



# **SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT AUTHORITY**

## **FY 2023-2024 RESEARCH PLAN EXECUTIVE SUMMARY**

**Approved by the SCCWRP Commission  
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# Introduction

The Southern California Coastal Water Research Project (SCCWRP) is a public research agency that develops and applies next-generation science to improve management of aquatic systems in Southern California and beyond. Since its founding in 1969, SCCWRP has focused on developing strategies, tools and technologies that the region's water-quality management community relies on to effectively protect and enhance the ecological health of Southern California's coastal ocean and watersheds. SCCWRP's reputation is built on conducting scientific research and translating it into actionable guidance that informs management decision-making and policy development. SCCWRP science has served as the basis for discharge permits and watershed basin plans, runoff requirements for development, biological objectives for aquatic life, sediment quality criteria, and microbial contamination standards for beach ocean water. SCCWRP also plays a key role in developing and facilitating long-term regional monitoring programs, stewardship of environmental data, and regional planning efforts and regulatory compliance strategies. Through its governing board, the SCCWRP Commission, SCCWRP works to build scientific consensus and unify its 14 member agencies and other environmental organizations around best-practices approaches for improving management of aquatic systems.

## Mission

SCCWRP's mission is to enhance the scientific foundation for management of Southern California's ocean and coastal watersheds. The SCCWRP Commission's vision is that the effective transfer of science from SCCWRP to member agencies and other stakeholders will lead to implementation of appropriate, viable management strategies that protect the ocean and coastal watershed resources for present and future generations. To achieve this mission and vision, SCCWRP is guided by four goals:

1. Undertake and participate in scientific investigations to understand ecological systems in the coastal waters and associated watersheds, in order to document relationships between these systems and human activities relevant to SCCWRP member agencies.
2. Serve as a respected source of unbiased coastal water quality science.
3. Develop scientific consensus on issues relevant to management decisions and application of science by member agencies.
4. Stimulate conversion of science to action.

## Research Vision

SCCWRP scientists apply biological, chemical, toxicological, biogeochemical, and microbiological principles to monitor and assess the condition of aquatic ecosystems, with an overarching goal to solve significant challenges in water-quality and aquatic ecosystem management. SCCWRP leverages its direct connections to the water-quality management community to set a comprehensive, independent research agenda that guides its priorities and directions. This research vision is conceptualized and advanced through collaborative planning with the SCCWRP Commission's Technical Advisory Group (CTAG), which is the scientific advisory panel formed by the lead scientists and managers from each of SCCWRP's 14 member agencies. While SCCWRP conducts basic research, it does so within a strategic context of transitioning this science into real-world applications. Accordingly, the agency's research vision spans multiple years and transcends individual projects. As SCCWRP staff weighs taking on specific projects and works to balance competing demands, CTAG and SCCWRP staff work together to ensure that all projects remain integrated into – and integral to – the shared master vision.

## Research Areas

SCCWRP consists of six science departments – Toxicology, Chemistry, Biogeochemistry, Biology, Microbiology and Engineering – that work in an interdisciplinary, interconnected fashion across SCCWRP's major research areas:

1. **Bioassessment**
2. **Ecohydrology**
3. **Eutrophication**
4. **Climate Change**
5. **Contaminants of Emerging Concern**
6. **Microbial Water Quality**
7. **Stormwater BMPs**
8. **Regional Monitoring**

Furthermore, SCCWRP conducts new and emerging research that has yet to grow into a thematic focus area, as well as research that addresses topics of immediate interest to member agencies but that may not grow into a full-scale research program. This area is known as **Emerging Research and Member Agency Support**.

## Research Planning Process

SCCWRP staff works in partnership with the agency's 14 CTAG Representatives to develop and periodically update a five-year research vision for each of SCCWRP's major thematic research areas. Written for knowledgeable scientists working in each particular field, these full thematic Research Plans, which are [published on SCCWRP's website](#), provide an overview of how SCCWRP conceptually approaches the research theme and how SCCWRP's multi-faceted research strategy fits together. These comprehensive technical documents also identify broadly supported priorities for research. CTAG and SCCWRP staff collaborate in all-day research planning workshops to update these documents on a rolling basis, typically every three years. CTAG's goal is to ensure SCCWRP's research agenda remains relevant to member agency needs, and to help identify opportunities to transfer SCCWRP's research to application.

Separately, SCCWRP annually prepares this document – the Research Plan Executive Summary – for the SCCWRP Commission to convey the broad thematic areas around which SCCWRP research is focused, and to provide an overview of the major projects being worked on to advance those thematic areas. This document, written for a management-level audience, consists of a series of concise summaries of SCCWRP's research directions within each research theme, plus corresponding financial information for the upcoming fiscal year.

# Bioassessment

Biological assessment, or bioassessment, is the science of evaluating the health of an ecosystem by assessing the organisms that live within it. In aquatic ecosystems, algae and invertebrates serve as particularly useful indicators of ecosystem health because they are relatively sessile and live along bottom habitats where chemical and other stressors often concentrate. Unlike traditional chemistry-based monitoring, which provides only limited information about a relatively narrow portion of the environment at a discrete point in time, bioassessment accounts for living organisms exposed to multiple chemicals and other stressors (such as altered habitats and changes in life-sustaining water-flow patterns) over extended time periods. Consequently, bioassessment has the potential to provide a more integrated reflection of the condition of an aquatic ecosystem; bioassessment also is more closely tied to environmental managers' end-goal focus on ecosystem protection and serves as an important way to monitor and protect the populations of endangered species and fisheries. SCCWRP is focused on developing an overall bioassessment framework (e.g., survey design, interpretation methods) and associated tools that environmental managers can use to assess the health of aquatic ecosystems and inform regulatory and management decisions. SCCWRP has made considerable progress on developing bioassessment tools for streams, wetlands and marine environments for a subset of organisms, including benthic invertebrates, fish and algae. SCCWRP is also developing molecular methods for assessing each of these communities individually as well as interactions between communities. SCCWRP's goal is to develop bioassessment tools for all aquatic habitats using a wide variety of organisms, as different organisms are uniquely suited to evaluate specific habitats.

SCCWRP's bioassessment work revolves around four main research areas: (1) condition assessments, which encompasses developing multiple bioassessment tools and methods to evaluate and quantify the condition of multiple water body types; (2) development of molecular methods, eDNA in particular, to more cost-effectively conduct condition assessments, (3) causal and protective assessments, which encompasses applying bioassessment data and analyses to diagnose potential causes of water body impairment and vulnerabilities of healthy waterbodies to future impairment, and (4) bioassessment targets for improved water body health, which encompasses establishing scientifically defensible, quantitative benchmarks and targets for maintaining and/or working toward attainment of beneficial-use goals. To ensure condition and causal assessments are used to guide management decision aimed at improving overall condition, SCCWRP develops synthesis and integration tools that can translate and interpret bioassessment data and findings to actionable information. In particular, SCCWRP focuses on developing bioassessment interpretation frameworks to help managers understand how to use bioassessment results to inform decision-making, and how to connect bioassessment results to policies intended to protect water body health.

This year, SCCWRP will continue to develop, refine, and expand its capacity to conduct both condition assessments and causal/protective assessments, as well as pursue development of guidance and decision support tools to inform management actions. SCCWRP's focus for 2023-2024 will be on:

- **Expanding capacity to assess different waterbody types:** Building on past successes developing bioassessment indices for freshwater and marine ecosystems, SCCWRP will focus on developing capacity to use bioassessment tools to assess other waterbody types, such as seagrass meadows, ephemeral streams, lakes, and estuaries. This research involves the development of sampling methods, taxonomic standardization protocols, creation of indices or other interpretive tools, data management improvements and training programs.

- **Integration of molecular methods:** Building on more than a decade of collaborative development of molecular methods, SCCWRP will continue to focus on the development and integration of molecular methods into monitoring and assessment programs. SCCWRP will further develop the use of environmental DNA (eDNA) technologies – including DNA metabarcode sequencing and quantitative PCR (qPCR) – as rapid, cost-effective molecular methods to augment traditional monitoring for priority taxa, such as invasive and endangered species, bioindicators such as benthic algae and macroinvertebrates, and harmful toxigenic algae. In addition to developing molecular methods for collecting and analyzing eDNA, SCCWRP will also be working to better understand fate and transport dynamics of eDNA in the environment, including eDNA shedding and decay rates. Finally, SCCWRP will explore new ways to interpret and synthesize data from multiple indicators, such as multi-trophic network models and functional gene assays, to improve understanding of ecosystem function and evaluate how they support policies aimed at protecting water body health.
- **Linking conditions to stressors:** SCCWRP will continue to evaluate the relationship between biological condition measures and stressors (ranging from conventional pollutants such as chloride, to new and emerging pollutants) to help managers set stressor levels that will protect aquatic life. These relationships are foundational to SCCWRP’s ability to develop tools that make causal assessment a reality and an integrated part of routine monitoring. Ongoing efforts focus on linking measures of biointegrity to indicators of eutrophication, freshwater salinization, and temperature alteration. Through the development of response models, managers can set targets for improving conditions in freshwater and marine ecosystems.
- **Enhancing causal and protective assessment:** SCCWRP’s bioassessment research not only facilitates the detection of waterbodies in poor biological condition, but it also helps identify stressors causing the impacts. For example, SCCWRP will continue to expand prototype Rapid Screening Causal Assessment (RSCA) tools that facilitate automated analysis of regional monitoring data to diagnose likely causes of poor conditions at sites of interest; this expansion will include additional stressors, such as hydrologic alteration, water or sediment toxicity, and invasive species. In addition, SCCWRP is developing a web-based dashboard to enable application/interpretation of bioassessment data. These tools and their data interface will speed up the traditionally time-consuming process of analyzing stream bioassessment data to pinpoint which stressors are responsible for poor stream condition. SCCWRP also will continue developing a framework to link causal assessment results with specific, practical management actions to improve water body condition. Finally, SCCWRP will work toward developing tools that use bioassessment data to support protective management actions, including identifying water bodies that have high conservation value and water bodies that are healthy but vulnerable to future stressor exposure. For both causal and protective assessment tools, SCCWRP research will expand efforts to incorporate environmental justice concerns to ensure that managers can prioritize their activities in equitable ways that benefit underserved communities.
- **Supporting applications to management:** Perhaps the greatest obstacle to using biological data is their relative complexity compared to other types of monitoring data. To get around this obstacle, SCCWRP is developing tools capable of high-level syntheses of complex data sets, while also supporting deeper investigations for audiences requiring high levels of detail

about their biological monitoring data. This work will be mainly accomplished through improved data science tools, such as easily understood data interfaces and automated report cards that advance open science principles, including analytical transparency and repeatability, as well as clear communication of results. Finally, SCCWRP will continue to support the consistent production and use of bioassessment data through the development of protocols for standardizing monitoring data, and through participation in workgroups focused on these goals. This includes development of web-based and video training materials that facilitate consistent application of bioassessment tools.

[Full thematic Research Plan for Bioassessment](#) (PDF)

## Ecohydrology

Ecohydrology is the study of how changes to flow patterns affect the health of aquatic ecosystems. Streams, estuaries, wetlands and other aquatic environments all experience routine natural variation in the timing, magnitude, duration and frequency of flows. But human activities also can trigger significant disruptions to flow patterns that alter the structure and composition of aquatic ecosystems. California's water resources management community needs to understand the ecological consequences of these alterations to environmental flows, so managers can make optimal decisions about how to impound, divert, recharge and otherwise control the release of water to serve a variety of societal needs – from flood control to agricultural irrigation to water recycling. SCCWRP is working to help water resources managers take science-informed approaches to solving complex flow management issues. By developing tools and strategies that help managers evaluate various potential options for offsetting threats to environmental flows, SCCWRP is helping to bring greater consistency, standardization and coordination to the design of environmental flow management programs across California.

SCCWRP's ecohydrology research is driven by three major objectives: (1) Understand and predict hydrologic change in response to natural and anthropogenic drivers (e.g., land use, climate change, water use practices), (2) develop tools, including statistical and deterministic models, to evaluate the relationship between changes in hydrology, physical habitat (e.g., sediment-flux and channel form) and biologically relevant water-quality parameters (e.g., temperature, turbidity, specific conductance) to biological response in the stream, and (3) evaluate the effectiveness of various management actions (e.g., BMPs) and other efforts to reduce or mitigate the impacts of flow modification. Effectiveness assessment includes development of user-friendly decision support tools and case studies that demonstrate implementation of ecohydrology management actions.

This year, SCCWRP will continue to focus on developing tools that can be used to predict how changes in flow translate to changes in physical structure and in biological communities – and how these changes affect water resources management decisions. SCCWRP's focus for 2023-2024 will be on:

- **Assessing flow duration to understand the extent of aquatic resources:** SCCWRP will continue working to help watershed managers in the Arid West and beyond understand the extent of their aquatic resources by developing critically needed tools that enable streams to be classified by their flow duration (i.e., as perennial, intermittent, or ephemeral). SCCWRP will continue to support rollout and implementation of the recently released “beta” version of

the Streamflow Duration Assessment Method (SDAM) for the Arid West, while also supporting development and implementation of comparable tools for other regions of the United States, including the Western Mountains, the Great Plains, Alaska and Hawaii. SCCWRP's efforts will focus not just on SDAM development, but also on creation of training programs and data management and visualization tools for agencies that are seeking to incorporate SDAMs into their programs.

- **Applying flow-ecology to water resources management:** SCCWRP is continuing to examine how to apply flow-ecology principles to optimally support water resources management, including urban stormwater and dry-weather flow management, evaluation of hydrologic vulnerability and climate change effects on long-term basin planning and management, and evaluation of water use and reuse proposals. SCCWRP's work to answer pressing flow management questions for watersheds in Southern California and beyond is being guided by the California Environmental Flows Framework (CEFF), a standardized, multi-step approach for evaluating the environmental flow needs of California streams and balancing these needs with recreational uses and other beneficial uses. The findings and insights from this work are informing development of environmental flow targets that sustain the health of freshwater fish, amphibians and riparian habitats, while also optimally balancing competing demands on finite water resources, especially reuse of treated wastewater effluent discharges and enhanced stormwater capture practices. Stormwater and wastewater managers are able to use these flow ecology analyses and insights to take informed actions in areas like wastewater recycling, stormwater capture and stream restoration.
- **Advancing ecological modeling for informing environmental flow and temperature management:** SCCWRP is advancing the science of species occurrence and distribution modeling by applying this science to several case studies. SCCWRP is drawing on previously developed statistical approaches that relate changes in flow to effects on biological communities (especially benthic invertebrates and algae). Concurrently, SCCWRP is exploring new hybrid statistical and mechanistic approaches for conducting assessments that enable proposed flow alterations to be evaluated in terms how they affect higher trophic communities, such as fish, amphibians, and birds, and piloting their application to inform environmental flow decisions. These initial models will be further developed to include stream temperature and evaluation of the combined effects of multiple stressors on biological communities in multiple watersheds. SCCWRP also intends to further expand these models to include consideration of interactions between physical modification of stream channels and flow alteration. These relationships will be used to develop eco-risk curves that will be applied to inform diversion limits and development of statewide flow criteria under the State's cannabis policy and Water Action Plan.
- **Improving understanding of flow-ecology and temperature-ecology relationships in arid, ephemeral streams:** Determining flow and temperature ecology relationships in arid, ephemeral streams is particularly challenging due to their flashy nature, extremely low (or absent) flows, and potential reliance on groundwater contributions. SCCWRP will advance the assessment and modeling of dry-season low flows using machine learning methods that build on past statewide modeling efforts. SCCWRP will also explore mechanisms to account for the contribution of shallow groundwater (vadose zone) on streamflow and temperature to better account for their influence on flow-ecology and temperature-ecology relationships.

[Full thematic Research Plan for Ecohydrology](#) (PDF)



# Eutrophication

Nutrient pollution and other anthropogenic activities that result in increased temperatures, physical habitat and hydrological alteration can trigger eutrophication, which is accelerated accumulation of organic matter from overgrowth of aquatic plants and algae. These aquatic blooms can be unsightly and, in some cases, produce toxins and noxious odors. They can also lead to low dissolved-oxygen and pH levels that trigger declines in fishery harvests and in diversity of aquatic life. However, determining the nutrient load a water body can sustainably assimilate is challenging because, unlike with contaminants, some level of nutrient input is necessary to sustain life. Climate change is altering CO<sub>2</sub> levels, temperature regimes, and freshwater inputs, all of which can exacerbate eutrophication driven by local land use changes. SCCWRP is working to characterize the extent of the problem, particularly focused on toxic bloom species, and the bioaccumulation of their toxins in the food web. SCCWRP is conducting process studies and developing and validating models that link eutrophication drivers to adverse outcomes. These models are being used to develop comprehensive eutrophication management strategies, including the ability to pinpoint when and where eutrophication is likely to occur and which strategies, including nutrient management and ecosystem restoration, are likely to be effective and cost effective.

Management applications are in the forefront of this work. In inland waters, SCCWRP is serving as the technical lead on a multi-year effort by the State Water Board to develop a combined biostimulatory (i.e., nutrient) and biointegrity policy to protect California's wadeable streams, lakes and estuaries. Wadeable streams and lakes are the current priority for the first phase of this policy. SCCWRP is also supporting the development of comprehensive eutrophication and harmful algal bloom monitoring protocols to protect human and ecosystem health, including both remote sensing and field-based methodologies. Of particular focus are methods that lend themselves to successful implementation by citizen science programs. In coastal waters, SCCWRP is studying if and how anthropogenic nutrient inputs to the California Current ecosystem are contributing to eutrophication, particularly with respect to increasing algal blooms and declines in dissolved oxygen and pH, and declines in habitat for submerged aquatic vegetation such as kelp and seagrass.

This year, SCCWRP will continue building a knowledge base that allows nutrient loading, HABs and eutrophic events to be more effectively monitored and managed in California, both in fresh and marine waters. SCCWRP's focus for 2023-2024 will be on:

- **Building the technical foundation for eutrophication targets in California water bodies:** SCCWRP is pursuing a multi-pronged approach to build the technical foundation upon which future policy decisions regarding biointegrity, nutrient and eutrophication targets for California's wadeable streams, lakes and estuaries will be based. SCCWRP will continue to advance the science supporting the State's proposed biostimulatory/biointegrity policy, which is intended to govern the health of wadeable streams, lakes and estuaries. This ongoing work includes refining statistical models that link algal and benthic macroinvertebrate community composition to pathways of eutrophication impacts; these models will support State decision-making on eutrophication (a.k.a. biostimulatory) targets. SCCWRP also will continue its work to support policy discussions for biostimulatory targets in lakes, including developing statistical models that relate harmful algal bloom and hypoxia endpoints in lakes to eutrophication gradients of nutrients and chlorophyll-a; this work is being coupled with landscape models that predict how land use and other remotely sensed data influence

eutrophication risk. Finally, SCCWRP will continue demonstration projects illustrating how to apply a combined biostimulatory/biointegrity approach to watershed management decision support, with case studies in the San Joaquin and Sacramento River watersheds.

- **Assessing harmful algal blooms:** To understand the magnitude and spatial extent of HABs across marine, estuarine and freshwater systems, SCCWRP is studying the ecophysiological factors that drive HABs initiation and proliferation. SCCWRP is continuing its focus on: (1) supporting the State in implementing a comprehensive inland freshwater HABs monitoring and assessment program, including building monitoring methodology, infrastructure and coordination; (2) conducting field-based and remotely sensed status and trends assessments of HABs in lakes, streams and estuaries, including pinpointing which HAB organisms are present and which toxins are being produced; (3) comprehensively characterizing HAB drivers, including nutrients, temperature and hydromodification, and how these drivers trigger the production of toxins; (4) identifying factors that influence fate and transport of HAB toxins that are measured in edible shellfish and other organisms; and (5) supporting development of mechanistic numerical HAB models for estuaries and the California coastal ocean.
- **Biogeochemical effects of anthropogenic nutrients and carbon in California coastal waters:** SCCWRP will continue working with West Coast researchers to apply coupled physical oceanographic and biogeochemical models to examine how regional carbon dioxide emissions and discharges of land-based nutrient sources into the Southern California Bight and the San Francisco and Monterey coasts are influencing coastal ocean acidification, hypoxia and HABs. SCCWRP and collaborators will be using the models to: (1) quantify causal linkages to particular sources (point source vs. non-point source) and pathways (river runoff vs. atmospheric deposition vs. ocean outfalls); (2) develop and apply tools to estimate the biological effects of these changes, (3) simulate alternate scenarios for wastewater nutrient management and water recycling to predict the efficacy of various management strategies to reduce eutrophication; and (4) explore how global climate change is altering the ocean state and how these changes influence anthropogenic nutrient transport, fate and effects. Finally, SCCWRP is facilitating conversations around the uncertainty associated with modeling analyses, specifically with respect to: (1) conducting new validation studies and (2) facilitating independent peer review of the model, with an ultimate goal to help managers optimally use these models to inform coastal nutrient management decisions.

[Full thematic Research Plan for Eutrophication](#) (PDF)

## Climate Change

Global climate change will fundamentally alter how aquatic systems are managed. As anthropogenic carbon dioxide emissions drive increasingly severe changes to weather, rainfall patterns, and ocean temperature and chemistry, water-quality managers will be tasked with developing long-term strategies and management responses. Although climate change drivers operate primarily at a global scale, the effects will largely be managed at a local scale. To that end, managers must be prepared to confront the local effects of climate change, including understanding how water bodies of all kinds are being altered by changing environmental conditions, and how the diverse plant and animal

communities they support are adversely affected by these changes. SCCWRP is helping Southern California water-quality managers connect rapidly growing knowledge about the physical manifestations of climate change to aquatic ecosystem responses. SCCWRP's end goal is to provide managers with viable, cost-effective strategies and tools for mitigating and offsetting climate change's ecosystem impacts.

SCCWRP's research is focused around four main areas: (1) Altered hydrological flow patterns, which encompasses how changing rainfall and runoff patterns, drought cycles, and changing water use and reuse practices are impacting efforts by California's water resources management community to optimally protect the environmental flows that sustain aquatic ecosystems; (2) sea level rise, which encompasses how vulnerable animals and plants in coastal wetlands and other low-lying habitats will be affected by rising sea levels in the coming decades, and how California's coastal resources management community can use these insights to protect sensitive species and preserve maximum ecological functioning; (3) warming waters, which encompasses how toxic cyanobacterial blooms and other nuisance species – which are becoming more common as waters warm – threaten both public and ecosystem health, and how to design long-term management strategies and improved monitoring programs to combat this emerging threat; and (4) ocean acidification and hypoxia, which encompasses how corrosive coastal ocean conditions and low dissolved oxygen levels threaten the health of marine food webs, and how California's water-quality management community can better control and manage human activities on land to mitigate ecological consequences at sea. Understanding climate change effects on coastal resources requires quantifying the extent of biological effects through field studies and multiple co-related stressors experimental programs, coupled with process studies and models that link stressors mechanistically to ecological responses.

This year, SCCWRP will continue to focus on understanding biotic responses to the stressors of climate change. SCCWRP's focus for 2023-2024 will be on:

- **Evaluating climate change's effects on in-stream beneficial uses:** Given that climate change will affect rainfall patterns and temperature, which will, in turn, affect the ability of streams to support beneficial uses in the future, SCCWRP is coupling temperature response models with flow-ecology principles to evaluate the effects of climate change on aquatic life across Orange and San Diego County watersheds. SCCWRP is evaluating the effects of future changes in rainfall and water use patterns on stream flows and biological integrity, with a goal to inform flow management priorities. SCCWRP also is evaluating the linked effects of multiple stressors, including developing tools to relate climate change-induced flow and stream temperature changes to eutrophication and effects on biological communities. Finally, SCCWRP is evaluating hydrologic vulnerability on stream biological health in light of projected future changes in rainfall and land use.
- **Assessing the biological effects of ocean acidification and hypoxia:** SCCWRP is continuing to build unique capacity to assess biological trends and variability associated with coastal seawater chemistry conditions (temperature, oxygen, pH, productivity). SCCWRP is investigating how multiple biological communities, including HABs, kelp, seagrass, and pelagic and benthic organisms, are being affected by changing seawater chemistry and how these effects will intensify in the coming decades. SCCWRP's focus areas include: (1) identifying the pathways of biological effects and the best indicators for measuring these effects; (2) identifying the seawater chemistry thresholds at which these biological effects occur; and (3) developing statistical and mechanistic numerical models characterizing the

relative importance of these effects, both individually and at a population level. SCCWRP will continue facilitating ongoing efforts to build international consensus on the thresholds at which sentinel organisms can be expected to experience adverse impacts of ocean acidification and hypoxia (OAH). SCCWRP also will continue laboratory experiments, field experiments, and historical data analyses to better characterize how multiple stressors, including OAH, are affecting economically and ecologically important marine populations; this work includes partnering on West Coast-wide acidification surveys and linking them to the Southern California Bight Regional Monitoring Program, as well as conducting a status and trends assessment of kelp based on historical data sets. Finally, SCCWRP is helping to develop integrative indices that predict potential effects of climate change stressors on various habitats, and that then can be extended to population-level effects; these tools will be used both to disentangle the effects of climate change and local anthropogenic inputs when modeling coastal eutrophication (see Eutrophication research theme), as well as to support California's climate change mitigation strategies.

- **Evaluating regional strategies and solutions to climate change:** SCCWRP is working not only to identify the adverse effects of climate change, but also to identify and quantify the efficacy of potential solutions to offset and mitigate these effects. The potential solutions that SCCWRP is investigating include: (1) how strategies such as augmenting accretion, management of mouth dynamics, and facilitating transgression could help reduce anticipated wetland losses associated with sea level rise; (2) how implementing “living shoreline” solutions could help biological communities in estuaries and similar ecologically fragile habitats adapt to sea level rise; (3) how aquatic plants (e.g., seagrass and macroalgae such as kelp) could fix carbon and remove nutrients that, via coastal eutrophication, exacerbate OAH and HABs, and (4) how regenerative kelp farming – either alone or in combination with bivalve culture – could be optimally sited to minimize adverse environmental effects and bolster coastal economies.

[Full thematic Research Plan for Climate Change](#) (PDF)

## Contaminants of Emerging Concern

Contaminants of emerging concern (CECs) refer to the thousands of chemical contaminants in aquatic environments for which evidence is emerging that they may pose a threat to ecosystem and human health – a category that also encompasses microplastics. Introduced to water bodies through a wide array of human activities, CECs have the potential to impact the health of fish and other animals over time. Because these effects generally are not lethal or acute, California's water-quality management community has historically struggled to manage these chemical contaminants and document their biological effects. SCCWRP is developing and applying next-generation strategies and tools for comprehensively monitoring emerging contaminants in aquatic environments. SCCWRP's goal is to help water-quality managers efficiently and cost-effectively prioritize chemical classes that pose potential health risks to wildlife and humans.

SCCWRP's CEC research is centered around building, testing, and refining tools for measuring chemical contaminants and microplastics in aquatic environments, and applying these tools to understand occurrence, fate and effects of CECs. This CEC management paradigm is designed to help managers more cost-effectively and efficiently zero in on which of the tens of thousands of

CECs in aquatic environments are potentially triggering adverse biological effects. SCCWRP's research focuses on three main themes: (1) Exposure tool development, including bioanalytical cell screening assays to screen water bodies for bioactive chemicals such as endocrine disruptors, and both targeted and non-targeted chemical analysis to identify unknown chemicals; (2) effects assessment to understand biological dose-response of CECs and develop relevant bioindicators; and (3) environmental fate and transport of CECs to understand their physical, chemical, biological and ecological behavior that controls exposure levels and informs remediation strategies to mitigate their presence.

This year, SCCWRP will continue advancing bioanalytical screening methods for screening aquatic environments for a wide variety of CECs. SCCWRP will also continue developing and applying targeted analysis methods, as well as passive sampling, to identify and monitor water-soluble CECs and other chemical stressors in the environment. Finally, SCCWRP will continue supporting ongoing efforts to standardize microplastics measurement methods, develop and standardize collections methods, and understand the biological effects of microplastics exposure. SCCWRP's focus for 2023-2024 will be on:

- **Advancing bioanalytical screening methods:** SCCWRP is continuing to advance the use of high-throughput cellular assays as a cost-effective, rapid tool for screening a wide variety of bioactive CECs in aquatic environments. SCCWRP is working to expand the number of cell assay endpoints that can be used for screening multiple additional classes of contaminants in aqueous matrices, including recycled water and ambient water. SCCWRP also is continuing to apply these tools to monitoring programs (e.g., Surface Water Ambient Monitoring Program, Southern California Bight Regional Monitoring Program) and to support their transition into routine adoption and use by water-quality agencies, including in California and Europe.
- **Pursuing novel chemical sampling and measurement methods:** SCCWRP is continuing to pursue development and application of novel targeted sampling methodology to identify and track the increasingly widening universe of CECs in aquatic systems more effectively and efficiently. SCCWRP is developing multi-class methods for processing and analyzing a wide suite of pesticides that have been collected from both traditional grab sampling and from passive samplers for both single-laboratory and multi-laboratory validation. SCCWRP is also providing training on accredited methods for assessors to enable more efficient evaluation of laboratories seeking accreditation.
- **Understanding occurrence and fate of chemical stressors:** SCCWRP is using previously developed sampling and measurement tools to understand occurrence, fate, and transport of chemical contaminants. SCCWRP is using passive samplers to measure levels and fluxes of legacy persistent organic contaminants, as well as "DDT+" (i.e., DDT plus DDT breakdown products that are poorly understood), in the Southern California Bight at existing Superfund sites and at oil platforms that could be decommissioned, to assess hazards that may be associated with exposure.
- **Investigating microplastics methods and health effects:** As the State Water Resources Control Board and California Ocean Protection Council develop statewide strategies for managing microplastics in aquatic systems, SCCWRP is building a scientific foundation for crafting informed management actions that optimally protect wildlife and humans from the health effects of microplastics exposure. SCCWRP is working to standardize methods (and

variation of these methods) for sampling and measuring microplastics in source water, sediments, and tissues, and ensuring that laboratories are capable of producing accurate, reproducible results. SCCWRP is initiating efforts to develop standardized methods to collect representative microplastics samples in these matrices, plus in stormwater. SCCWRP is conducting a series of studies to quantify the inputs, fate and transport, and bioaccumulation of various microplastic types and shapes for the region's streams, estuaries and coastal ocean, and in drinking water. Finally, SCCWRP is studying how aquatic life is affected by environmentally relevant exposure scenarios, including evaluating the effects of microfiber exposure on local fish and bivalve species to refine existing risk thresholds.

[Full thematic Research Plan for Contaminants of Emerging Concern](#) (PDF)

## Microbial Water Quality

SCCWRP's microbial water quality research is focused on developing tools that allow managers to understand and minimize risk of human exposure to waterborne pathogens. Whether swimming and surfing at the beach, or consuming shellfish harvested from coastal waters, the public depends on rigorous, fully vetted science to rapidly detect aquatic microbial contamination and to inform remediation strategies. Advances in molecular microbiology are enabling the water-quality management community to develop incrementally stronger, more effective solutions for protecting public health. SCCWRP's goal is not only to improve the speed at which microbial contamination can be detected, but also to develop molecular methods for tracing contamination back to a specific source and upstream origin point. SCCWRP also is focused on helping water-quality managers better understand how field measures of microbial contamination correspond to specific levels of health risk.

SCCWRP's microbial water quality research is focused around three major areas: (1) Microbial source tracking, which involves using molecular methods to identify whether humans vs. various individual animal species are responsible for observed contamination – and to identify where in a watershed the contamination is coming from and potentially which specific type of stormwater or wastewater infrastructure is responsible; and (2) microbial risk assessment, which involves quantifying health risk for Southern California's beachgoing population through epidemiological studies, as well as through health risk modeling approaches such as Quantitative Microbial Risk Assessment (QMRA) that estimate illness risk based on site-specific considerations; and (3) advancing molecular methods for microbial contamination detection, which involves validating the accuracy and applicability of DNA-based methods for measuring microbial contamination and expanding the range of pathogens for which those techniques are applied. SCCWRP's focus for 2023-2024 will be on:

- **Identifying human sources of fecal contamination:** SCCWRP is working to identify specific sources of human fecal contamination in Southern California waterways by tracking and quantifying the relative contributions of public sewers, private laterals, septic systems, illicit connections and illegal discharges, and individuals experiencing homelessness. This work, which includes quantifying both relative contributions and the factors that control these contributions, is a reflection of the fact that human fecal sources appear to be widespread in Southern California waterways, particularly during wet weather. During the region's short but dynamic storm events, source tracking is incredibly difficult because so many possible

human sources are mixed together in stormwater runoff. SCCWRP's source-tracking investigations build off previous SCCWRP research that has found that the risk of gastrointestinal illness from body contact recreation during wet weather is greater than the risk illness during dry weather, and that genetic markers of human fecal contamination (i.e., HF183) and human pathogens are commonly found in wet-weather discharges. SCCWRP also is working to establish relationships between HF183 and human pathogens, utilizing QMRA to establish health risk thresholds for wet-weather discharges. Especially as management questions shift from "Are human fecal sources found in wet weather?" to "Which specific human source(s) are found in wet weather?" SCCWRP's overarching goal is to help managers optimally remediate human fecal sources during storm events to protect beachgoer health.

- **Evaluating the SHEL water-quality standard:** SCCWRP and its partners are continuing to investigate whether a State water-quality standard known as SHEL that is designed to protect the health of people who consume shellfish from Newport Bay in Orange County has been appropriately set. With a preliminary study finding that there is no relationship between water-quality indicators and pathogens found in Newport Bay shellfish during dry weather, SCCWRP will continue to support managers in determining if there is a scientific basis for pursuing development of a site-specific standard for Newport Bay. The findings of the Newport Bay work could have broad implications for other water-quality managers statewide that are managing discharges that exceed the SHEL standard.
- **Enhancements to PCR-based measurement methods:** SCCWRP has been at the forefront of developing molecular measurement methods such as qPCR and then later ddPCR for application to beach water quality monitoring. This technology continues to evolve with development of more sophisticated instrumentation that can measure more channels simultaneously and target more endpoints. SCCWRP will continue to develop this technology and work to transition it into application in partnership with its member agencies. SCCWRP will also this year focus on developing new approaches to distinguish genetic material associated with viable bacteria from that which represents remnant material associated with disinfected discharge or other natural degradation processes – the latter of which could lead to overestimation of infective particles in the environment.

[Full thematic Research Plan for Microbial Water Quality](#) (PDF)

## Stormwater BMPs

Stormwater BMPs (best management practices) are a disparate collection of engineered solutions, landscaping modifications and other strategies for managing how water runs off the land during both dry and wet weather. Although Southern California's stormwater management community is expected to spend billions of dollars on stormwater BMPs in the coming decades to reduce contamination levels in runoff and better control flows, relatively little is known about how to optimize their design, placement and long-term effectiveness. SCCWRP is developing BMP strategies and tools intended to bring clarity and confidence to the science of stormwater management. SCCWRP's focus is on building a comprehensive understanding of the sources, fates



and effects of runoff across Southern California, then using these insights to help managers design maximally effective BMP interventions.

SCCWRP's stormwater BMP research is centered around four main areas: (1) Understanding BMP mechanisms and processes, which involves quantifying how different BMP treatment mechanisms and processes remove various levels and types of pollutants from runoff; (2) developing design criteria for BMPs, which involves creation of decision support tools that help managers select optimal BMPs and combinations of BMPs for specific geographical and environmental settings; (3) optimizing long-term BMP performance, which involves developing strategies for monitoring and maintaining BMPs to maximize their long-term performance effectiveness; and (4) maximizing watershed-scale benefits, which involves developing frameworks and solutions for optimizing the synergistic effects of BMPs to improve and protect overall watershed health. SCCWRP prioritizes understanding not just performance effectiveness of BMPs themselves, but also the way BMPs influence the health of receiving water bodies – from hydrology and physical habitat to water chemistry to the biological communities they support.

This year, SCCWRP will focus on supporting management decisions for how to optimize the long-term performance effectiveness of BMPs. SCCWRP's focus for 2023-2024 will be on:

- **Developing quantitative techniques and metrics for assessing BMP performance:** Given the difficulty that managers have in choosing the “right” BMPs to address site-, watershed- and sewershed-specific objectives (due in part to the fact that many criteria can be used to assess success), SCCWRP is developing robust, quantitative ways to evaluate BMP performance based on multiple criteria, including technical effectiveness, site opportunities and constraints, and long-term maintenance requirements. The index scoring tools are intended to enable managers to choose from a wide variety of individual technologies in their BMP “toolbox” as they evaluate different potential BMP options for a given site. Drawing on data generated by BMP monitoring programs, SCCWRP will develop data structures and dashboards to support index calculation and compliance reporting, and to evaluate effectiveness of design and maintenance activities in near-real time.
- **Developing a comprehensive regionwide BMP monitoring network:** SCCWRP is working with the Southern California Stormwater Monitoring Coalition (SMC) to develop a regional program for site-scale BMP performance monitoring to answer critical management questions regarding BMP performance, design, and maintenance across Southern California. This monitoring network, which could be among the largest in the country, is predicated on well-defined research objectives, consistent and coordinated data collection, and a unifying framework for sharing data. Researchers will be able to leverage the regional monitoring network to cost-effectively generate robust, statistically relevant data sets covering a range of BMP types that serve multiple land uses across a spectrum of operating conditions. These data will be used to improve BMP selection guidance, streamline annual reporting, develop cost-effective asset management programs, and support Reasonable Assurance Analysis and Alternative Compliance. In parallel, SCCWRP is working with the SMC to develop technically rigorous approaches for measuring the effectiveness of non-structural BMPs (e.g., street sweeping) at reducing pollutant concentrations and loading; nonstructural BMPs are a category of management actions for which even less performance effectiveness information is available than for structural BMPs.



- **Informing adaptive watershed management strategies:** SCCWRP is working with regulated and regulatory stormwater managers to develop watershed adaptive management guidance that can support multi-decadal stormwater management planning. The guidance will help address the design of capital improvement projects estimated to cost billions of dollars in the coming decades. Although stormwater managers are building adaptive strategies into planning scenarios on a regular basis, these focal-point decisions are often ill-defined, non-specific and unquantified. The guidance SCCWRP is developing will address what decisions need to be considered, what management options might be considered for different outcomes, and how to generate the appropriate data to inform these challenging adaptive decisions.

[Full thematic Research Plan for Stormwater BMPs](#) (PDF)

## Regional Monitoring

Southern California environmental managers and scientists spend an estimated \$50 million every year on monitoring aquatic environments, but have struggled to answer the big-picture questions being asked by the public: “Is it safe to swim in the ocean?” “Are locally caught fish safe to eat?” and “Are local ecosystems adequately protected?” The reason? Most of this money is allocated to keep tabs on the relatively compact areas that surround specific outfalls – monitoring that is required under state and federal laws. Consequently, when scientists compile this compliance-based monitoring data from dozens of agencies, the resulting regional picture is incomplete. Recognizing this challenge, SCCWRP has stepped in to coordinate and facilitate wide-scale regional monitoring programs across a variety of habitats, including streams, wetlands, estuaries, beaches and coastal waters. For each monitoring program, SCCWRP works with dozens of local and regional agencies to standardize data collection and coordinate analysis efforts, leveraging the limited resources of many to obtain comprehensive data on some of the region’s most pressing environmental challenges. These programs are among the top regional monitoring programs in the nation and have served as models for developing similar programs internationally.

SCCWRP’s best-known monitoring program is the Southern California Bight Regional Monitoring Program, conducted every five years since the mid-1990s. The ongoing program mobilizes participating agencies to collect data from across a much greater spatial area than just their outfall zones, allowing environmental managers to paint a comprehensive picture of the health of coastal waters that stretch from Point Conception in Santa Barbara County to just south of the U.S.-Mexico border. The Bight program’s freshwater counterpart, the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program, was launched in 2009 to monitor an area that stretches from the Ventura River in Ventura County to the Tijuana River straddling the U.S.-Mexico border. SCCWRP also is helping to develop and implement a statewide program to monitor the health and resiliency of estuaries and other coastal habitats. Finally, SCCWRP is developing a standardized monitoring design that will generate comparable assessments of the dozens of stormwater BMPs that are installed each year throughout Southern California, laying the groundwork for regional assessment of this critical infrastructure (see Stormwater BMPs research theme). The key to success in developing integrated monitoring designs is SCCWRP’s ability to bring all parties to the table – from local and regional agencies to state and federal entities – to work toward agreement on goals, study design and data interpretation. Not only do the comprehensive data sets help environmental managers

establish appropriate priorities and goals for addressing big-picture challenges, but regional monitoring also fosters productive interactions among dischargers and regulators as they develop and collaboratively interpret monitoring information and implement findings. Regional monitoring also provides an important launching platform for SCCWRP's member agencies and research collaborators to test new technologies and assessment tools.

This year, SCCWRP will continue to coordinate multiple regional monitoring programs and initiatives across Southern California and beyond. SCCWRP's focus for 2023-2024 will be on:

- **Regional marine monitoring (Bight '23):** SCCWRP is continuing to work with more than 80 partner agencies to finalize planning for and launch the 2023 cycle of the Southern California Bight Regional Monitoring Program (Bight '23), one of the largest and longest running marine monitoring programs in the country. Bight '23 program will consist of seven elements: Sediment Quality, Ocean Acidification and Hypoxia, Trash and Microplastics, Harmful Algal Blooms, Shoreline Microbiology, Estuarine Condition, and Submerged Aquatic Vegetation Condition. The Bight program is an integrated, ongoing regional monitoring collaboration that provides holistic answers to questions regarding the extent and magnitude of anthropogenic impacts, the range of natural variability upon which scientists evaluate these impacts, and shifting baselines of natural condition as global pressures alter even our most untouched parts of the coast. During each Bight cycle, SCCWRP facilitates the development of study designs, data management plans, data analysis, and co-authoring of final assessment reports. Since its inception in 1994, the Bight program has conducted comprehensive monitoring of approximately 1,500 square miles of near-coastal ocean, with more than 2,000 sites sampled.
- **Regional watershed monitoring:** SCCWRP is facilitating the third cycle of the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program, which runs from 2019 to 2023. SCCWRP is coordinating field sampling activities for the annual regional survey, which samples more than 500 sites across all 15 major watershed areas between the Ventura River in the north and the Tijuana River in the south. Among the largest watershed monitoring programs in the nation, the program encompasses data on water quality, physical habitat and riparian condition, and biological communities, including benthic invertebrates and algae. The monitoring questions for the third five-year cycle are: (1) What are the extent and magnitude of impact in Southern California's streams? (2) Are the extent and magnitude getting better or worse? and (3) What are the stressors responsible for the impacts observed? For the third cycle of SMC regional monitoring, participants also are focusing more effort on trend assessment, and adding a new element focusing on causal assessments at sites of interest in poor biological conditions. Additionally, this cycle of regional monitoring is targeting assessment work at specific sites of interest, including soft-bottom engineered channels and sites where restoration efforts and/or implementation of stormwater BMPs (best management practices) are likely to affect biological condition. Through this monitoring initiative, the SMC also is working to identify ways to improve biological conditions in modified channels by reducing stress levels or changing management activities.
- **Statewide estuary monitoring:** SCCWRP is working with a statewide team of partners to develop and implement a monitoring and assessment framework for estuaries across the state. The framework addresses which components of the ecosystem should be assessed, and how to evaluate ecological functioning in these highly heterogeneous systems. SCCWRP is

focusing on California's 24 estuarine Marine Protected Areas (MPAs), plus another 25 estuaries of management concern in Southern California and Baja California. SCCWRP is refining the application of suites of indicators (and associated sampling protocols) across multiple trophic levels that can be used to assess key estuarine functions. SCCWRP also is developing approaches for contextualizing the resulting information using comparisons to reference, paired estuaries and regional ranges of condition. SCCWRP is also developing advanced data management and data visualization systems to improve coordination across statewide programs and to enhance access to data and data products for agencies and the public.

[Full thematic Research Plan for Regional Monitoring](#) (PDF)

## Emerging Research and Member Agency Support

SCCWRP provides support for its member agencies in a number of ways, including field support, methodological training, quality assurance, serving on expert panels, expert panel facilitation, data analysis and integration, and producing management-friendly documents such as the SCCWRP Annual Report and SCCWRP Director's Report. SCCWRP also provides presentations to member agencies upon request and hosts a biennial Symposium for the staff of member agencies to learn about SCCWRP research.

In addition, SCCWRP conducts research on burgeoning issues of management concern that have not yet grown into a thematic focus area. SCCWRP's adeptness in rapidly responding to pressing management needs is a hallmark of SCCWRP research. The Emerging Research and Member Agency Support section of SCCWRP's 2023-2024 research agenda includes:

- **Ecological risk assessment:** SCCWRP is pursuing development of a potential new thematic research area called Eco-Risk Assessment that quantifies the relative risk associated with exposure to multiple co-occurring stressors; the goal is to prioritize stressors more likely to affect biological populations, and quantify the effectiveness and benefits of various management options intended to address these risks. Risk assessment relies on several steps: (1) Characterization of exposure and effects profiles for key indicator species, (2) assessment of ecological implications based on models that link dose-response to species abundance/population viability over time, (3) risk characterization to quantify magnitude of impact and risk reduction based on different management scenarios, and (4) benefit-cost analysis for valuation of beneficial uses and ecosystem services. Despite decades of utilization, risk assessment for multiple stressors is under-developed in aquatic ecosystems and particularly under-developed in Southern California. While SCCWRP has a long history of stressor exposure and characterizing effects (i.e., finding problems), SCCWRP has done much less work on risk characterization, risk reduction and benefit-cost analysis (i.e., finding effective solutions). The risk assessment research theme provides a framework to find optimal solutions for difficult environmental management choices. SCCWRP's risk assessment work is focusing initially on the ecological risks of microplastics and cyanobacteria exposures on bivalve populations in estuarine habitats. These initial case studies will serve to develop tools for (1) modelling ecological implications, (2) risk

characterization and (3) risk reduction. Modeling of ecological effects will combine occurrence data, field biological data and laboratory dose-response information to assess impacts that span from individuals to populations to communities. Risk characterization will build Bayesian network models that include occurrence data, mechanistic information, biological indices and pollution reduction prediction to prioritize stressors most likely to impact beneficial uses and evaluate effectiveness of management solutions. Future work will develop the framework and tools to conduct benefit-cost analyses and assess monetary and societal values of beneficial uses at risk.

- **Optimization of a toxicity testing protocol:** SCCWRP is working to increase consistency, confidence and comparability of the *Ceriodaphnia dubia* chronic reproduction test, which is widely used in toxicity assessments. Despite its long history of use in compliance-based monitoring, the *C. dubia* test has been subject to culture crashes, sometimes inexplicable variability, and seemingly random toxic responses to negative controls. SCCWRP is investigating the test conditions and factors that can be controlled, and developing quality assurance and quality control guidance to ensure labs can produce comparable, high-quality test results. SCCWRP's ultimate goal is to ensure management decisions based upon this toxicity test can be made with confidence.