor.

microbial source tracking. Especially if water-quality managers are considering replacing or repairing sewer infrastructure, they need assurances that this potentially costly investment will achieve intended reductions in beach fecal contamination.

During the study, researchers will explore whether non-targeted analysis can be used to pinpoint potential sources of sewage entering storm drain pipes – perhaps down to a specific neighborhood block. Researchers also hope non-targeted analysis will be able to shed light on whether the sewage is coming from a sewer leak vs. illegal dumping vs. contaminated groundwater.

Results of the study could inform how researchers move forward with investigating other potential sources of human fecal contamination in Channel Islands Harbor and beyond.

For more information, contact Dr. [Bowen Du](#).

Updates by Thematic Area

SCCWRP Research Themes [BIOASSESSMENT](#) • [ECOHYDROLOGY](#) • [EUTROPHICATION](#) • [CLIMATE CHANGE](#) • [SEDIMENT QUALITY](#) • [CONTAMINANTS OF EMERGING CONCERN](#) • [MICROBIAL WATER QUALITY](#) • [STORMWATER BMPs](#) • [REGIONAL MONITORING](#)

ECOHYDROLOGY

Statewide environmental flows framework featured in California water resilience report

An ongoing effort by SCCWRP and its partners to develop a standardized approach for setting environmental flow targets for streams statewide is being featured in a new State report intended to guide California in promoting long-term water resilience.

A draft of the State's [Water Resilience Portfolio](#) report, which was released in January, recommends using the California Environmental Flows Framework to better protect the environmental flow patterns that sustain fish and wildlife. The

California Environmental Flows Framework is a multi-tiered framework intended to help managers set optimal environmental flow targets for California streams.

The report contains a suite of recommended actions intended to help California cope with more extreme droughts and floods, rising temperatures, declining fish populations, aging infrastructure and other challenges.

The draft report, which was created through a 2019 executive order from Gov. Gavin Newsom, is undergoing a public comment period through February 7, 2020.

SCCWRP to contribute to report on balancing demands for water resources in California

SCCWRP has been invited to contribute to a statewide report that will examine ways to balance competing demands on California's limited water resources.

The Public Policy Institute of California began working with SCCWRP and other partners in January to explain how the California Environmental Flows Framework – a management framework for setting environmental flow patterns in streams statewide to protect ecological health – can be used to help inform State

efforts to balance water demands.

In the report, titled "Making the Most of Water for the Environment," researchers will explain how the framework can support the State's [Recycled Water Policy](#), [Instream Flows Policy](#) and [Water Action Plan](#).

The report is expected to be completed by early 2021.

Statewide framework to be used to inform flow management for south Orange County streams

Watershed managers working to restore more natural flow patterns to streams in southern Orange County have agreed to use a proposed statewide framework to pursue development of environmental flow targets that optimally protect stream health.

At a January meeting, stakeholders and technical advisors reached conceptual agreement on moving forward with the approach outlined by the California Environmental Flows Framework, a proposed, multi-tiered management framework for setting appropriate environmental flow targets for streams statewide.

The South Orange County Flow Ecology Study will serve as a key demonstration project supporting development of the statewide framework, which is ongoing.

Stakeholders and technical advisors in January reviewed technical analyses completed by SCCWRP and its partners that support the framework's first two tiers: a screening-level analysis comparing the stream's flows to reference flow patterns, followed by an evaluation of how the altered flows are impacting biological communities.

EUTROPHICATION

Study shows freshwater cyanotoxins spread to marine environments

SCCWRP and its partners have completed a three-year study showing that toxins produced by freshwater cyanobacterial blooms are spreading through waterways in California and mixing with marine toxins in downstream coastal ecosystems.

The study, completed in November, showed the pervasiveness of multiple types of freshwater toxins at all of the study's more than 20 coastal monitoring sites. Furthermore, toxins produced by both marine and freshwater HABs (harmful algal blooms) were detected at many coastal sites, with freshwater toxins also found in the tissues of mussels.

A final report summarizing the findings has been submitted to the National Oceanic and Atmospheric Administration.

Causes of cyanotoxin-producing blooms to be investigated in Northern California lake

SCCWRP and its partners have launched a two-year study to investigate the environmental factors that are driving the proliferation of ecologically disruptive, toxin-producing cyanobacterial blooms in Northern California's Clear Lake.

The study, which kicked off in November, will use state-of-the-art remote sensing and observational technologies to gain insights into when, where and why the blooms are occurring. Clear Lake is California's largest freshwater lake; concentrations of the microcystin toxin have been above the state's trigger levels for recreational uses in five out of the past six years.

The methods and technologies being tested in Clear Lake will help inform similar efforts statewide to better understand how managers can mitigate and prevent cyanobacterial blooms.



Clear Lake has exceeded California's trigger levels for cyanotoxins in five out of the past six years. SCCWRP and its partners are examining the factors driving these ecologically disruptive bloom events for a study that help inform management strategies statewide.

Volunteer HABs monitoring program under development for California freshwater environments

SCCWRP and California's Surface Water Ambient Monitoring Program (SWAMP) have launched an effort to develop a voluntary, citizen science-driven monitoring program to boost statewide capacity for monitoring harmful algal blooms (HABs) in freshwater environments.

At a December workshop, academic scientists, regional water board HABs coordinators, scientific NGO staff and representatives from tribal environmental protection departments conceptualized a framework to facilitate the collection of high-quality, comparable freshwater HABs data for SWAMP's Freshwater and Estuarine Harmful Algal Bloom Program.

The recommendations are scheduled to be finalized and published this summer.

Volunteer-driven monitoring is envisioned as one element of a three-pronged approach for increasing freshwater HABs monitoring capacity statewide. Researchers also are pursuing development of statewide field surveys and remote sensing approaches.

CLIMATE CHANGE

Acidification model being updated to reflect present-day conditions

Researchers working to develop a computer model that predicts how the Southern California Bight will be affected by ocean acidification and hypoxia (OAH) have begun updating the model to reflect present-day environmental conditions.

The model, which SCCWRP will work to update in the coming months, was initially calibrated to describe OAH conditions in the 1990s, a period that included an array of El Niño and La Niña conditions that were conducive for assessing model performance.

For the model update, researchers will use more recent atmospheric carbon dioxide levels and nutrient levels being discharged to the coastal ocean.

This next phase of model development is being initiated in partnership with two CTAG stakeholder subcommittees that are advising SCCWRP.

At a January 23 meeting, the first advisory committee provided feedback to SCCWRP on model validation analyses from the 1990s; the committee had requested these additional analyses last year.

A second stakeholder advisory committee, which met for the first time on January 13 at SCCWRP, has begun working on an assessment framework that will help shape how researchers produce modeling outputs for the various future nutrient loading scenarios that will be run through the model.

Expert panel to develop acidification thresholds for crustaceans

A scientific advisory panel of leading global experts on crustaceans will convene at SCCWRP on February 10-12 to begin

developing consensus on biologically relevant thresholds at which these marine organisms can be expected to experience adverse impacts from ocean acidification.

The goal of the panel's work is to be able to use organisms that are sensitive to corrosive seawater conditions as a sentinel indicator of how acidification is impacting West Coast marine communities.

A newly published [journal article co-authored by SCCWRP](#) found that the larvae of commercially important Dungeness crab already are showing signs of shell dissolution because of OA.

SCCWRP and its partners already have convened two other expert panels to determine acidification response thresholds for echinoderms and [pteropods](#), respectively.

Determining these thresholds is critical to interpreting the findings of an ongoing modeling effort to quantify future acidification conditions in Southern California's coastal ocean. The development of such thresholds also is called out in the State's [Ocean Acidification Action Plan](#).

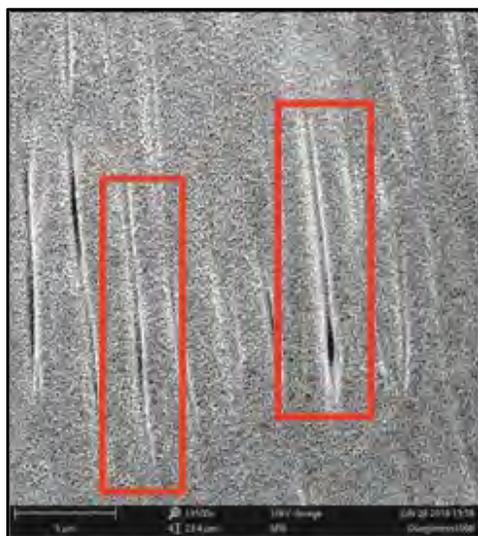
SEDIMENT QUALITY

Ecological health of areas near offshore oil platforms evaluated

SCCWRP and the U.S. Bureau of Ocean Energy Management (BOEM) have completed a two-year study examining the ecological health of the area surrounding offshore oil platforms in the Santa Barbara Channel.

The study, [published in October](#) by BOEM, found that the habitats near the channel's four oldest oil platforms are considered unimpacted by sediment contamination. The study was part of a broader BOEM project evaluating the ecological condition of the continental shelf and slope region of Southern California's coastal ocean.

The oil platform study marked the first sediment quality assessment of this area since the early 1990s. Most monitoring programs, including the Southern



The carapace, or external shell, of crab larvae is vulnerable to shell dissolution as a result of ocean acidification (OA). Above, extensive pit marks are visible on the carapace of a Dungeness crab larva magnified 11,000 times. SCCWRP has convened an expert panel to develop consensus on the thresholds at which these marine organisms can be expected to experience adverse impacts from OA.

California Bight Regional Monitoring Program, avoid assessing the areas near oil and gas platforms because of their relatively small geographical footprint and their unique contamination challenges.

The study will provide important context for energy resources managers as Southern California's offshore oil and gas platforms reach the end of their life and are considered for decommissioning.

Toxicity analysis underway for study revisiting copper TMDL in Marina del Rey Harbor

Researchers have begun analyzing toxicity data for a SCCWRP-led study examining whether existing regulatory targets for dissolved copper in Marina del Rey Harbor should be modified to more accurately reflect the ecological threat posed by copper.

At a meeting in December, the project's technical advisory committee reviewed initial results that SCCWRP obtained via a toxicity analysis method known as the Water Effects Ratio (WER), which quantifies how chemical characteristics of a water body influence the bioavailability of metal contaminants.

Under the Los Angeles County harbor's existing TMDL (total maximum daily load) regulatory target, Marina del Rey Harbor is required to reduce copper loading by 85%, which would require boat owners to make significant changes to the types of anti-fouling paint they typically use on the underside of boats.

The State Water Board is working to update guidance on how to use the WER method to set site-specific criteria for metal contamination in water bodies statewide; results from the Marina del Rey study are expected to inform this update.

Study examining how to use Biotic Ligand Model to update copper loading limits in freshwater systems

SCCWRP has launched a study examining the feasibility of using a toxicity modeling

tool known as the Biotic Ligand Model (BLM) to update copper loading limits for freshwater systems across the Los Angeles region.

The study, launched in December with the Los Angeles Regional Water Quality Control Board, will evaluate whether sufficient data already exist to support use of the freshwater BLM. The BLM, which is an alternative to the established Water Effects Ratio (WER) toxicity analysis method, estimates how chemical characteristics of a water body and their interaction with biological communities influence the bioavailability of metal contaminants.

The U.S. Environmental Protection Agency has endorsed using the BLM to develop site-specific criteria for copper contamination in freshwater systems.

For the study, SCCWRP has compiled a database with more than 30,000 data points from about 50 projects over the past two decades. Researchers also will investigate the feasibility of getting additional data points needed for BLM analyses by leveraging existing monitoring efforts in the L.A. region.

CONTAMINANTS OF EMERGING CONCERN

First phase completed for study examining fate of bioactive CECs from treated wastewater effluent

SCCWRP and the Orange County Sanitation District have completed the first phase of analysis for a one-year study examining whether bioactive chemical contaminants persist at detectable levels after being discharged via treated wastewater effluent to coastal waters.

The first phase, completed in December, involved using bioanalytical assays to screen water-column samples for the presence of bioactive contaminants that could pose health risks to wildlife and humans. The samples were collected along the diffusion gradient of a wastewater plume.

Researchers also will screen sediment samples, then use targeted chemical analysis and possibly gene-expression analysis to learn more about any contaminants they find. The study is scheduled to be completed this summer.



SCCWRP's Dr. Alvina Mehinto transfers small aliquots of cells into assay wells for a bioanalytical screening test. SCCWRP and the Orange County Sanitation District are using bioanalytical screening and other approaches to examine whether bioactive chemical contaminants persist at detectable levels after being discharged via treated wastewater effluent to coastal waters.

REGIONAL MONITORING

Bight '18 Sediment Quality element nearing completion on assessment reports

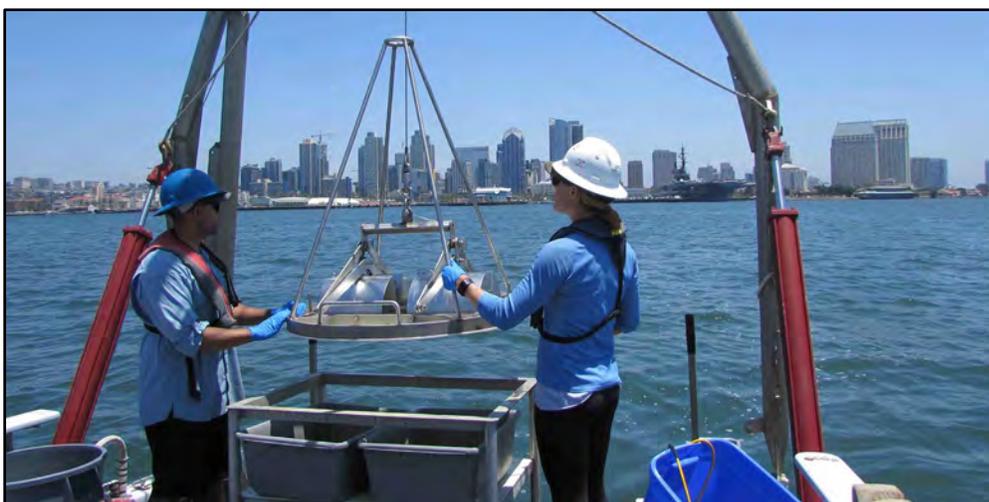
The Sediment Quality element of the Southern California Bight 2018 Regional Monitoring Program is scheduled to publish the first of its assessment reports this spring, with four other report volumes to follow over the next 12 months.

The Bight '18 Sediment Toxicity assessment report is undergoing final review and is scheduled to be published by May.

Meanwhile, the technical committees overseeing sediment chemistry, trawling and bioaccumulation in sport fish have completed their preliminary data analyses, and could begin publishing their assessment reports as early as this summer.

The technical committee overseeing benthic infauna is scheduled to publish its final assessment report in early 2021.

The Sediment Quality element will hold a planning committee meeting February 10 at SCCWRP to review progress to date.



Courtesy of Wood Environment & Infrastructure Solutions

A field crew lowers a sediment grab sampler into San Diego Bay during field sampling for the Southern California Bight 2018 Regional Monitoring Program. The Bight '18 Sediment Quality element is nearing completion on the first of its final assessment reports.

ADDITIONAL RESEARCH

Panel develops recommendations for managing vegetation without glyphosate

An expert advisory panel convened by SCCWRP to explore options for managing vegetation in Los Angeles County without using the herbicide glyphosate has developed a set of recommended alternative strategies.

The five-member panel, which [published its recommendations](#) in January, reviewed a dozen alternative vegetation control measures, from hand removal to application of organic chemicals. Each approach was evaluated for its relevance and effectiveness based on eight criteria.

L.A. County banned the use of glyphosate at all County facilities last year; glyphosate is sold commercially as Roundup.

The panel's recommendations are scheduled to come before the L.A. County Board of Supervisors later this year.

New SCCWRP Publications

Journal Articles (Published)

[Bednaršek, N.](#), R.A. Feely, M.W. Beck, S.R. Alin, S.A. Siedlecki, P. Calosi, E.L. Norton, C. Saenger J. Strus, D. Greeley, N.P. Nezlin, M. Roethler, J.I. Spicer. 2020.

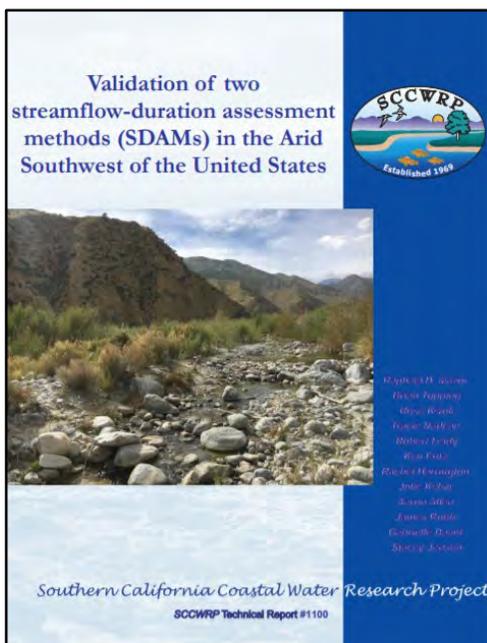
[Exoskeleton dissolution and mechanoreceptor damages in Dungeness crab related to severity of present-day ocean acidification vertical gradients.](#) *Science of the Total Environment* DOI:10.1016/j.scitotenv.2020.136610.

Gomez-Alvarez, V., N.J. Ashbolt, [J.F. Griffith](#), J.S. Domingo, J. Lu. 2019. [Whole-Genome Sequencing of Four Campylobacter Strains Isolated from Gull Excreta Collected from Hobie Beach \(Oxnard, CA, USA\).](#) *Microbiology Resource Announcements* 8:1-3.

Leon, P., [N. Bednarsek](#), P. Welsham, K. Cook, S.E. Hartman, D. Wall-Palmer, J. Hindson, K. Mackenzie, L. Webster, E. Bresnan. 2019. [Relationship between shell integrity of pelagic gastropods and carbonate chemistry parameters at a Scottish Coastal Observatory monitoring site.](#) *ICES Journal of Marine Science* DOI:10.1093/icesjms/fsz178.

Journal Articles (Online)

Harvey, M.E., S.N. Giddings, [E.D. Stein](#), J.A. Crooks, C. Whitcraft, T. Gallien, J.L. Largier, [L.L. Tiefenthaler](#), H. Meltzer, G. Pawlak, K. Thorne, K. Johnston, R. Ambrose, S.C. Schroeter, H.M. Page, H. Elwany. 2020. [Effects of Elevated Sea Levels and Waves on Southern California Estuaries During the 2015–2016 El Niño.](#) *Estuaries and Coasts* DOI:10.1007/s12237-019-00676-1.



SCCWRP has co-authored a new report that describes a rapid method for distinguishing streams in the U.S. Southwest based on the duration of their flows.

Li, X., M. Sivaganesan, C.A. Kelty, P. Clinton, J.R. Reichman, Y. Johnson, W. Matthews, S. Bailey, O.C. Shanks, [A.G. Zimmer-Faust](#). 2019. [Large-scale implementation of standardized quantitative real-time PCR fecal source identification procedures in the Tillamook Bay Watershed.](#) *PLoS One* DOI:10.1371/journal.pone.0216827.

Simons, A.L., [R.D. Mazor](#), [S. Theroux](#). 2019. [Using Co-occurrence Network Topology in Assessing Ecological Stress in Benthic Macroinvertebrate Communities.](#) *Ecology and Evolution* DOI:10.1002/ece3.5751.

[Stein, E.D.](#), C.L. Doughty, J. Lowe, M. Cooper, E. Sloane, D. Bram. 2020. [Establishing Targets for Regional Coastal Wetland Restoration Planning Using Historical Ecology and Future Scenario Analysis: The Past, Present, Future Approach.](#) *Estuaries and Coasts* DOI:10.1007/s12237-019-00681-4.

Sultana, R., M. Mroczek, A. Sengupta, S. Dallman, [E.D. Stein](#). 2020. [Improving Effective Impervious Estimates to Inform Stormwater Management.](#) *Water Resources Management* DOI:10.1007/s11269-019-02474-7.

Yarnell, S.M., [E.D. Stein](#), J.A. Webb, T. Grantham, R.A. Lusardi, J. Zimmerman, R.A. Peek, B.A. Lane, J. Howard, S. Sandoval-Solis. 2020. [A Functional Flows Approach to Selecting Ecologically Relevant Flow Metrics for Environmental Flow Applications.](#) *River Research and Applications* DOI:10.1002/rra.3575.

Technical Reports

Chiotti, D., L. Ritter, D. Schlenk, C. Wilen, [K.C. Schiff](#). 2020. [Alternatives to Glyphosate for Vegetation Management in Los Angeles County.](#) Technical Report 1103. Southern California Coastal Water Research Project. Costa Mesa, CA.

[Mazor, R.D.](#), B. Topping, R. Kwok, T. Nadeau, R. Leidy, K. Fritz, R. Harrington, J. Kelso, A. Allen, J. Robb, G. David, S. Jensen. 2019. [Validation of Two Streamflow-duration Assessment Methods \(SDAMs\) in the Arid Southwest of the United States.](#) Technical Report 1100. Southern California Coastal Water Research Project. Costa Mesa, CA.

Quarter in Review

Conference Presentations

Bianchi, D., F. Kessouri, J. McWilliams, L. Renault, C. Deutsch, H. Frenzel and P. Damien. Impacts of submesoscale ocean dynamics on the biogeochemistry and

ecosystem of the California Current. Coastal and Estuarine Research Federation Biennial Conference. November 3-7, 2019. Mobile, AL.

Ho, M., F. Kessouri, M. Sutula, J. McWilliams, D. Bianchi, T. Gallien, G. Robertson, J. Molemaker. 2019. High resolution numerical ocean outfall plume modeling in the southern California bight. Coastal and Estuarine Research Federation

Biennial Conference. November 3-7, 2019. Mobile, AL.

Kessouri, F., M.A. Sutula, D. Bianchi, J. McWilliams, C. Deutsch, K. McLaughlin, M. Ho, N. Bednarek, E. Howard, L. Renault, S. Yang and S.B. Weisberg. Submesoscale Simulations to Support Management Conversations on the Impact of Local Pollution in Southern California. Coastal and Estuarine Research Federation Biennial Conference. November 3-7, 2019. Mobile, AL.

Kessouri, F., D. Bianchi, M. Sutula, C. Anderson, R.M. Kudela, J. Smith. Ocean Modeling Supports Management Conversations on the Impact of Local Pollution Sources on Algal Blooms in Southern California. American Geophysical Union Fall Meeting. December 9-13, 2019. San Francisco, CA.

McLaughlin, K., F. Kessouri, M. Ho, M.A. Sutula, D. Bianchi, J.C. McWilliams, C. Deutsch, L. Renault, N. Bednarek, E. Howard, L. Renault, S. Yang, R. Feely, S. Alin, R. Ambrose, M. Gold and S.B. Weisberg. Validation of a High-Resolution Physical-Biogeochemical Model for Pollution Impact Assessments in the Southern California Bight. Coastal and Estuarine Research Federation Biennial Conference. November 3-7, 2019. Mobile, AL.

McLaughlin, K., K. Schiff, N. Bednarek, D. Diel, B. Du, D. Gillett, J. Griffith, D. Greenstein, A. Parks, J. Smith, S. Weisberg. Regional Monitoring for Sediment and Water Quality in the Urban Ocean of the Southern California Bight. California Cooperative Oceanic Fisheries Investigations Conference. December 2-3, 2019. La Jolla, CA.

Schiff, K., M. Beck, N. Afroz. Assessing stormwater treatment effectiveness using flow-through best management practices. Society of Environmental Toxicology and Chemistry Annual Conference. November 3-7, 2019. Toronto, Canada.

Smith, J., A.O. Tatters, M.D.A. Howard, R.M. Kudela, K. Negrey, M. Roethler, D.A. Caron. King Tides Result in Episodic Cross-Contamination of a California Coastline with Cyanobacterial and Algal Toxins. American Geophysical Union Fall Meeting. December 9-13, 2019. San Francisco, CA.

Sutula, M.A., F. Kessouri, J. McWilliams, C. Deutsch, D. Bianchi, N. Bednarek, E. Howard, L. Renault, K. McLaughlin, R.A. Feely, S.R. Alin, and R.F. Ambrose. Nutrient Pollution Effects on Acidification and Hypoxia in Southern California Bight: Biological vs. Water Quality Impacts. Coastal and Estuarine Research Federation Biennial Conference. November 3-7, 2019. Mobile, AL.

Weisberg, S. Enhancing our ocean acidification monitoring network. West Coast Ocean Alliance meeting. December 4, 2019. Tacoma, WA.

Other Presentations

Bednaršek, N. Multi-faceted integration for more accurate ocean acidification assessment in the open-coastal ocean. National Oceanic and Atmospheric Administration Strategic Planning and Implementation of the Ocean Acidification Program. 2020.

Bednaršek, N. The emerging science of acidification impacts across various spatial scales. Global Ocean Acidification Observing Network North American Hub. December 16-18, 2019. Huatulco, México.

Bednaršek, N. Linking present-day ocean acidification impacts to socio-economic and governmental implications. COST Action OceanGov Conference. November 25-27, 2019. Piran, Slovenia.

Fassman-Beck, E. Modernizing Performance Metrics for Stormwater Infrastructure. Norwegian University of Science and Technology. January 22, 2020. Trondheim, Norway.

Fassman-Beck, E. LID-GI BMP Performance. Orange County Co-Permittee Monitoring Group Meeting. January 26, 2020. Orange, CA.

Mazor, R. Overview of the San Diego Creek Causal Assessment Report. Newport Bay Watershed Executive Committee. December 18, 2019. Irvine, CA.

McLaughlin, K., K. Schiff. Partnership with the Southern California Bight Regional Marine Monitoring Program. California Cooperative Oceanic Fisheries Investigations Program Workshop. December 4, 2019. La Jolla, CA.

Mehinto, A.C. Use of Cell Bioassays for Assessing Chemicals in Water Matrices. WaterReuse Association Los Angeles Chapter. December 3, 2019. Burbank, CA.

Mehinto, A.C. Bioanalytical Tools: A Screening Approach to Assess Chemical Mixtures. California Water Environment Association Water Reuse Workshop. January 15, 2020. Whittier, CA.

Mehinto, A.C. Bioanalytical Tools: A Screening Approach to Assess Chemical Mixtures. California Water Environment Association Water Reuse Workshop. January 22, 2020, San Francisco, CA.

Schiff, K. Assessing stormwater treatment effectiveness using flow-through best management practices. State Water Resources Control Board Stormwater Roundtable. December 5, 2019. Riverside, CA.

Smith, J. Harmful Algae and Triggers of Algal Blooms in the Southern California Bight Region. County of San Diego Department of Environmental Health Land and Water Quality Division All Hands Meeting. December 12, 2019. San Diego, California.

Smith, J., and K. McLaughlin. HABs Element of the Southern California Bight Regional Monitoring Program. California Cyanobacteria and Harmful Algal Bloom Network Quarterly Meeting (CCHABs). December 19, 2019. Sacramento, California.

Stein, E. Effects of Sea Level Rise and Alternative Sediment Management Practices on Habitat and Species of Upper Newport Bay. Newport Bay Watershed Executive Committee. December 18, 2019. Irvine, CA.

Stein, E. Balancing Water Reuse and Stream Quality in the Highly Urbanized Los Angeles River Watershed: Application of Statewide Framework. National Water Reuse. December 2, 2019. Via webinar.

Taylor, J. Potential climate change effects on riparian habitats and species. Los Angeles Regional Water Quality Control Board. January 23, 2020. Los Angeles, CA.

SCCWRP Personnel Notes

Commission

Christina Yin, Manager of the Water Quality Standards and Assessment Section for the U.S. Environmental Protection Agency, Region 9, was appointed Alternate Commissioner in December, replacing David Smith, who took on a new role with EPA Region 9.

Promotions



Dr. **Jennifer Taylor**, who just earned her doctorate in Environmental Science and Engineering while working as a Senior Research Technician in the Biology Department, was promoted to Scientist in January.



Dr. **Susanna Theroux**, who has worked as a Scientist in the Biology Department since 2016, was promoted to Senior Scientist in January.

Departures

Shelly Moore, a Senior Scientist in the Biogeochemistry Department who has worked at SCCWRP since 1994, left SCCWRP in December to take a position with Algalita Marine Research and Education.

Scientific Leadership

Dr. **Martha Sutula** has been appointed an Associate Editor of the journal *Elementa: Science of the Anthropocene*.

Dr. **Nina Bednaršek** has been named Topic Editor for Acidification and Hypoxia in Marginal Seas for the journal *Frontiers in Marine Science*.

Dr. **Nina Bednaršek** led a discussion on the biological effects of ocean acidification at a Global Ocean Acidification Observing Network North American Hub meeting, held December 16-18, 2019 in Mexico.

Dr. **Stephen Weisberg** has been appointed to the Planning Committee for the U.S. Environmental Protection Agency's National Beach Conference, scheduled for April 21-24, 2020 in Chicago.

Dr. **Stephen Weisberg** has been appointed to the Science Review Panel for the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle, Washington.

SCCWRP COMMISSIONER SPOTLIGHT

Veteran manager thrives on solving problems

The way Shauna Lorange sees it, there's no problem that's too big to solve. In fact, she thrives on finding solutions to issues that seem insurmountable.

During her two-decade tenure at the San Juan Water District east of Sacramento, one of her most exciting experiences was collaborating with dozens of other agencies to manage regional water resources – a highly contentious, complex issue that required balancing the many competing human uses of water resources with the need to protect the ecological health of the lower American River.



Shauna Lorange

Now, as Director of the City of San Diego Public Utilities Department, she's working to reform a 1,700-employee department that in recent years has struggled with customer service issues, especially billing for residential service.

"I don't feel a lot of constraints about trying to get something solved," Lorange said. "I like thinking outside the box, and most people who've worked for me say I don't have a box and I should get in a box sometimes."

Lorange became a SCCWRP Commissioner in August 2019, when she was hired following a nationwide search to replace Vic Bienes, who retired.

Lorange fell into the world of water management by accident. A math lover, she majored in mechanical engineering as a UC Davis undergraduate. But after a brief stint working on heating and air-conditioning units in the 1980s, she realized mechanical engineering wasn't for her.

She decided to try her hand at environmental consulting, where she



Shauna Lorange explores Gunnison, Colorado with her husband, Ron, in 2019.

Shauna Lorange, P.E.

Job: Director, City of San Diego Public Utilities Department (August 2019-present)

SCCWRP role: Commissioner

Prior jobs: Interim General Manager, Monterey County Water Resources Agency (2019); One Water Community of Practice Leader, Kennedy/Jenks Consultants (2017-18); General Manager and Assistant General Manager, San Juan Water District (1996-2006); Project Manager, Kennedy/Jenks Consultants (1989-96)

Education: B.S. mechanical engineering, University of California, Davis (1987)

Residence: San Diego

Hometown: Cupertino, California

Family: Husband Ron, retired construction engineer; daughters Amy, a Realtor, and Nicole, a marketing major at Western Colorado University; son Ryan, a ride-sharing driver; dog Missy, an Australian shepherd; cat Lulu

Hobbies: Traveling, especially beach destinations; spending time with friends; reading

was assigned to work on water distribution modeling and planning. She fell in love with water – and has never looked back.

In 1996, after working for seven years as a consultant, she was hired as Assistant General Manager of the San Juan Water District, a wholesale water supplier serving eastern Sacramento County and southern Placer County. She was promoted to General Manager seven years later, and served in the role for 13 years.

After retiring from the San Juan Water District in 2016, Lorange stayed busy – first by returning to consulting for a year, then by taking a short-term, six-month position as Interim General Manager of the Monterey County Water Resources Agency in 2019. Although she planned to continue serving in interim positions, the City of San Diego offered her the Director position on a permanent basis.

"It's kind of fun when your kids have moved out and you realize you can do whatever you want," said Lorange, who has relocated to San Diego from her long-time home in the Sacramento suburb of Newcastle. "If I can make a difference for the people who work here – help them understand that we work for the customer and that it's fun to do so – then everyone's life is going to be better."

In San Diego, Lorange has fallen in love with Coronado Beach and Coronado Island, and also has been enjoying exploring Balboa Park.

CTAG SPOTLIGHT

Scientist comes full circle with Water Boards

Dr. Emily Duncan's first encounter with the California Water Boards was as an undergraduate intern 13 years ago in the Ocean unit of the State Water Resources Control Board.



Dr. Emily Duncan

But the UC Davis student wasn't interested in pursuing employment at the time – she was itching to expand her horizons in graduate school first.

In 2010, she moved back east to earn her Ph.D. in soil science and biogeochemistry from Pennsylvania State University. Then, she spent three years as a post-doc in Ohio working on agricultural runoff issues for the U.S. Department of Agriculture.

It was not until Duncan relocated back to California for her husband's job last year that she realized how much she enjoyed working at the Water Boards.

"It really is a full-circle situation," said Duncan, who started in September 2019 as a Senior Environmental Scientist for the Los Angeles Regional Water Quality Control Board. "I realized how rewarding this line of work is – I like the applied side of research, and the Water Boards align with my values."

At the L.A. Regional Board, Duncan specializes in contaminated sediment issues, including dredging permits, and also serves as the regional coordinator for the California Surface Water Ambient Monitoring Program (SWAMP). She replaces Dr. Jun Zhu on CTAG; Zhu has taken on new job responsibilities.

Duncan's interest in soils and agriculture was forged when she took a sustainable agriculture course while studying abroad in the Netherlands. She was fascinated by the connections between food



Dr. Emily Duncan and husband Andrew explore the Amalfi coast during a 2019 vacation in Italy.

Emily Duncan, Ph.D.

Job: Senior Environmental Scientist, Los Angeles Regional Water Quality Control Board (September 2019-present)

SCCWRP role: CTAG Representative

Prior jobs: Postdoctoral Research Soil Scientist, U.S. Department of Agriculture (2016-19); Research Assistant, UC Davis Center for Spatial Technology and Remote Sensing (2006-2010); Intern, California State Water Resources Control Board (2007-10)

Education: Ph.D. soil science and biogeochemistry, Pennsylvania State University (2016); B.S. environmental resource science, University of California, Davis (2009)

Residence: Pasadena

Hometown: Davis, California

Family: Husband Andrew, an automotive engineer; a cat, Jack

Hobbies: Baking; crocheting; local hiking; traveling; reading, yoga

production and protection of soil resources.

"It's something we don't necessarily think about – how soils are an underlying component of many ecosystems," Duncan said. "It affects what we eat and how we choose to farm."

After earning her Ph.D. in 2016, Duncan moved to Ohio to work as a Postdoctoral Research Soil Scientist for the USDA's Soil Drainage Research Unit, based in Columbus. She studied how to improve water quality in agricultural lands, and conducted soil health assessments on privately owned farms.

"Water quality has always been a theme in the work I've done," Duncan said. "Now I'm just doing much more urban water quality than rural."

On CTAG, Duncan is looking forward to working collaboratively across the regulatory aisle to advance water-quality management.

"SCCWRP is really valuable in bringing us together, executing projects we cannot execute on our own, and figuring out what we need," Duncan said. "It's not common to have an organization like SCCWRP."

In her spare time, Duncan is an avid baker who religiously watches the Great British Bake Off, a televised U.K. baking competition. She also enjoys doing yoga, especially Katonah yoga, and crocheting a wide variety of items, from baskets to potholders to stuffed animals.

SCCWRP PARTNER SPOTLIGHT

HABs researcher drawn to applied side of science

Dr. Keith Bouma-Gregson started his Ph.D. program at UC Berkeley eight years ago planning to pursue a career in academia.



Dr. Keith Bouma-Gregson

He was interested in studying algae at the bottom of aquatic food webs – and thus figured his research niche would be more theoretical than applied.

But then, Bouma-Gregson started working on harmful algal blooms (HABs) in the Eel River in Northern California. The more he learned about HABs' ties to public health and natural resources management, the more he was drawn to the applied side of HABs research.

"I saw opportunities to contribute my data analytics and analysis skills to what will hopefully be long-term policy recommendations and decisions," said Bouma-Gregson, who joined the State Water Resources Control Board last year as an Environmental Scientist. "It piqued my curiosity – the doors just kept opening for me."

Bouma-Gregson, who has been interacting with HABs scientists and managers since he started his Ph.D. program in 2012, is a key SCCWRP collaborator on HABs research and monitoring.

He is co-lead of the State Water Board's freshwater HABs program, and works closely with SCCWRP to advance scientific understanding of HABs in freshwater environments. Most recently, he partnered with SCCWRP to develop recommendations for designing a statewide HABs monitoring program.

"SCCWRP brings valuable knowledge of how other management entities are addressing their monitoring challenges to help us tackle the challenges of HABs monitoring and management.," Bouma-



Dr. Keith Bouma-Gregson explores Henry W. Coe State Park in the San Francisco Bay Area with wife Lindsey, daughter Betsy and son Desmond during a 2019 backpacking trip.

Keith Bouma-Gregson, Ph.D.

Job: Environmental Scientist, California State Water Resources Control Board (2019-present)

SCCWRP role: Partner on freshwater HABs research and monitoring programs

Prior jobs: Postdoctoral Researcher, UC Berkeley (2018); Intercultural Programs Coordinator, LCC International University in Lithuania (2007-09); Naturalist, Mission Springs Outdoor Education in Scotts Valley (2006-07); Senior Instructor, Summit Adventure in Bass Lake (2006-09)

Education: Ph.D. integrative biology, University of California, Berkeley (2017); M.S. natural resource management and the environment, University of Michigan (2011); B.A. sociology, Westmont College (2005)

Residence: Berkeley, California

Family: Wife Lindsey, an oncology nurse; children Desmond, 3, and Betsy, 1; five chickens

Hometown: Thousand Oaks, California

Hobbies: Rock climbing, backpacking, bird-watching, running

Gregson said. "That's been a great asset to our small team."

Bouma-Gregson has not always known he wanted to study algae and HABs. As an undergraduate at Westmont College in Santa Barbara, he was a sociology major – drawn to studying issues of race, power and class conflict.

After graduating in 2005, he taught outdoor education and worked as a wilderness tour guide. In 2007, seeking an international adventure, he moved to Lithuania, where he worked for two years as a coordinator for extracurricular student programs at an English-speaking university.

But increasingly, Bouma-Gregson realized he wanted to pursue a career in environmental science. In 2009, he returned to the U.S. to enroll in a master's program in natural resource management at the University of Michigan, followed by his Ph.D. at UC Berkeley.

In his spare time, Bouma-Gregson is an avid outdoorsman; he enjoys hiking, rock climbing and backpacking in the Sierras. One of his all-time favorite spots is Bench Canyon southeast of Yosemite National Park.

"It offers amazing views as the sun is setting on Mt. Ritter," he said. "I love watching the slopes turn pink."

SCCWRP STAFF SPOTLIGHT

Biologist finds calling in freshwater sciences

Dr. Katherine Irving entered graduate school planning to pursue a career in marine biology. But very quickly, she discovered she preferred freshwater biology – and has never looked back.



Dr. Katherine Irving

During her master's program at Queen Mary University in the U.K., Irving became fascinated by hydrological flow regimes and how they shape landscapes. Faculty mentors opened her eyes to the significant knowledge gaps that persist on the freshwater side.

"I realized that freshwater is not as promoted as terrestrial and marine science," said Irving, who went on to earn her Ph.D. in biology from Berlin's Leibniz Institute for Freshwater Ecology and Inland Fisheries. "What I work on is

exciting because there are not a lot of experts out there to say if you're doing something right or wrong – we're blazing a trail."

Irving, who studies the ecological impacts of altered flow patterns, joined SCCWRP in September as a Scientist in the Biology Department. She is working on multiple SCCWRP projects exploring the relationship between flows and ecological health, including via mechanistic modeling.

Irving's interest in environmental science began at a young age, when she would watch BBC wildlife documentaries produced by the famed David Attenborough.

At age 7, Irving, who grew up in the rural Lake District in northwestern England, wrote to Attenborough asking why his documentary crew couldn't intervene to save a baby penguin that



Dr. Katherine Irving approaches a manta ray in the waters off Indonesia during a scuba diving trip in 2017.

Katherine Irving, Ph.D.

Job: Scientist, SCCWRP Biology Department (started September 2019)

Prior jobs: Science Divemaster, Operation Wallacea in Honduras (2014); Microplastic Research Supervisor, Archipelagos Institute of Marine Conservation in Greece; Assistant Ecologist, Hesketh Ecology in the U.K. (2013)

Education: Ph.D. biology, Leibniz Institute for Freshwater Ecology and Inland Fisheries in Germany (2019); M.S. freshwater and marine ecology, Queen Mary University in the U.K. (2015); B.S. marine biology, University of Plymouth in the U.K. (2008)

Residence: Long Beach

Hometown: Lake District, U.K.

Hobbies: Scuba diving; traveling; sewing and crocheting

had been orphaned. Attenborough wrote back that the penguin's death was part of the circle of life.

Just before graduate school, Irving completed two international internships to gain experience in environmental field work. First, she spent six months in Greece in 2013 counting microplastics particles in fish stomachs as a research supervisor; the following year, she traveled to Honduras to teach school children about coral conservation.

Irving joined SCCWRP last year as she was finishing her doctorate. She had never been to California before, but was drawn to SCCWRP's focus on applied science.

"I knew I wanted to see my science get used in real life – that means more to me than just publishing papers," Irving said.

Irving also is drawn to working in California because it is an international leader on flow-ecology issues. She is looking forward to seeing science get used to inform water resources management statewide.

"It's just amazing to be part of something like this – it's so cutting-edge," she said.

In her spare time, Irving is an avid scuba diver; she is certified as a Divemaster, and plans to join a diving club near her home in Long Beach. She also enjoys sewing and crocheting, including making many of her own clothes.

SCCWRP SCENES

Looking for leaks

SCCWRP is honing its ability to measure exfiltration from underground sewer pipes by constructing an experimental, above-ground system that mimics the flows inside sewers. The prototype system, which was custom-built in January at SCCWRP, will enable researchers to study how to use flow meters to detect and measure tiny leaks in public sewer systems. For the initial investigation at SCCWRP, researchers have placed a pair of ultrasonic flow meters upstream and downstream of a 20-foot-long sewer pipe that has been suspended with chains above the ground. Clean water is being circulated through the closed system.



Clockwise from top right, SCCWRP researchers test a newly constructed sewer exfiltration test system on SCCWRP's patio; Dr. Joshua Steele, Dr. Amy Zimmer-Faust and Dr. John Griffith inspect yellow-colored, ultrasonic flow meters placed upstream and downstream of a sewer pipe that measure flows through the system; and Dr. John Griffith inspects the downstream end of a sewer pipe as clean water pours from it.

