SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT AUTHORITY

FY 2017-2018
RESEARCH PLAN
EXECUTIVE SUMMARY

Approved by the SCCWRP Commission
June 2017

Introduction

The Southern California Coastal Water Research Project Authority, or SCCWRP, is a leading U.S. environmental research institute that develops a scientific foundation for informed water-quality management in Southern California and beyond. Since its founding as a public agency in 1969, SCCWRP has been a champion of sound interdisciplinary approaches to solving complex water-management challenges. SCCWRP's staff of approximately 45 researchers investigates not only how to more effectively monitor and protect watersheds and coastal waters, but also how to bridge the gap between water-quality research and the management community that relies on this science. Through a 14-member governing board – known as the SCCWRP Commission and made up of senior managers from Southern California's largest wastewater treatment, stormwater management and water-quality regulatory agencies – SCCWRP builds consensus and develops real-world management solutions, paving the way for collaborators and stakeholders to coalesce around shared, long-range research goals.

Mission

SCCWRP's mission is to enhance the scientific foundation for management of Southern California's ocean and coastal watershed resources. 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 and information-technology principles to monitor and assess the condition of aquatic ecosystems, with an overarching goal to solve significant identified 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 six science departments – Toxicology, Chemistry, Biogeochemistry, Biology, Microbiology, and Information Management & Analysis – that work in an interdisciplinary, interconnected fashion across SCCWRP's major research areas:

1. **Bioassessment**
2. **Ecohydrology**
3. **Eutrophication**
4. **Climate Change**
5. **Sediment Quality**
6. **Contaminants of Emerging Concern**
7. **Microbial Water Quality**
8. **Regional Monitoring**
9. **Information Technology and Visualization**

Furthermore, SCCWRP conducts new and emerging research that have 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 continuously 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 comprehensive technical publications provide an overview of how SCCWRP conceptually approaches each research theme and how our multi-faceted research strategy fits together. The detailed documents also identify broadly supported priorities for research. CTAG and SCCWRP staff collaborate in all-day research planning workshops to flesh out and periodically update these living documents. 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 on SCCWRP's website.

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 chemistry-based monitoring, which provides only limited information about a relatively narrow portion of the environment at a discrete point in time, bioassessment can account 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'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 creates assessment tools that can identify and characterize reference conditions, as well as develops sampling protocols and indices that can transform complex biological data into simple measures of condition. Additionally, SCCWRP focuses on creating appropriate interpretive frameworks for understanding bioassessment data, 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 upgrading standard evaluation frameworks and 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 decision aimed at improving overall condition, SCCWRP develops synthesis and integration tools that can translate assessment results to actionable information. In this way, SCCWRP can 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 and expand its protocols and processes for both condition assessments and causal assessments, as well as pursuing development of guidance and decision support tools to inform management actions. SCCWRP's focus for 2017-18 will be on:

- **Condition assessment:** To assess the condition of Southern California's full range of aquatic resource types, SCCWRP is working to develop a broad suite of condition assessment tools,

with a long-term goal of having bioassessment tools based on invertebrates, algae, vertebrates or molecular indicators that can be applied in streams, wetlands, coastal lagoons, and/or ocean ecosystems. This year, SCCWRP will focus on developing statewide condition indices for algae, a critical bioassessment indicator for evaluating impacts from nutrients, flow, temperature and habitat alteration. The new algal indices will directly incorporate molecular data into the index development process for the first time. SCCWRP is also expanding its 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, and is beginning to develop eelgrass assessment tools for coastal lagoons. SCCWRP is also piloting additional species, including freshwater fish and ichthyoplankton (larval marine fishes), as new bioindicators of water body condition. Ichthyoplankton holds tremendous promise because of next-generation measurement methods, including genetic barcoding, that are allowing scientists to link water quality and natural resources to the California Cooperative Fisheries Investigation (CalCOFI), one of the longest-running fish monitoring programs in the nation.

- **Causal assessment**: To identify potential causes of degraded condition, SCCWRP applies and adapts the U.S. EPA's Causal Analysis/Diagnosis Decision Information System (CADDIS) framework. This year, SCCWRP will focus on developing an integrated and tiered approach to causal assessment. Rapid causal screening tools will be developed and tested to achieve a streamlined approach for identifying major classes of stressors (e.g., flow vs. habitat alteration vs. contaminants). This will be followed by development of stressor-specific metrics based primarily on life history traits and molecular assessment tools, as appropriate, that are designed to improve diagnostic ability. This framework will be demonstrated through 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 conceptualizing (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 – changes that are ultimately linked to ecosystem health. SCCWRP's focus for 2017-18 will be on:

- **Development of statewide framework for evaluating in-stream flow needs**: SCCWRP has facilitated formation of a statewide workgroup that is developing a tiered framework for assessing in-stream flow needs across California. The workgroup, which includes partners from UC Berkeley, UC Davis, U.S. Geological Survey and The Nature Conservancy, will develop a three-tiered framework that includes statewide hydrologic 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 example management needs, including dam management, agricultural water withdrawals, and urban stormwater management.
- **Application of flow-ecology to water resources management**: Past SCCWRP research has produced flow-ecology relationships that linked changes in flow to changes in stream condition as indicated by benthic macroinvertebrate community composition. SCCWRP is now pursuing development of flow targets based on algal communities, freshwater fish and riparian habitats. This broader suite of tools will be applied to support applications that include urban stormwater management, evaluation of climate change effects, and evaluation of water use and reuse proposals.
- **Development of site-specific and watershed-scale BMPs**: 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 has partnered 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. LID performance can be affected by a variety of factors, such as influent concentrations, rainfall intensity, design attributes, and maintenance history. The results of this work will ultimately be used to support development of mechanistic models of LID performance. Separately, 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 sustainably 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 the knowledge base and the 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 2017-18 will be on:

- **Building the technical foundation for nutrient 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 is developing an Algal Stream Condition Index (ASCI) to support biointegrity assessments and to link algal and benthic macroinvertebrate community composition to pathways of eutrophication impacts.
- SCCWRP is using the consensus of wadeable stream experts to calibrate the range of scores for ASCI and the benthic macroinvertebrate-based California Stream Condition Index (CSCI) that correspond to levels of ecological condition and function, from high to low. This information will support decisions regarding biological goals for CSCI and ASCI by helping to relate these targets back to levels of beneficial-use protection.
- SCCWRP is working toward development of statistical models that relate standardized stream bioassessment indices to nutrient concentrations and eutrophication indicators. Such models may provide the approach to decisions on nutrient targets as a part of the statewide biostimulatory/biointegrity policy.
- SCCWRP is continuing to demonstrate how science can inform a combined biostimulatory/biointegrity approach to watershed management. 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 Santa Margarita River Estuary and the main stem of the River, 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 in order to better characterize the extent of the problem, including through DNA barcoding, which is being coupled with a 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 to develop chlorophyll-a and cyanotoxin targets for lakes, and (4) playing a role in unifying the 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 nutrients 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 and acidification conditions as sources of land-based nutrient inputs enter 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 don't exist for near-coastal environments, will be used to evaluate the extent to which anthropogenic nutrients are affecting trends in oxygen and acidification conditions.

Climate Change

Global climate change will fundamentally alter how aquatic systems are managed. As anthropogenic carbon dioxide emissions drive increasingly severe changes to 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 impacts will largely be managed at a local scale. To that end, managers must be prepared to confront the local impacts of climate change, including how climate change will alter biological communities, how it will disrupt sensitive ecological areas along the coast, and how it will shift societal attitudes about how aquatic resources should be managed. SCCWRP is helping Southern California water-quality managers pursue a multi-pronged research agenda aimed at developing next-generation solutions for monitoring, mitigating and offsetting the local impacts of global climate change.

SCCWRP's research is focused on identifying, evaluating, refining and implementing viable mitigation and preparedness options that will position aquatic systems to optimally cope with the impacts of rising atmospheric carbon dioxide emissions. Among SCCWRP's top priorities is investing in advancing scientific understanding of ocean acidification, a phenomenon caused by oceanic assimilation of atmospheric carbon dioxide. This ocean acidification research is wide-ranging and encompasses disparate areas, including: (1) how to differentiate the changing distribution of organisms with temperature relative to existing biological monitoring programs, (2) advancing the state of the science on acidification impacts by moving beyond dissolution of calcium carbonate in shelled organisms to more subtle, but potentially more far-reaching, chronic sub-lethal impacts, and (3) developing predictive models for ecosystem transitions in streams, wetlands, lagoons and estuaries. Additionally, as climate change drives rising sea levels and increased storm surge, as well as fundamental shifts in weather patterns and increases in seawater temperatures, SCCWRP also will seek to understand these impacts and evaluate the effectiveness of possible management actions.

This year, SCCWRP will work toward improving managers' ability to monitor ocean acidification and to assess its impacts on the Southern California Bight, as well as assess the vulnerability of coastal areas to sea level rise and storm surge. SCCWRP's focus for 2017-18 will be on:

- **Assessment of acidification and its impacts:** SCCWRP is developing new technologies and approaches to assess the changing chemistry of seawater, as well as conducting research to assess how ocean acidification may already be impacting the water quality and biota in the Southern California Bight.
    - SCCWRP is improving the ability to monitor potentially acidifying waters by quantifying the error rate of existing pH monitoring technology, as well as evaluating strategies for improving these measurements through alternative calibration approaches for existing technology and by identifying promising new measurement technologies.
    - To assess possible effects of acidification that have already manifested, SCCWRP is working with its member agencies to digitize and analyze historical Bight data sets dating back 50 years or more, with the intent to examine possible local trends in acidification. Those analyses are focused on assessing possible changes to pH, which is a direct measure for changes in water quality, and assessing condition of benthic infauna, which allows for assessment of the potential biological response to changing water quality exposure. The benthic infaunal analysis will examine whether there

have been any faunal shifts in the biota over the 40+-year data record and whether any changes can logically be associated with acidification stress, such as the ratio or spatial distribution of shelled vs. non-shelled organisms.
    - SCCWRP is conducting science and leading a synthesis of science to develop a framework to assess the effects of ocean acidification on marine organisms, including pteropods (sea snails). This science includes laboratory and field experiments and a series of workshops with leading experts to synthesize the effects of acidification on selected marine taxa.
    - SCCWRP is working with partners to develop and apply a coupled physical-biogeochemical model of the California Current to estimate the current and future extent of acidification and hypoxia under climate change (see Eutrophication research theme). This model will be used to investigate the contribution of local pollution inputs to acidification and hypoxia. It will also be used to support conversations among marine resource managers on adaptation strategies for marine resource management and marine spatial planning.
- **Evaluation of 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 this year will focus on evaluating adaptation strategies aimed at helping wetlands persist in the face of expected dramatic increases in mean sea level and storm surge. Recent 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 will be used to evaluate how strategies such as augmenting accretion, management of mouth dynamics, and transgression facilitation can help reduce anticipated wetland losses associated with sea level rise.
- **Evaluation of climate change and water resources management effects on southern California streams**: Because climate change complicates decisions regarding how to balance competing ecological and human demands for instream flows, and because changing precipitation patterns and warmer temperatures are likely to reduce summer baseflows and increase the variability of winter storm flows, SCCWRP will work to help water resources managers maintain desired biological communities as part of their goal to provide adequate environmental flows. SCCWRP will incorporate local downscaled predictions of changing temperature and rainfall patterns into flow ecology models to evaluate how climate change may affect decisions regarding in-stream flow management. This, in turn, will be used to inform deliberations regarding setting flow targets aimed at ensuring healthy biological communities, within the context of other demands on water supply.

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 framework designed to gauge the impacts of sediment contamination on bottom-dwelling organisms.

In California, this assessment framework has become the technical foundation for implementing the state's Sediment Quality Objectives program that went into effect in 2009. SCCWRP also has begun developing sophisticated mathematical models that quantify how contamination from sediment moves through the food web and bioaccumulates in wildlife and humans.

SCCWRP's research falls into the 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 indirect exposure, where predators accumulate toxins 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 sediment science to application by environmental managers. SCCWRP's focus for 2017-18 will be on:

- **Direct effects on sediment quality**: To build upon research focusing on the impacts of direct exposure to contaminated sediment, SCCWRP is pursuing projects across all three lines of evidence used in sediment quality assessments. In the chemistry arena, SCCWRP is studying how to accurately measure the freely dissolved concentration of sediment contamination by a technique known as passive sampling. In the toxicity arena, SCCWRP is examining the spatial and temporal variability in sediment toxicity identification evaluation (TIE) tests to develop guidance for TIE study design. In the biological assessment arena, SCCWRP is evaluating if and how to use DNA barcoding to rapidly assess the condition of marine benthic invertebrate communities. Research is also underway to develop a rapid causal assessment framework for macrofaunal community impacts in embayments.
- **Indirect effects on sediment quality**: To assess sediment contamination's health risks for humans and wildlife, SCCWRP is pursuing development of bioaccumulation models and assessment frameworks that integrate consumption risk and sediment 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.
- **Sediment quality objectives implementation**: To support implementation of new evaluation tools for assessing sediment quality impacts on human health, SCCWRP is updating its technical support resources, including an SQO technical support document that will be expanded to include guidance on SQO assessment for impacts on human health, and guidance regarding stressor identification.

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 literally tens of thousands of chemicals to triage, making the traditional chemical-by-chemical approach to monitoring and regulation unwieldy and obsolete. 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 ("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 investigate 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 develop and apply targeted and non-targeted chemical methods for identifying water-soluble CECs and biotoxins. In addition, SCCWRP will test different passive sampling materials that can efficiently sample and concentrate CECs from the environment. SCCWRP's focus for 2017-18 will be on:

- **Bioanalytical screening methods**: To expand the current bioanalytical toolbox, SCCWRP is working to identify high-throughput cellular assays that can screen for a wider variety of CECs, including those identified as bioactive using chemical analysis. Once selected, these assays will be tested in the lab using known chemicals and mixtures thereof. 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 observed in test fish (e.g., growth, development and reproductive maturity).
- **Identification of bioactive CECs and toxins**: To identify CECs and toxins that have the greatest impact on water quality, SCCWRP is developing methods to analyze water and sediment samples for bioactive CECs and toxins that are produced by harmful algal blooms (HABs). SCCWRP will apply these methods to samples from receiving environments subject to stormwater runoff and treated wastewater discharge.
- **Passive sampling of CECs**: SCCWRP is applying and developing passive sampling methods to more efficiently collect CECs of interest that occur at very low concentrations in water and sediment. Passive samplers have the potential to improve on existing sediment quality assessments in that they can detect very low levels of persistent pollutants in seawater, and they represent a more relevant parameter of chemical exposure to target.

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 healthful 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) Develop methods to provide same-day health warnings to ocean bathers, (2) improve the approaches used to identify sources of microbial contamination, and (3) understand 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 the presence of 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 prevalence of antibiotic-resistant bacteria and the genes that confer resistance in wastewater treatment plants and discharges. SCCWRP also is examining the utility of source-associated markers to identify microbial water pollution, and assessing the health effects of contaminated ocean water on swimmers. SCCWRP's focus for 2017-18 will be on:

- **Evaluating antibiotic-resistant bacteria and genes in wastewater:** SCCWRP and its member agencies are collaborating on a study to examine 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.
- **Assessing health effects on swimmers**: SCCWRP and collaborators are conducting a Quantitative Microbial Risk Assessment, or QMRA, to determine the appropriateness of

setting site-specific objectives for water-quality criteria. The study, being conducted at Inner Cabrillo Beach in Los Angeles Harbor, is the first QMRA to be conducted in California during dry weather. Inner Cabrillo is a popular swimming spot in the Los Angeles Harbor area where fecal indicator bacteria concentrations frequently exceed water-quality guidelines. More than $20 million has been spent to reduce contamination levels, but bacterial concentrations continue to exceed objectives; the beach has a TMDL (total maximum daily load) for fecal bacteria.

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 up to 100 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 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 be kicking off 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 mid-span of its second cycle started in 2014. SCCWRP’s focus for 2017-18 will be on:

- **Regional marine monitoring (Bight ’18)**: The Southern California Bight Regional Monitoring Program, an integrated collaborative regional monitoring initiative, is kicking off

its sixth cycle, known as Bight ’18, in fall 2017. 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 judge these impacts. Previous iterations encompassed several design elements and nearly 100 collaborating agencies, addressing issues such as sediment contamination, bioaccumulation, trash and debris, shoreline microbiology, marine protected areas, and nutrient impacts. Prior to initiation of Bight ’18 sampling in summer 2018, a number of key steps must be completed:

- Key regulated, regulatory, non-governmental and academic representatives will work toward agreement on the primary monitoring questions of interest and the potential management responses they will take in response to the survey’s findings.
- SCCWRP will facilitate the process of creating a study design that answer monitoring questions with defined levels of scientific rigor and confidence.
- Bight technical committees will come to agreement on implementation details, including field and laboratory methods, and ensure comparability among participating agencies through a series of training, audits, and intercalibration exercises.
- SCCWRP will facilitate the process of creating an information infrastructure to support automated data collection, data checkers and QA filters, and on-the-fly data analysis tools.
- Bight planning and technical committees will write workplans, quality assurance plans, and sampling and laboratory analysis plans that document the study questions, designs and supporting implementation details.

- **Regional watershed monitoring**: SCCWRP is facilitating the second cycle of the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program. After successfully facilitating the first regional monitoring survey cycle of streams from 2009 to 2014, SCCWRP and the SMC are again assessing the health of Southern California’s approximately 4,300 miles of streams in its coastal watersheds. The regional stream survey is among the largest in 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, which runs through 2019, 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? The 2017 survey also addresses several special study components, including assessing non-perennial streams, which is a habitat that comprises nearly three-quarters of all stream-miles in the region. Additional novel components include assessing the extent and magnitude of current-use pesticides (pyrethroid and fipronil) and the effects of variable climate (i.e., the swing from extreme drought in 2015-16 to extreme rainfall in winter 2016-17).

Information Technology and Visualization

Monitoring, assessment and management of aquatic ecosystems is a data-driven process, with millions of dollars spent every year in Southern California on the collection of monitoring data. To effectively use data, the methods used to acquire, manage and assess data must be well-documented. The goal is to generate data that are reproducible, consistent and comparable. Increasingly, environmental managers are seeking sophisticated approaches to visualizing data to effectively communicate big-picture ideas and complex findings; these visualization tools include data dashboards, map-based tools and virtual-reality simulations that can examine what-if scenarios by

altering hypothetical conditions and decisions. SCCWRP is at the forefront of efforts to develop and standardize data management across Southern California, beginning with an ocean-monitoring pilot study in 1994 that has evolved into the ongoing Southern California Bight Regional Monitoring Program. Development of standardized data collection and management protocols through the Bight program and others has greatly improved data quality and comparability throughout the region, offering environmental managers comprehensive, detailed snapshots of the changing condition of coastal waters in Southern California and beyond. Signature data-collection initiatives such as the Bight program also serve as national models for effective environmental-monitoring design.

As SCCWRP advances its research agenda to leverage emerging information technologies in data acquisition and analysis, the agency evaluates opportunities to use new and emerging technologies to improve the data workflow. This workflow falls into three main stages: (1) data acquisition, (2) data management, and (3) processing and interpretation of results. To improve quality, consistency and speed of data collection, SCCWRP is pursuing a number of emerging technologies for field data acquisition. To allow environmental researchers and managers to evaluate potential outcomes based on various assumptions and hypothetical courses of action, SCCWRP is pursuing development of environmental index and statistical calculators, data dashboard and visualization products, and scenario tools. SCCWRP's goal is to provide environmental managers and the public with consistent and transparent analytical methods and outputs, so the science developed by SCCWRP and its collaborators can be effectively used to inform management action.

This year, SCCWRP will continue its work to further enhance data acquisition technologies, refine its data management processes and protocols, and build and test next-generation data processing and interpretation tools. SCCWRP's focus for 2017-18 will be on:

- **Data acquisition**: To improve scientists' ability to gather environmental data and field measurements, SCCWRP is working to expand and improve its field computing tools, including the utility and capabilities of mobile apps to support data collection, and the use of real-time web data services to more effectively integrate data collection. SCCWRP also is working to adapt the capabilities of remote sensors, especially satellites and unmanned aerial systems, to allow for collection of richer, more data-intensive imagery. Across all these data acquisition platforms, SCCWRP is exploring opportunities to effectively automate the analysis of image data being collected.
- **Data management**: SCCWRP is continuing its investment in open data technologies and industry-standard commercial and open-source software technologies to develop next-generation web-based data submission tools with integrated data-quality checkers, update databases to optimize functionality and ensure utility, provide support for efforts to identify and prioritize non-digitized historical data, and maintain updated databases as nomenclature and the state of the science evolve.
- **Data processing and interpretation**: To simplify the laborious, highly technical tasks associated with data crunching and analysis, SCCWRP is working to transfer its environmental index calculators to the end-user community. To improve managers' ability to visualize and analyze fully integrated data sets, SCCWRP is building 3D visualization tools that can support communication of complex information for planning and management. To pave the way for virtual- and augmented-reality scenario planning, SCCWRP is moving aggressively into the "what if" planning arena via a newly forged partnership with Esri, a leading commercial GIS software company.

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. In addition, 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.

FY 2017-18 Research Plan Budget

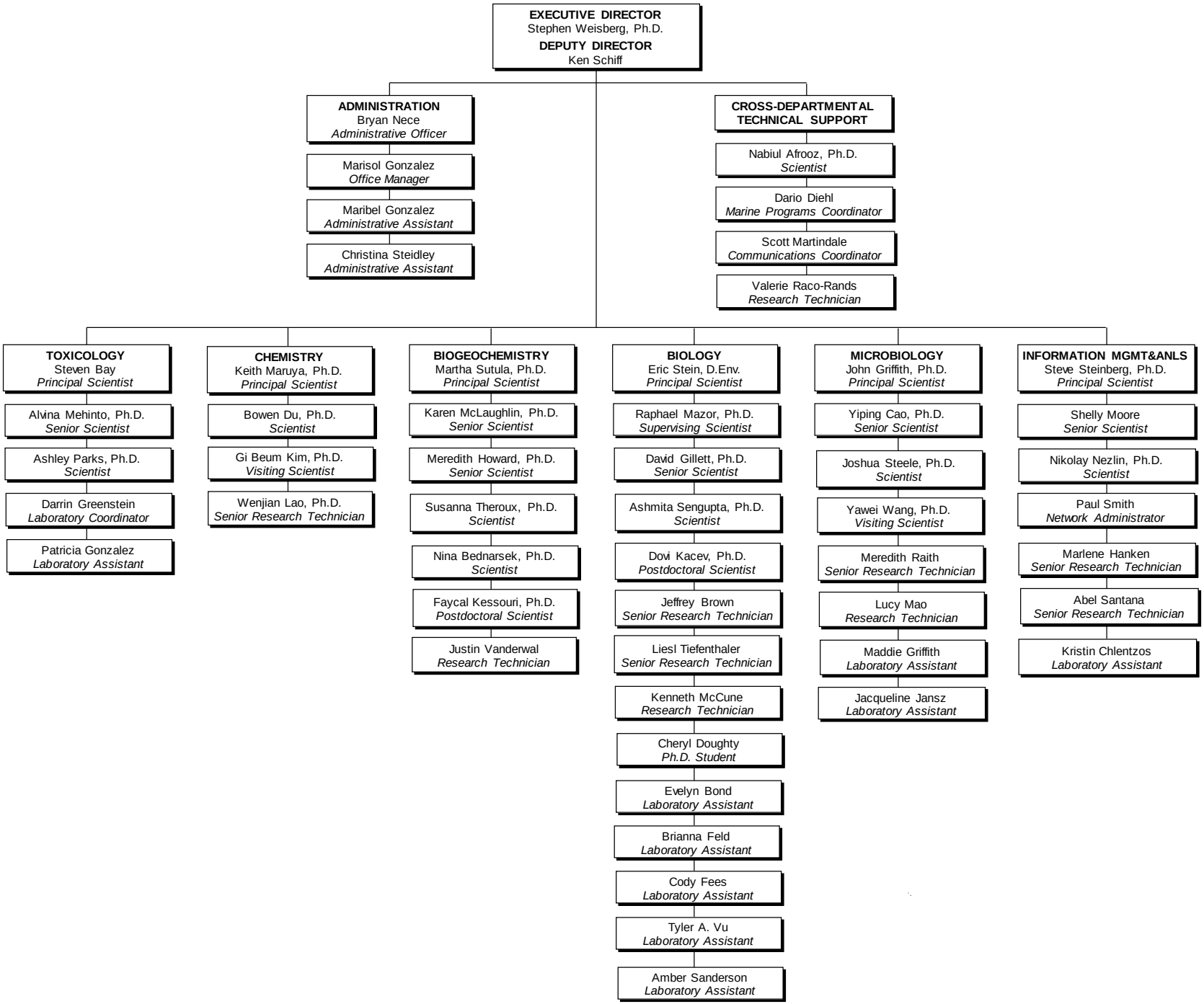
	RESEARCH THEMES	BUDGET	%
	Bioassessment		
A1	Condition Assessment	888,645	10.0
A2	Causal Assessment	194,051	2.2
A3	Integration and Implementation	115,064	1.3
	Ecohydrology		
B1	Development of Statewide Framework for Evaluating In-stream Flow Needs	34,772	0.4
B2	Application of Flow-ecology to Water Resources Management	122,379	1.4
B3	Development of Site-specific and Watershed-scale BMPs	126,536	1.4
	Eutrophication		
C1	Building the Technical Foundation for Nutrient Targets for California Water Bodies	976,227	11.0
C2	Assessments of Harmful Algal Blooms	318,322	3.6
C3	Biogeochemical Effects of Nutrients in the Southern California Bight	222,343	2.5
	Climate Change		
D1	Assessment of Acidication and its Impacts	408,769	4.6
D2	Evaluation of Coastal Adaptation Strategies to Sea Level Rise	144,378	1.6
D3	Evaluation of Climate Change and Water Resources Management Effects on Sou	35,549	0.4
	Sediment Quality		
E1	Direct Effects on Sediment Quality	118,484	1.3
E2	Indirect Effects on Sediment Quality	131,771	1.5
E3	Sediment Quality Objectives Implementation	506,766	5.7
	Contaminants of Emerging Concern		
F1	Bioanalytical Screening Methods	501,851	5.7
F2	Identification of Bioactive CECs and Toxins	408,809	4.6
F3	Passive Sampling of CECs	151,395	1.7
	Microbial Water Quality		
G1	Evaluating Antibiotic-resistant Bacteria and Genes in Wastewater	86,550	1.0
G2	Assessing Human Health on Swimmers	313,488	3.5
	Regional Monitoring		
H1	Regional Marine Monitoring	495,267	5.6
H2	Regional Watershed Monitoring	82,108	0.9
	Information Technology and Visualization		
I1	Data Acquisition	131,893	1.5
I2	Data Management	239,750	2.7
I3	Data Processing and Interpretation	139,699	1.6
J1	**Emerging Research and Member Agency Support**	405,933	4.6
K1	**Future Projects**	1,562,546	17.6
	Total	8,863,345	100.0

FY 2017-18 Line Item Budget

Revenues	
Member Contributions	2,200,000
Grants and Contracts	6,638,345
Interest Income	25,000
Total Revenues	**8,863,345**
Expenses	
Salaries	3,858,264
Employee Benefits	560,000
Deferred Compensation	444,000
Workers Compensation	66,000
Payroll Taxes	83,000
Rent	585,000
Telecommunications	38,000
Utilities	70,000
Facilities Maintenance	65,000
Equipment Purchase & Maint	55,000
Office Supplies	20,000
Information Technology	170,000
Business Insurance	80,000
Printing	45,000
Shipping	8,000
Travel and Meetings	300,000
Legal Services	15,000
Financial Services	35,000
Other Professional Services	50,000
Subscriptions/Memberships	24,000
Taxes/Licenses	8,000
Other Expenses	8,000
Project Supplies	279,581
Scientific Services	1,724,000
Capital Expenditures	272,500
Total Expenses	**8,863,345**

Financial History

	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018
Revenues	Actual	Actual	Actual	Estimate	Budget
Member Contributions	2,000,000	2,000,000	2,000,000	2,000,000	2,200,000
Grants and Contracts	7,320,608	7,011,814	6,603,370	5,500,000	6,638,345
Interest Income	6,314	12,113	18,602	25,000	25,000
Other Income	1,802	34	822	0	0
Totals	9,328,724	9,023,961	8,622,794	7,525,000	8,863,345
Expenses					
Salaries	3,710,129	3,773,683	3,606,173	3,500,000	3,858,264
Employee Benefits	624,656	523,946	465,081	510,000	560,000
Deferred Compensation	346,506	409,400	389,063	390,000	444,000
Workers Compensation	45,610	62,998	62,416	60,000	66,000
Payroll Taxes	80,275	54,716	73,427	75,000	83,000
Rent	518,135	515,189	550,247	555,000	585,000
Telecommunications	51,929	43,705	33,563	35,000	38,000
Utilities	62,326	71,152	64,567	68,000	70,000
Facilities Maintenance	58,620	64,746	61,668	60,000	65,000
Equipment Purchase & Maint	41,746	50,306	51,131	50,000	55,000
Office Supplies	14,841	14,886	14,448	18,000	20,000
Information Technology	129,766	132,965	131,946	160,000	170,000
Business Insurance	78,013	81,424	73,234	75,000	80,000
Printing	104,851	27,564	40,660	42,000	45,000
Shipping	11,014	6,056	3,897	8,000	8,000
Travel and Meetings	230,805	220,432	237,737	210,000	300,000
Legal Services	8,423	5,219	5,840	10,000	15,000
Financial Services	24,168	30,826	30,774	32,000	35,000
Other Professional Services	60,170	9,055	17,873	90,000	50,000
Subscriptions/Memberships	4,837	16,402	16,014	22,000	24,000
Taxes/Licenses	7,128	5,868	6,890	7,000	8,000
Other Expenses	5,807	7,077	6,556	7,000	8,000
Project Supplies	355,133	490,212	454,873	250,000	279,581
Scientific Services	2,533,452	2,128,884	1,927,950	1,300,000	1,724,000
Capital Expenditures	60,213	77,509	93,809		272,500
Totals	9,168,555	8,824,221	8,419,834	7,534,000	8,863,345
Surplus/Deficit	160,169	199,741	202,960	-9,000	0
Beginning Unrestricted Fund Balanc	2,832,096	2,992,265	3,192,005	3,394,965	3,385,965
Ending Unrestricted Fund Balance	2,992,265	3,192,005	3,394,965	3,385,965	3,385,965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Stephen Weisberg, Ph.D.
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Ken Schiff
ADMINISTRATION
Bryan Nece
Administrative Officer
Marisol Gonzalez
Office Manager
Maribel Gonzalez
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Christina Steidley
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Dario Diehl
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Scott Martindale
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Dovi Kacev, Ph.D.
Postdoctoral Scientist
Jeffrey Brown
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Liesl Tiefenthaler
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Joshua Steele, Ph.D.
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Abel Santana
Senior Research Technician
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