SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT AUTHORITY

FY 2019-2020 RESEARCH PLAN
EXECUTIVE SUMMARY

Approved by the SCCWRP Commission
June 21, 2019
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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 been developing strategies, tools and technologies that the region’s water-quality management community relies on to more 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 and recommendations that inform management decision-making and policy development. SCCWRP science has served as the basis for discharge permits and watershed basin plans, runoff requirements for new development and redevelopment, 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, promoting stewardship and sharing of environmental data, and informing regional planning efforts and regulatory compliance strategies. Through the SCCWRP Commission governing board, 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

SCCWP’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 public water 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 five science departments – Toxicology, Chemistry, Biogeochemistry, Biology, and Microbiology – that work in an interdisciplinary, interconnected fashion across SCCWRP’s major research areas:

1. Bioassessment  
2. Ecohdrology  
3. Eutrophication  
4. Climate Change  
5. Sediment Quality  
6. Contaminants of Emerging Concern  
7. Microbial Water Quality  
8. Stormwater BMPs  
9. 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 10-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 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 flesh out and update these documents on a 3-year rolling basis. 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. The detailed technical documents are available online.

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, also includes the research plan budget, which the SCCWRP Commission is required to approve annually. Accordingly, this document contains two portions: a series of concise summaries of SCCWRP’s research directions within each research theme, and the 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 tend to be concentrated. Unlike traditional chemical-based monitoring, which provides only limited information about a relatively narrow set of environmental stressors at a discrete point in time, bioassessment integrates exposure of living organisms to multiple chemicals and other stressors (such as altered habitats and changes in life-sustaining water-flow patterns) over extended time periods. Consequently, bioassessment provides a more comprehensive reflection of the condition of an aquatic ecosystem; bioassessment also is more closely tied to environmental managers’ focus on ecosystem protection. 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’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 three main research areas: (1) assessing the condition of different water body types using multiple indicators, (2) identifying potential causes of poor condition and vulnerabilities to healthy resources, and (3) using the data to support management activities, such as prioritization and effectiveness assessments. To assess condition, SCCWRP develops standardized sampling protocols, characterizes reference conditions, and develops assessment tools that transform complex biological data into simple measures of condition. Additionally, SCCWRP focuses on creating appropriate interpretive frameworks for understanding bioassessment outcomes, including connections to beneficial uses, and for incorporating multiple indicators into integrative assessments. To identify potential causes of degraded condition, SCCWRP uses causal assessment, a process that relies on creating rigorous evaluation procedures to understand the relationships between stressors and condition. The goals of SCCWRP’s causal assessment research are to: (1) develop causal assessment diagnostic indicators via traits-based analysis and molecular methods, (2) improve stressor measurements such as habitat condition indices, (3) explore relationships between stressors and biological responses, such as flow and nutrient responses, and (4) investigate the relative constraints on biological condition that come from different natural and anthropogenic sources. To ensure condition and causal assessments are used to guide management decisions aimed at improving overall condition, SCCWRP develops synthesis and integration tools that can translate assessment results to actionable information. In this way, SCCWRP products can be used to protect healthy waterbodies and effectively reverse the historically negligible role that biological data have played in informing key management decisions, such as designation of new conservation areas and selection of sites for restoration.

This year, SCCWRP will continue its work to develop, refine and expand its capacity to conduct both condition assessments and causal assessments, as well as pursue development of guidance and decision support tools to inform management actions. SCCWRP’s focus for 2019-20 will be on:

• **Condition assessment:** SCCWRP is working to develop a broad suite of condition assessment tools, with a long-term goal of having bioassessment tools based on prokaryotic communities, invertebrates, algae, vertebrates and multiple assemblages. SCCWRP is also continuing efforts to develop molecular indicators that can be applied in streams, wetlands,
coastal lagoons, and/or ocean ecosystems. This year, SCCWRP will focus on finalizing development of bioindicators for ephemeral streams (i.e., streams that flow for short durations immediately following rain events), where a lack of tools precludes assessment. SCCWRP will also work toward developing a first-generation, molecular-based index for algae; for this effort, the recently developed Algal Stream Condition Index (ASCI) will be adapted to accommodate DNA barcode-derived data for diatoms and soft-bodied algae; then, performance will be compared to the traditional, morphology-based version of the ASCI. Molecular methods also will be used to continue development of multi-trophic level assessment tools that provide a more integrative measure of ecosystem function. These tools use analysis of the food web network of prokaryotic, algal, and benthic invertebrate communities to provide a more holistic picture of stream condition. SCCWRP also will continue working to develop environmental DNA (eDNA) methods for vertebrate monitoring. Finally, SCCWRP will begin developing assessment tools for coastal estuaries and lagoons, a habitat for which we currently lack bioassessment indices; this work, which will build on existing efforts to develop assessment tools for eelgrass beds, will add indicators for fish communities and physical habitat.

• **Causal assessment:** SCCWRP will continue to work toward developing an integrated and tiered approach to causal assessment that improves upon the U.S. EPA’s Causal Analysis/Diagnosis Decision Information System (CADDIS) framework. Testing of rapid causal screening tools will continue as SCCWRP pursues development of a streamlined approach for identifying major classes of stressors (e.g., flow vs. habitat alteration vs. contaminants). This work will be followed by development of stressor-specific metrics designed to improve diagnostic ability that are based primarily on life history traits and molecular assessment tools, as appropriate. This framework is being demonstrated through ongoing case studies that provide roadmaps for broader implementation of the tools throughout the region and state.

• **Integration and implementation:** Although SCCWRP’s research on condition and causal assessment provides the technical foundation to support management decisions, this technical foundation must be informed by the development of guidance and decision support tools. SCCWRP is continuing development of: (1) tools that will allow for the development of report cards and similar data synthesis methods, (2) decision support tools that help locate high-value areas for protection and prioritize management actions, and (3) screening tools that help evaluate the restoration potential of degraded water bodies and establish appropriate management targets.

Ecohydrology

Ecohydrology is the study of how changes in the frequency, magnitude, and duration of flow affect ecosystem structure and composition. As water runs off land surfaces with varying frequency, magnitude, and duration, these flows can not only directly affect biological communities, but also trigger erosion and deposition that alters the physical structure of water bodies, which, in turn, affects the ability of aquatic systems to support desired plant and animal communities. Past SCCWRP research has focused on predicting changes in water chemistry in response to specific anthropogenic actions, and on developing management measures – including best management practices (BMPs) – aimed at offsetting the effects of these chemical changes. Substantially less effort has been devoted to relating hydrologic and physical (or geomorphic) alterations to how biological communities respond to these alterations. As regulatory programs increasingly rely on biological endpoints to assess compliance and the effectiveness of mitigation efforts, SCCWRP is working to develop and
improve tools that can help environmental managers better understand and ultimately predict the relationship between flow (and its associated hydrologic and geomorphic impacts) and ecosystem health. Better tools will better inform management actions aimed at reducing and mitigating the impacts of flow alterations, especially human-induced alterations associated with flood control, stormwater capture, and water reuse practices.

SCCWRP’s ecohydrology research is driven by three major objectives: (1) Understand and predict patterns in key drivers of hydrologic change (e.g., land use, climate change, water use practices), (2) develop tools including statistical and deterministic models to evaluate the relationship between key drivers and changes in flow and related physical and biological responses 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. Evaluating possible management actions includes developing mechanisms that enhance performance and that improve understanding of how multiple BMPs can work synergistically across broad areas to improve the condition of receiving waters.

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 community composition – how these changes affect water resources management decisions. SCCWRP’s focus for 2019-20 will be on:

- **Developing a statewide framework for evaluating in-stream flow needs:** SCCWRP has facilitated formation of a statewide workgroup under the California Water Quality Monitoring Council that is developing a tiered framework for assessing in-stream flow needs across California. The workgroup, which features partners from UC Berkeley, UC Davis, U.S. Geological Survey and The Nature Conservancy, is developing an environmental flows management framework that includes statewide hydrologic and geomorphic classification, coarse-level flow requirements for each hydrologic class in the state, and a framework for selecting the most appropriate site-specific tool based on consideration of stream type, biological endpoint, and management needs. The framework will be applied to support several needs related to flow management, including dam management, agricultural water withdrawals, and urban wastewater and stormwater management.

- **Applying flow-ecology to water resources management:** Past SCCWRP research has produced flow-ecology relationships that linked changes in flow to changes in stream ecological condition, as indicated by benthic macroinvertebrate and algal community composition. SCCWRP is now pursuing development of flow targets based on freshwater fish, amphibians and riparian habitats. This broader suite of tools will be applied to support applications including urban stormwater management, evaluation of climate change effects, and evaluation of water use and reuse proposals. SCCWRP will focus on several watershed studies aimed at demonstrating how the emerging ecohydrology tools can be applied to establish flow targets, prioritize management actions, and optimize competing water demands.

- **Developing site-specific and watershed-scale BMPs for flow control:** To facilitate BMP implementation to achieve physical and biological targets, SCCWRP is focusing on a combination of local and watershed-scale strategies, both of which are required for effective flow management. SCCWRP is partnering with members of the Southern California Stormwater Monitoring Coalition (SMC) to investigate performance of low-impact development (LID) practices under a range of design and implementation scenarios, including developing recommendations for standard monitoring and data management approaches. LID practices, which are one of the main tools used to meet stormwater runoff,
hydromodification, and water-quality requirements, operate by capturing, retaining, detaining, or infiltrating runoff from developed land uses. SCCWRP is working with local partners on developing technical approaches to determine optimal placement of hydromodification and water-quality management measures to achieve agreed-upon, watershed-scale objectives. These approaches include helping to develop a system that can determine appropriate offsets between BMPs and impacts along different portions of a watershed.

**Eutrophication**

Excess nutrients introduced to aquatic habitats through human activity (i.e., nitrogen and phosphorus) – combined with other changes such as modifications to hydrology, temperature and light – 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 also can lead to low dissolved-oxygen levels that can trigger declines in fishery harvests and in diversity of aquatic life. However, determining the nutrient load a water body can assimilate is challenging because, unlike with contaminants, some level of nutrient input is necessary to sustain life. Consequently, environmental managers must work to control the deleterious impacts of excessive nutrients and other waterbody conditions that can exacerbate eutrophication. SCCWRP has been at the forefront of eutrophication research efforts in both freshwater and coastal-ocean systems, working to build a foundational body of science for diagnosing eutrophication, identifying appropriate nutrient targets for California’s water bodies, and tracking where nutrients are coming from and what is happening to them. 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 (nutrients) and biointegrity policy to protect all of California’s wadeable streams, lakes and estuaries. 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.

While the symptoms of eutrophication vary by water body type, the conceptual approach to developing tools to diagnose eutrophication and identify nutrient targets is similar for all water bodies. The first step is to build consensus around a conceptual model that identifies symptoms of eutrophication (e.g., altered dissolved oxygen concentrations, increased algal abundance) and their link to both nutrient loads and other contributing water body factors. The second step is to design a framework for assessing the condition of a water body, one that focuses on eutrophication symptoms instead of nutrients themselves. An important element of this framework is to identify thresholds for each symptom that equate to protection of human and ecosystem values and avoidance of adverse impacts. The third step is to build statistical and mechanistic models that link eutrophication symptoms to nutrients and other factors, such as habitat and hydromodification, to examine environmental-management scenarios that might prevent an ecosystem impact. An important element of mechanistic model development is conducting process studies that document the fate of nutrients as they are cycled through an aquatic habitat. The final step is to assist in transferring this technology to environmental managers.

This year, SCCWRP will continue its work to incrementally build a knowledge base and technical foundation that will allow nutrient inputs to be more effectively monitored and managed in California, both in fresh and marine waters. SCCWRP’s focus for 2019-20 will be on:

- **Building the technical foundation for eutrophication targets for California water bodies**: SCCWRP is pursuing a multi-pronged approach toward building the technical
foundation upon which policy decisions regarding biointegrity, nutrient and eutrophication targets for California’s wadeable streams, lakes and estuaries will be based.

- SCCWRP developed an Algal Stream Condition Index (ASCI) to support biointegrity assessments and, in combination with the California Stream Condition Index (CSCI), links algal and benthic macroinvertebrate community composition to pathways of eutrophication impacts. Technical work continues to support policy decisions and implementation discussions. SCCWRP is working on refinements of statistical models that relate standardized stream bioassessment indices to nutrient concentrations and eutrophication indicators. Such models may provide the approach used by the statewide biostimulatory/biointegrity policy on how to make decisions on nutrient targets.

- SCCWRP is developing statistical models that relate harmful algal bloom and hypoxia endpoints in lakes to eutrophication gradients of nutrients and chlorophyll-a gradients, as preliminary work to support policy discussions for biostimulatory targets in lakes. This will be coupled with landscape models to predict how land use and other remotely sensed data influence eutrophication risk. This landscape tool could be used to prioritize monitoring resources for lakes that are at high risk of eutrophication.

- SCCWRP is continuing to demonstrate how science can inform a combined biostimulatory/biointegrity approach to watershed management, considering possible impacts of climate change. Through the Santa Margarita River Nutrient Management Initiative, SCCWRP is supporting stakeholders by collecting monitoring data and developing statistical and mechanistic process models to establish watershed-specific nutrient targets for the Santa Margarita River’s estuary and main stem, based on biointegrity goals.

**Assessments of harmful algal blooms (HABs):** To understand the magnitude and spatial extent of harmful algal blooms across marine, estuarine and fresh water systems, SCCWRP is studying the ecophysiological factors that drive HABs development and proliferation. SCCWRP is focused on: (1) supporting partners to pinpoint which HAB organisms are present and which toxins are being produced to better characterize the extent of the problem, including through DNA barcoding, which is being coupled with rigorous analyses of toxin presence to more fundamentally characterize lakes, streams and estuaries, (2) conducting studies to understand the drivers for HABs proliferation and toxin production, including nutrients, temperature and hydromodification, and (3) supporting the State Water Board’s efforts to develop chlorophyll-a and cyanotoxin targets for lakes, and (4) playing a role in unifying the HABs monitoring and research efforts taking place in freshwater habitats and the coastal zone. To understand the prevalence of cyanobacterial blooms and toxins in California lakes and streams – which can pose a potential threat to human and ecosystem health – SCCWRP is supporting a statewide group that is working to implement a statewide cyanobacteria monitoring strategy.

**Biogeochemical effects of anthropogenic nutrients and carbon in the Southern California Bight:** SCCWRP is working with partners to couple biogeochemical models with physical oceanographic models to ascertain the relationship between coastal hypoxia, acidification, harmful algal blooms, and nitrogen emissions from land-based nutrient sources in the Bight and other locations along the North American West Coast. Management actions, including nutrient load reduction, have been suggested as a strategy for improving local water quality, but the extent of change achieved from nutrient load reductions are uncertain, given that coastal hypoxia and acidification may be driven primarily by climate change and thus operate at a global scale. Coupled biogeochemical and physical circulation models, which have been validated for anthropogenically-influenced near-coastal environments, will be used
to virtually evaluate the extent to which anthropogenic nutrients are affecting trends in these outcomes of concern.

Climate Change
The science community has invested heavily in understanding how climate change will manifest in the coming decades. Researchers have developed sophisticated monitoring programs to document carbon dioxide emissions in the atmosphere, track changes in air and water temperature, and measure acidity of the ocean. Similarly, researchers are using state-of-the-art computer models to predict how weather and rainfall patterns will be altered, how sea levels will rise over the next century, and the uncertainty and nuances that necessarily accompany multi-decade predictions. These detailed analyses are beginning to answer pressing societal questions about what ways global climate change will play out in local communities, and starting to drive long-term planning and priority setting by state, federal and local governments. Most climate change research focuses on physical changes in the ocean and terrestrial ecosystems, such as sea level rise and temperature. To effectively protect aquatic environments in the face of global climate change, water-quality managers also must know how animals, plants and entire ecosystems will respond to this changing physical environment. Just as importantly, managers need to know which strategies, tools and approaches are viable, cost-effective and optimized to help mitigate ecosystem impacts and how responses to climate change (e.g., seawalls, channel armoring, water diversion) may translate to secondary impacts to aquatic resources.

Toward that end, SCCWRP’s climate change research is focused on connecting rapidly growing knowledge about the physical aspects of climate change with assessments and prediction of how aquatic ecosystems will respond. SCCWRP is working to understand biotic response to four climate change stressors: (1) how changing rainfall and runoff patterns will influence California’s efforts to protect the environmental flows that sustain aquatic ecosystems, and how the state’s water resources management community can improve and better coordinate its approaches to protecting these flows, (2) how biological communities that live in low-lying coastal wetland environments will be impacted by rising sea levels in the coming decades, and how coastal resources managers can use this information to chart courses of action that maximize opportunities for these ecological resources to adapt, (3) how warming waters affect distribution of biota, including nuisance species such as cyanobacterial blooms, and (4) how rising ocean acidity affects the health of marine food webs. SCCWRP invests in creating and strengthening monitoring programs that evaluate the biological impacts of these changing environmental conditions, as well as building sophisticated computer simulations of how climate change will affect the health, distribution and resiliency of sentinel aquatic species.

This year, SCCWRP will continue to focus on understanding biotic responses to the stressors of climate change. SCCWRP’s focus for 2019-20 will be on:

- **Assessment of acidification, hypoxia and its biological impacts:** Among SCCWRP’s top priorities are developing a scientific understanding of ocean acidification, a phenomenon caused by oceanic assimilation of atmospheric carbon dioxide. This ocean acidification research compasses several topical areas, including: (1) developing and applying a coupled physical-biogeochemical model to estimate the current and future extent of acidification and hypoxia under climate change (see Eutrophication research theme) and to investigate the contribution of local pollution inputs to acidification and hypoxia, (2) defining biological endpoints affected by acidification, hypoxia and the chemical thresholds at which those effects manifest; this includes laboratory and field experiments, as well as workshops with


leading experts to synthesize the effects of acidification and hypoxia on selected marine taxa, and (3) mining historical data to assess the extent to which acidification may have already manifested; SCCWRP is working with its member agencies to digitize and analyze historical data sets dating back 50 years or more, with the intent to examine possible local trends in acidification.

- **Evaluating coastal adaptation strategies to sea level rise**: While prior SCCWRP research has focused on evaluating the susceptibility of coastal wetlands to the effects of sea level rise, SCCWRP will continue its work to evaluate adaptation strategies aimed at helping wetlands persist in the face of expected dramatic increases in mean sea level and storm surge. Computer modeling suggests that coastal California may experience several meters of sea level rise by the turn of the century. To understand how coastal wetlands might accommodate these changes, SCCWRP and its partners are developing linked physical and biological models that can be used to evaluate adaptation planning. These models are being used to evaluate how strategies such as augmenting accretion, management of mouth dynamics, and facilitating transgression can help reduce anticipated wetland losses associated with sea level rise.

**Sediment Quality**

The quality of sediment that underlies water bodies is a sentinel indicator of the health of marine ecosystems. Pollutants discharged from wastewater treatment plants and urban watersheds have led to sediment contamination along California’s coastline, with contamination levels most acute in bays and estuaries, where slower-flowing waters promote settling of contaminant-laden particles. SCCWRP has been at the forefront of efforts to quantify, monitor and develop solutions to remediate contaminated sediment. SCCWRP and its collaborators have advanced sediment-quality science into the regulatory arena through the development of a widely applicable sediment quality assessment frameworks. In California, these assessment frameworks are the technical foundation for implementing the state’s Sediment Quality Objectives program. An assessment framework to protect bottom-dwelling organisms went into effect in 2009. A companion framework to gauge the human health impacts of food web contamination due to sediment pollutants was approved for use in 2019.

SCCWRP’s research falls into two main categories that reflect the two main routes by which organisms become exposed to sediment contamination: direct exposure, where bottom-dwelling marine life come into contact with and/or ingests contamination in sediment and/or water, and indirect exposure, where predators accumulate pollutants in their bodies as they consume contaminated prey. Each exposure route calls for a different conceptual approach to build a comprehensive assessment framework that can accurately measure and estimate the impacts of sediment contamination on the organisms exposed to it, including humans. SCCWRP’s goal is to build a common, agreed-upon technical foundation for assessing sediment quality to help water-quality managers make better-informed decisions about sediment remediation and clean-up activities.

This year, SCCWRP is continuing its work across both the direct and indirect exposure arenas, as well as pursuing case studies that can assist in translating water and sediment quality objectives to application by environmental managers. SCCWRP’s focus for 2019-20 will be on:

- **Assessing indirect effects on sediment quality**: To assess sediment contamination’s health risks for humans and wildlife, SCCWRP is continuing to refine bioaccumulation models and assessment frameworks that integrate chemical exposure and sediment contaminant linkage.
indicators. In the sediment linkage arena, SCCWRP is using passive sampling and tissue contamination measurements to improve the ability of bioaccumulation models to address the influence of dissolved contamination in the water column on food web contaminant transfer.

- **Implementing sediment and water quality objectives:** To support implementation of new evaluation tools for assessing sediment quality impacts on human health, SCCWRP is continuing to update its technical support resources and guidance documents and provide training in the use of sediment quality assessment frameworks. In addition, SCCWRP is conducting a case study to investigate the effects of site-specific water quality factors on copper bioavailability in the water column. The development of site-specific objectives provides environmental managers with a mechanism to ensure that regulatory targets for contaminants will provide the intended level of environmental protection.

**Contaminants of Emerging Concern**

Managers are challenged with addressing contaminants of emerging concern (CECs) in the face of a limited but rapidly growing knowledge base about their sources, pervasiveness and effects. There are tens of thousands of chemicals to triage, making the traditional chemical-by-chemical approach to monitoring and regulation unwieldy. Moreover, CECs are a “moving target,” as new chemicals are substituted for ones that are being phased out. In some cases, their potential for impact occurs at much lower levels and is manifested over longer periods of time when compared with chemicals already being regulated, which has presented additional challenges for their detection and assessment. As a result, a new approach to monitoring and assessment of aquatic contaminants is needed.

SCCWRP is developing three types of tools for sampling and measurement of chemical and biological parameters that will best inform whether CECs associated with permitted discharges are negatively impacting aquatic systems in California. Methods that employ state-of-the-art engineered cell biology (“bioanalytical tools”) can screen for many chemicals at the same time, making monitoring more efficient, relevant and comprehensive than the status quo. New chemical techniques that identify CECs responsible for exerting toxicity and that accumulate in wildlife (“targeted” and “non-targeted” chemical analysis) will provide a means for interpreting biological monitoring results. Tools that concentrate chemicals directly from the environment (“passive sampling methods”) will make sampling and collection of CECs more efficient and relevant. Integration of these tools with diagnostic toxicity testing and monitoring for CEC impacts *in situ* using a tiered monitoring framework will allow managers to make informed decisions concerning the level of treatment, discharge and occurrence of CECs.

This year, SCCWRP will continue investigating new bioanalytical tools that screen for CECs responsible for non-endocrine modes of action, while continuing to assess the quantitative linkage between cellular (“bioscreening”) assay responses and effects to organisms for endocrine-disrupting CECs (“EDCs”). SCCWRP will also continue developing and applying targeted and non-targeted chemical methods for identifying water-soluble CECs and biotoxins. Finally, SCCWRP will test different passive sampling materials that can efficiently sample and concentrate CECs, including biotoxins, from the environment. SCCWRP’s focus for 2019-20 will be on:

- **Bioanalytical screening methods:** To expand the current bioanalytical toolbox, SCCWRP is using high-throughput cellular assays to screen for a wider variety of CECs, including those identified as bioactive using chemical analysis. These assays are being evaluated using spiked chemicals and mixtures of chemicals, as well as on ambient (field-collected) samples.
This year, SCCWRP will employ these tools for ocean outfall monitoring and for an ongoing, large-scale pilot study as part of the Southern California Bight 2018 Regional Monitoring Program (see Regional Monitoring research theme). In parallel, SCCWRP is extending the scope of linkage testing using freshwater and estuarine/marine fish species (e.g., fathead minnow, inland silverside) to look for concordance between bioscreening results and the degree of both lethal and non-lethal harm for fish exposed in the lab and in the field. To accomplish the latter, researchers will compare bioscreening results with sublethal toxicity endpoints as measures of aquatic health (e.g., gene biomarkers, developmental and behavioral endpoints).

- **Analytical methods for biotoxins and source fingerprinting**: To identify the type of biotoxins that occur in State waters, SCCWRP is developing targeted methods that quantify the occurrence of microcystin, cylindrospermopsin and anatoxin variants in water, sediment and tissue. Researchers also are developing and applying non-targeted methods to distinguish among sources of contamination in receiving environments subject to stormwater and/or wastewater discharge.

- **Passive sampling of CECs**: SCCWRP is applying and developing passive sampling methods to more efficiently collect CECs of interest that occur at low concentrations in water and sediment, but could still exert biological effects. Passive samplers have the potential to facilitate improved sampling and enhanced analysis of CECs (e.g., pharmaceuticals, current use pesticides and biotoxins) by increasing speed, reducing labor, minimizing cross-contamination, and measuring CECs in a more bioavailable form to species of concern.

**Microbial Water Quality**

With more than 233 million visits per year, Southern California’s beaches are a precious natural resource and a major economic driver for the state and region. As such, protecting beachgoers from waterborne microbes that come from a disparate array of sources is vital to maintaining the economic benefits and perception of healthy living associated with California beach culture. Although California runs the nation’s most comprehensive beach water monitoring program, the public can benefit greatly from continuing advances in how microbial water contamination is monitored. Existing methods take 24 hours or more to yield results, which isn’t fast enough to provide same-day warnings to beachgoers. Moreover, when environmental managers find fecal indicator bacteria that may be associated with potentially pathogenic microbes in water, they want to identify where the contamination is coming from to stop it at the source. Given that waterborne microbes can travel long distances, remain infectious for extended periods (as in the case of some viruses), leave behind genetic material long after being rendered non-viable via disinfection treatment processes, and come from any combination of human and animal feces, the process of identifying sources of microbial water contamination and their associated health risks can be challenging and complex – an area for which the technology is still evolving. SCCWRP has been at the forefront of efforts to more rapidly detect beach microbial contamination and to advance the breadth and accuracy of emerging source-identification technologies. Working with its collaborators, SCCWRP has evaluated methods for identifying fecal sources, created a tiered framework for investigating sources of fecal bacteria at beaches, and developed and evaluated multiple assays designed to measure pathogens in both fresh and marine water. SCCWRP also is actively involved in applying these methodologies to epidemiology and modeling studies to characterize the risk of water-contact illness.

SCCWRP’s microbial water quality research is focused around three major objectives: (1) developing methods to provide same-day health warnings to ocean bathers, (2) improving the
approaches used to identify sources of microbial contamination, and (3) understanding the relationships between contamination measurements and observed impacts on human health. The first two areas revolve around transitioning from decades-old culture-based analyses – in which microbes must grow overnight in a lab – to genetic methods capable of rapidly detecting and quantifying microbes via their genetic material (DNA or RNA). This genetic technology also has the potential to provide important information about the source of fecal contamination, as specific genetic targets are diagnostic of different fecal sources (e.g., humans, dogs, cows, birds). Given the trove of data that these emerging technologies can yield, SCCWRP is working to incorporate these methods into epidemiological studies that can help environmental managers better understand the health risks associated with various beaches and fecal sources. SCCWRP’s ultimate goal is to provide managers with real-time information on sources of fecal contamination and commensurate risk to public health.

This year, SCCWRP will examine the relationship between fecal bacteria used to regulate recreational shellfish waters and pathogens in shellfish tissue. SCCWRP also is examining the prevalence of antibiotic-resistant bacteria and the genes that confer resistance in wastewater treatment plants and discharges, and assessing the utility of the bacterial community found in sanitary sewer infrastructure as a marker for identifying microbial water pollution. SCCWRP’s focus for 2019-20 will be on:

- **Evaluating the SHEL water-quality standard**: SCCWRP and its partners will assess whether a water-quality standard designed to protect the health of people who consume shellfish from Newport Bay in Orange County has been appropriately set, a response to a looming regulatory compliance deadline for recreational shellfishing. The study will examine whether California’s existing standard for permissible fecal coliform bacterial levels in the water correlates to potentially unsafe levels of pathogens in the tissue of bivalve shellfish harvested from Newport Bay. If the water-column bacterial measurements of indicators positively correlate with pathogen levels found in the shellfish, researchers would conclude that California’s existing standard for recreational shellfish harvesting is working as designed. However, if there is no relationship between water-quality indicators and pathogens found in the shellfish, the study could provide a scientific basis for developing a site-specific standard for Newport Bay, or trigger follow-up studies examining the appropriateness of using a fecal coliform-based standard to protect California shellfish.

- **Evaluating antibiotic-resistant bacteria and genes in wastewater**: SCCWRP is collaborating with its wastewater treatment member agencies to quantify the prevalence of antibiotic-resistant bacteria in wastewater treatment plants and their discharges. The study was prompted by media reports that potentially pathogenic antibiotic-resistant bacteria and antibiotic resistance genes may persist and even multiply during the wastewater treatment process before being discharged into the environment with treated effluent. The purpose of the study is to gain information about the type and prevalence of antibiotic-resistant bacteria and antibiotic resistance genes in southern California wastewater treatment plants and their discharges.

- **Tracking microbial biofilm communities in sewer pipes**: SCCWRP and collaborators are investigating whether the microbial community growing on the inner surfaces of public sewer pipes is unique to this type of infrastructure, a finding that could provide insights into the origins of human fecal contamination found in aquatic systems across Southern California. Researchers are using microbial source tracking methods to determine whether leaking sewer pipes could be responsible for the fecal contamination of Southern California waterways, or whether the contamination is coming from other sources, such as direct deposition of fecal matter into storm drain channels. The biofilm community that lines the insides of sewer pipes
is theorized to be the product of unique environmental factors, including temperature, moisture, darkness and a rich nutrient supply.

**Stormwater BMPs**

Wet- and dry-weather runoff in Southern California poses a particularly vexing challenge for the water-quality management community. During both wet and dry weather, contaminants wash off the land from across hundreds of square miles of urban, industrial and agricultural landscapes. Discharge of this contaminated runoff into receiving waters has been linked to microbial contamination in recreational surface waters (Marsalek and Rochfort 2004), excess nutrient loading that can trigger harmful algal blooms (Grigas et al. 2015), and increased toxicity that degrades ecological condition (Sebastian et al. 2015). Numerous regulatory and management programs have been implemented to reduce contaminant loading and mitigate the impacts of runoff on downstream aquatic ecosystems and on human health. But the diffuse nature of runoff has complicated management efforts to pinpoint and eliminate non-point sources.

For decades, SCCWRP has been facilitating research aimed at characterizing, monitoring and tracking the spread of runoff contamination through aquatic environments, and documenting downstream ecological impacts in coastal marine environments and other habitats. Building off this scientific foundation, SCCWRP is now increasingly shifting its focus to developing and evaluating management strategies, tools and insights for improving runoff water quality – an area known as best management practices (BMPs). SCCWRP’s research spans the two main types of stormwater BMPs: (1) Structural BMPs, which include detention, retention, and treatment systems designed to capture, treat, and recycle stormwater to minimize adverse impacts on receiving water bodies. A structural BMP may use a combination of various physical, chemical, and biological processes to accomplish its design objectives. (2) Non-structural BMPs, which include source control and other priority program management options such as street sweeping or public education. SCCWRP is working to build a foundational understanding of both structural and non-structural BMP processes. SCCWRP’s goal is to help inform the design, implementation and ongoing maintenance of BMPs across southern California – and ultimately, optimally reduce both pollutant loading and total runoff volumes. Especially as southern California’s environmental management community prepares to invest billions of dollars on BMPs to manage runoff in the coming decades, SCCWRP is committed to helping its member agencies understand how implementing a certain BMP or a combination of BMPs can be expected to influence receiving-water quality over the long-term. These insights are critical to turning contaminated runoff in southern California into a beneficial-use resource.

This year, SCCWRP will focus on supporting management decision-making regarding the interpretation and use of monitoring data, and how best to communicate this information to decision-makers. SCCWRP’s focus for 2019-20 will be on:

- **Developing a model monitoring program to support Alternative Compliance:** This project will develop a monitoring program that serves as a model for how to take a scientifically robust, practical approach to adaptive management under an Alternative Compliance pathway. Alternative Compliance pathways focus on long-term planning, phased implementation of BMPs, and then monitoring if those BMPs improve environmental outcomes; course corrections are made in an iterative manner to optimize achievement of long-term goals. Thus, it is critical that this iterative process be informed by a robust
monitoring program that provides the information necessary to support adaptive management decision-making.

- **Evaluating a stormwater monitoring program**: SCCWRP is evaluating Orange County Public Works’ stormwater monitoring program in north Orange County – which was last critically evaluated more than a decade ago – as part of a comprehensive monitoring review. SCCWRP will focus on defining the monitoring questions of greatest interest (i.e., to support priority decisions), review historical data, and develop recommendations for improving the effectiveness and efficiency of monitoring to optimally attain answers to monitoring questions. Orange County Public Works has been collecting surface water quality data since the early 1970s and is currently spending $2-3 million annually in north Orange County on a variety of stormwater and total maximum daily load monitoring requirements.

- **Developing the Stormwater Monitoring Coalition’s communications strategy**: SCCWRP will develop and implement a comprehensive communications strategy for the Southern California Stormwater Monitoring Coalition (SMC) to ensure the SMC is optimally positioned to publicize its goals, progress and accomplishments among both internal and external audiences. Although the SMC produces a large volume of actionable information every year, the SMC has struggled to publicize its technical products, and not all stormwater decision-makers are aware of the SMC’s work. The SMC’s communications plan is designed to not only ensure SMC products are transmitted and publicized to decision-makers, but also to convey pertinent information that can enhance decision-maker responsiveness.

**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 is that most monitoring is focused on addressing relatively compact areas that surround specific outfalls – monitoring that is required under state and federal laws. Even when scientists compile this compliance-based monitoring data from dozens of agencies, the resulting regional picture is incomplete. Recognizing this challenge, SCCWRP helps coordinate 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 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 expanse 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 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. 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 national 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 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 begin field sampling for the next five-year cycle of the Southern California Bight Regional Monitoring Program, known as Bight ’18. Additionally, the SMC Regional Watershed Monitoring Program is in the middle of its second cycle that started in 2014. SCCWRP’s focus for 2019-20 will be on:

- **Regional marine monitoring (Bight ’18):** The Southern California Bight Regional Monitoring Program, an integrated collaborative regional monitoring initiative, has developed five major study elements for the program’s sixth cycle, known as Bight ’18: Sediment Quality, Ocean Acidification, Harmful Algal Blooms, Trash and Microbiology. Dating back to 1994, the Bight program provides holistic answers to questions regarding the extent and magnitude of anthropogenic impacts and the range of natural variability upon which scientists evaluate these impacts. The Bight program covers approximately 1,500 square miles of near-coastal ocean and has sampled over 2,000 sites. For Bight ’18, more than 80 collaborating agencies will track trends in ecosystem health, including new habitats not previously monitored. Bight ’18 also will provide a platform for testing new monitoring technology, including new sampling techniques, new pollutants, and new ecosystem response assessment tools. Finally, Bight ’18 will examine emerging developments in water-quality management, including the success of previous management actions.

- **Regional watershed monitoring:** SCCWRP is facilitating the second cycle of the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program, which kicked off in 2014 and runs through 2019. The program assesses the health of approximately 4,300 miles of streams in coastal Southern California watersheds. The regional stream survey is among the largest in the country, with sampling at more than 500 sites across all 17 major watersheds between the Ventura and Tijuana Rivers. Data being collected encompass water quality, physical habitat and riparian condition, and biological communities, including benthic invertebrates and algae. The monitoring questions for the second five-year cycle include: (1) What are the extent and magnitude of impact in Southern California’s streams? (2) Are the extent and magnitude getting better or worse? (3) What are the stressors responsible for the impacts observed?

### 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 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 in areas that have not yet grown into a thematic focus area, but that have the potential to do so in the future. Work related to trash pollution is front and center in this category in SCCWRP’s 2019-20 research agenda:

- **Trash monitoring**: Development of reliable, repeatable trash-monitoring capabilities is crucial as California and its municipalities seek to document the effectiveness of aggressive, next-generation trash reduction and control programs being rolled out statewide. SCCWRP and its partners are working to establish cost-effective, repeatable methods for quantifying trash of all sizes, from macro-sized trash pieces to microplastic particles. The development of trash monitoring methodologies is ongoing in multiple types of aquatic environments, from streams to wastewater to drinking water. Through Bight ’18 and SMC regional monitoring programs, researchers are continuing to track the extent of trash on the seafloor and coastal watersheds, enabling managers to assess if recently enacted management programs are effective in reducing trash loading.

- **Microplastics measurement methods**: SCCWRP is facilitating a study that will quantitatively evaluate the accuracy, precision, sensitivity, and bias of multiple commonly used technologies for measuring microplastics in aquatic environments. The method evaluation study is an effort to standardize microplastic measurement methods in response to recently enacted California legislation that calls for microplastics to be tracked in drinking water and the coastal ocean. SCCWRP will facilitate the creation of split samples, training of participating laboratories in measurement methods, compilation of data and results, and consensus-building among the study participants regarding recommendations for the State Water Board and California Ocean Protection Council as they look to build capacity for conducting routine microplastics monitoring.