SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT AUTHORITY

THEMATIC RESEARCH PLAN

FOR

REGIONAL MONITORING

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Introduction

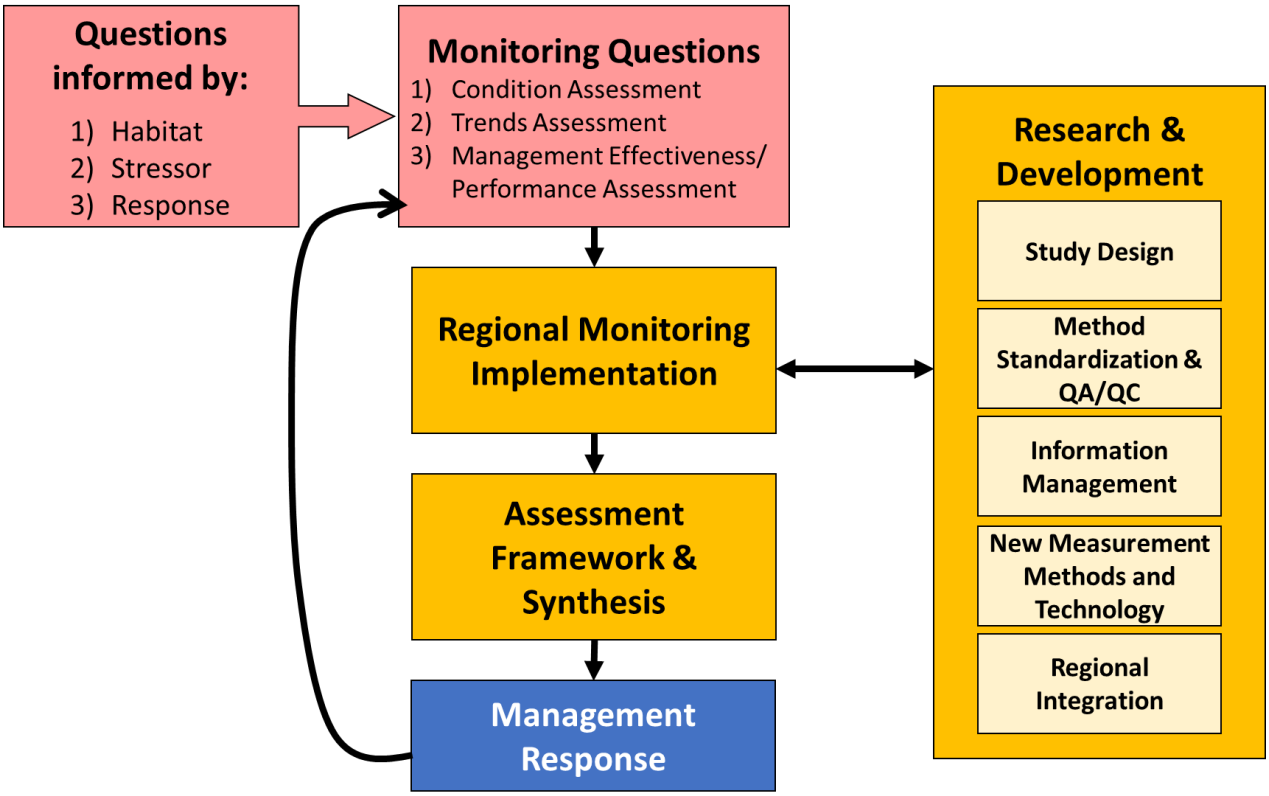
Southern California environmental managers and scientists spend an estimated $50 million every year on monitoring the condition of aquatic systems, but have struggled to answer the big-picture questions asked by the public: “Is it safe to swim in the ocean?” “Are locally caught fish safe to eat?” and “Are we harming our local ecosystems?” A National Research Council (1990) study used southern California as a case study to understand the challenges underlying our ability to answer these most basic of Clean Water Act questions. Fundamentally, the challenge was that most monitoring occurs in the relatively compact areas that surround wastewater outfalls, storm drain outlets and other discharge zones – monitoring that is required for compliance with state and federal laws. Consequently, when researchers attempt to compile compliance-based monitoring data, the resulting regional picture of holistic ecosystem condition can become skewed. Recognizing this challenge, SCCWRP has coordinated and facilitated regional-scale monitoring programs across a variety of habitats, including streams, wetlands, estuaries, offshore pelagic, rocky reefs and soft-bottom marine environments. Somewhat unique to southern California, SCCWRP works with dozens of local and regional agencies to coalesce common management information needs, then 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. SCCWRP’s best-known monitoring program is the ongoing Southern California Bight Regional Monitoring Program (Bight), conducted every five years since 1994 to monitor the region’s coastal areas. The Bight Program’s freshwater counterpart is the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program, which launched in 2009 and also runs on rolling five-year cycles. These two programs form the template upon which SCCWRP is building new monitoring programs and expanding existing programs to meet the challenges of the future. For example, SCCWRP is developing a regional effort to assess the performance of stormwater best management practices, engineering solutions which target the mitigation of stormwater contaminants. SCCWRP is also leading a coordinated monitoring program to assess condition across the myriad of California estuaries. SCCWRP-facilitated regional monitoring programs are among the top regional monitoring programs in the nation and have served as models for developing similar programs internationally.

Conceptual Model

SCCWRP’s conceptual model for regional monitoring frames the research needed to develop and implement a region-wide monitoring program successfully. All programs are driven by monitoring questions that seek to assess condition, trends and/or effectiveness of management solutions. These monitoring questions are informed by agreement on the habitat(s), stressor(s) and response(s) that are the focus of the regional monitoring assessment. Once the questions are framed, a monitoring program is designed and implemented, and the data collected is categorized and synthesized to answer the prescribed questions for communication to managers who can then take appropriate actions. The implementation of a regional monitoring program is supported by research and development in five areas: study design, method standardization and QA/QC,

information management, new measurement methods and technology, and regional integration. Research projects in each of these areas are typically tested, vetted, and refined in pilot studies by monitoring participants before transitioning into routine implementation. Assessment framework development is a large part of other SCCWRP research thematic areas, but is applied in Regional Monitoring, where assessment results are synthesized and communicated to managers. Advancements in each of these areas keep monitoring programs adaptive to current management needs and priorities.

Figure 1. SCCWRP's regional monitoring research supports the process of developing an effective regional monitoring program. SCCWRP's work in support of regional monitoring is focused on successful implementation of regional monitoring effort to answer basic questions of status, trends, and/or effectiveness of solutions. Other SCCWRP research areas inform development of assessment frameworks for interpretation of regional monitoring data. Regional monitoring collects data to support development and validation of these frameworks.



Monitoring Questions: Regional monitoring programs begin with prioritization of monitoring questions that are of mutual interest to program participants. Typically, regional monitoring programs are designed to gain insights into the condition and/or trends of any number of habitats, stressors, and responses and this is accomplished through the development of monitoring

questions. These questions, agreed upon by consensus, become the guiding force of the program; all subsequent decisions and actions regarding the scope and scale of the program revolve around answering the monitoring questions and what actions managers will take once they get an answer.

Research and Development in Support of Regional Monitoring Implementation: After the regional monitoring questions have been developed and agreed upon by participants, the details of how the regional monitoring program will be implemented must be fleshed out. The mechanics of defining these details fall into five main areas: study design, method standardization and QA/QC, information management, new measurement methods and technology, and regional integration:

1) ***Study Design****:* Many lessons learned from regional monitoring programs are universally transferrable; however, the design of every program is unique, involving a different set of habitats, stressors and responses. Some designs require a lot of repetition to answer questions about trends over time. Others focus on a large number of sites to answer questions about spatial extent or to create maps of condition. Some regional monitoring questions focus on environmental processes or determination of effectiveness of management solutions that require mechanistic designs. In southern California, all three basic study designs are sometimes commingled, presenting challenges for design optimization.
2) ***Method Standardization & QA/QC****:* A regional monitoring program, particularly one that relies on multiple participants, is only as good as its ability to obtain high-quality, comparable data. In southern California, a performance-based approach is often used, allowing participants to use their chosen methods while maintaining agreed-upon standards for sensitivity, accuracy, precision and bias. The performance-based approach enables innovation, while at the same time guaranteeing comparability. This is then supplemented with training, audits and laboratory intercalibrations to ensure comparability. The key to the performance-based approach is to not drop data quality objectives to the lowest common denominator. Rather, it is to lift all participants up to the necessary shared level of rigor and data quality to answer the monitoring questions.
3) ***Information Management****:* While creating a scientifically rigorous data set is important, the inability to successfully and reliably compile, store, and retrieve data for analysis can limit the success of a monitoring program. This issue is compounded when a large number of data generators and data users participate in a regional program, such as the southern California regional surveys. Information Management has taken on new roles in recent years as modern technology generates more and different data types, and at a higher rate than in previous years. Improved information management tools can meet these new challenges and incorporate powerful new data analysis and visualization tools to answer increasingly complex monitoring questions.
4) ***New Measurement Methods and Technology****:* Regional monitoring provides an unparalleled platform for developing and validating new methods and technologies. In a regional program, new technologies can be tested alongside existing methods, quantifying comparability and identifying the advantages/disadvantages of these new measurement tools. Besides efficiently leveraging resources, the regional monitoring platform exposes the prototype methods and technologies to the broad range of natural variability and human impacts for robust validation prior to its widespread

implementation in local programs. Finally, the regional monitoring platform is a perfect vehicle for technology transfer because each agency will be responsible for its deployment. Ultimately, side-by-side testing with existing technology, calibration and validation and technology transfer all lead to confidence in the new technology, enabling more rapid acceptance and transfer to other applications, including applications that are independent of regional monitoring.

5) ***Regional Integration****:* No monitoring program exists in isolation and collaborations between monitoring programs can add to our collective understanding of regional condition and trends. Regional integration consists of linking separate regional and local monitoring programs that generate similar or complimentary data sets, which can enhance regional assessments, thereby expanding the scope and breadth of the monitoring questions that can be answered.

Assessment Frameworks and Synthesis: Once a robust regional dataset is in hand, the next challenge is turning data into information about environmental condition. Managers, many of whom are not scientists, rely on assessment frameworks and tools to simplify the complex environmental data that monitoring programs generate into easy-to-understand assessments of whether a site is in "good" or "bad" condition. A suite of research activities specific to habitats and stressor types are required to develop a robust assessment framework, and many of these activities are documented in other SCCWRP thematic research plans. Regional monitoring is where the assessment frameworks rigorously developed in these SCCWRP research plans are ultimately applied. For new assessment frameworks, regional monitoring programs generate the calibration and validation datasets that span the range of natural variability and human disturbance which are critical for supporting robust framework development. For fully vetted assessment frameworks, regional monitoring regularly applies these frameworks and tools to efficiently reach consensus conclusions about regional environmental condition. In turn, regional monitoring helps identify and facilitate advancement and improvement of frameworks based on real world application. Once vetted in the regional monitoring program, these assessment frameworks often become the primary tools for evaluating conditions in local monitoring programs.

Management response and engagement: The success of any regional monitoring program, especially the multi-agency southern California regional monitoring programs, is dependent on good communication amongst its many participants and with the managers it intends to inform. Thus, it is crucial to develop effective ways to engage a broad range of participants that influence or have decision-making authority across the region. This is more than program governance – it is ensuring that there is a driving force that coordinates the many activities that unify a program, from program kick-off meetings to the leadership of Steering and Technical Committees to facilitating consensus about the messages synthesized in the final report. Successful regional monitoring programs that fully engage with managers will spring-board the next cycle of regional monitoring with new questions that arise from the recommendations from the previous program.

Research Directions

Regional monitoring programs play an essential role in answering big-picture environmental questions being asked by managers and the public, and SCCWRP is committed to seeing these programs continue to flourish. SCCWRP will continue to facilitate research and development initiatives that broaden the reach and utility of these programs. SCCWRP is also committed to long-term implementation, ensuring that these innovative regional monitoring programs are fully responsive to management needs and questions.

Research and Development in Support of Regional Monitoring

Study Design

Accomplishments

The Southern California Bight Regional Monitoring Program, which began as a pilot project in 1994, pioneered the use of a probabilistic study design that nests different habitats (i.e., strata) and produces statistically representative, bias-free assessments of environmental condition across the Bight (Stevens 1997). These nested probabilistic study designs continue to serve as the underlying framework supporting the study design of the Bight Program, SMC stream surveys, and other regional monitoring programs (Lackey and Stein 2014). Building off these successes, SCCWRP has continued to pioneer efforts to improve study design in regional monitoring, focusing on priorities for each regional program. For Bight, SCCWRP determined the best strategy for optimizing assessments in space and time was to have an equal number of new and revisited sites (Bight '18 Sediment Quality Planning Committee 2018). For the SMC stream surveys, SCCWRP has developed a toolkit to provide estimates of the spatial representativeness of bioassessments, allowing for estimates of condition at unsampled locations based on samples collected (Mazor et al. 2020). For our newest regional monitoring programs, advancements in study design have been the major milestones. For example, SCCWRP has developed a standardized monitoring design that will generate comparable assessments of the dozens of stormwater BMPs that are installed each year throughout southern California (Fassman-Beck and Schiff 2022). For the estuary monitoring program, SCCWRP has developed a function-based approach linked to defined wetland features, allowing data to be compared across disparate systems.

Priorities for Ongoing and Future Research

Projects in this area are focused on improving our existing study design practices to better document and communicate the variability in southern California aquatic habitats. Project priorities include:

> ***Optimize study design within a dynamic sampling frame (ongoing)***
> While a nested probabilistic study design is an established and widely used approach for determining sampling locations, dynamic sampling frames continue to present a challenge in some circumstances. This is particularly problematic for

regional stream monitoring in arid environments like southern California, where changes in streamflow between drought years and flood years can alter the sampleable stream network (i.e., study frame) by hundreds of miles. This research optimizes the sample selection approach for dynamic sampling frames such as these.

Use of models to optimize monitoring design for shifting baselines
Changing climate regimes will create multiple stressors on southern California streams and coastal ocean habitats. Higher sea levels, increased temperatures, changing flow patterns, lower dissolved oxygen, and acidification are just some of the noted stressors that create stress on biological communities in ways that are often synergistic with contaminant inputs. Regional monitoring can provide valuable information on these shifting baselines, by recording temporal trends and noting regional hotspots of change. However, to effectively monitor these shifting baselines, we need to know how many sites are needed and where to put them. Recent advancements in modeling can provide a realistic simulation of expected regional variability and predict hotspots of change. Modeling can also predict how climate change will affect future distributions of habitats which can be used in adaptable monitoring designs. This research will use models to determine the sampling frame needed to capture the depth and breadth of variability in climate stressors throughout the region.

Develop better maps and spatial analysis tools with estimates of confidence
Maps are one of the most effective communication products from our regional programs, illustrating, in one image, the spatial variability in contaminant exposure and/or ecosystem response. However, the regional monitoring maps created to date do not interpolate between sites, which leaves managers uncertain about spatial gradients. Development of useful communication tools requires incorporating new spatial analysis tools which would allow for extrapolation across watersheds and coastal ocean habitats. This research will implement new advancements in spatial statistics to generate better maps of regional contaminant exposure and/or response, as well as estimate confidence in those interpolations.

Method Standardization & QA/QC

Accomplishments

To ensure that the dozens of laboratories participating in the Southern California Bight Regional Monitoring Program were able to generate high-quality, comparable results, SCCWRP-facilitated the design of intercalibration exercises in the 1990s. These comparability studies were done for multiple indicators, and the rigor with which they were completed has withstood the test of time (Ranasinghe et al. 2003, Gossett et al. 2003, Greenstein et al. 2008). Since then, method standardization and QA/QC has been the cornerstone of all of SCCWRP-facilitated regional monitoring. Such efforts allow for uniform onboarding of new methods, as was done for the Bight ’18 Ocean Acidification Program, where participating agencies developed and implemented comparable field collection methods for coupling biological and chemical measurements of OA impacts (McLaughlin et al. in prep). SCCWRP also facilitates the state’s largest field intercalibration efforts in stream assessment protocols, held annually and attended

by both participants in the SMC and the state-wide Perennial Streams Assessment (PSA) programs. SCCWRP also hosts the annual algae taxonomist training for data harmonization of algae species data. SCCWRP research in this area not only helps local agencies adopt new methods but also understand how the new methods compare with existing methods, as was done in the Bight '18 Microbiology Program where the new EPA coliphage method was compared with existing enterococci methods (Zimmer-Faust et al. 2022). Furthermore, the methods standardized in our regional program have become the template for how regional data is collected throughout the State. As an example, methods for quantitative assessment of trash in receiving waters were piloted in the Bight/SMC program (Moore et al. 2016, McLaughlin et al. 2022) and these methods have subsequently been included in California's Trash Monitoring Methods and Assessments Playbook (Moore et al. 2020).

Priorities for Ongoing and Future Research

Projects in this area are focused on moving proven technology into the hands of monitoring participants for regional implementation. Such research helps us understand the variability in measurements across agencies and look for avenues to minimize uncertainty. Project priorities include:

Facilitate training and intercalibration with monitoring partners (ongoing)

The creation of comparable datasets through training, intercalibration and auditing is routinely cited by SCCWRP's Commission as one of the most important services the regional monitoring programs provide. The training and QA/QC provided during the regional monitoring programs is often adopted in local monitoring allowing for cross-comparisons between local datasets even outside of the regional programs. This project is focused on continuing this tradition. SCCWRP has identified several possible research areas ripe for this type of technology transfer: 1) adoption of uniform sampling and analysis protocols for ocean acidification and hypoxia biological impacts assessment; 2) lab-based training on cell bioassay methods for rapid assessment of contaminant impacts and site prioritization to facilitate wide-spread adoption; and 3) technology transfer of molecular methods, eDNA/DNA metabarcoding, for use in bioassessment in streams, estuaries, and coastal ocean habitats. Each of these technologies has been piloted in one or more regional monitoring efforts, proven sound, and generated relevant and interpretable data and are therefore ready to be adopted by multiple agencies.

Incorporate digital PCR in beach water quality monitoring

Digital PCR is a refinement of conventional PCR methods, allowing for direct quantification of nucleic acid strands, increasing accuracy and precision of the measurements. Digital PCR has been successfully piloted in the Bight Program as an effective technique to quantify enterococci in beach water quality measurements and has been adopted by San Diego County in their routine beach water quality monitoring. However, it is a relatively new technique and has not been approved in all counties. This research would seek to train all southern California agencies in the use of digital PCR for beach water quality measurements and conduct a regional method comparison study to compare digital PCR results with conventional PCR and culture-based methods. Such

comparisons are needed to allow for regulatory adoption of the protocols. In addition, once a laboratory is trained in the use of digital PCR, the methods can be modified to use any DNA target, providing a wide range of fecal source markers to evaluate water quality and aid in fate and transport studies (e.g., human marker HF183).

Performance assessment for stormwater BMP monitoring
Southern California's stormwater management community is expected to spend billions of dollars on stormwater BMPs in the coming decades to reduce runoff volume and contamination levels to protect the region's streams and coastline. A critical component of SCCWRP's Stormwater BMP Thematic Research Plan (2019) is developing strategies for monitoring BMPs to maximize their short- and long-term performance effectiveness. This research will focus on developing and transferring these new standard methods for assessing BMP performance and determining maintenance needs across the region. Such research would produce uniform and unbiased performance assessments for individual BMP solutions and recommendations for maintenance activities and frequency.

Information Management

Accomplishments

SCCWRP has facilitated the design and creation of database structures and systems that has enabled efficient data management for the many participants of regional monitoring programs (Hale et al. 2003). This data management process encompasses the development of online data submission portals with automated data checkers to ensure a high level of quality of all inputted data which has been applied in SCCWRP-facilitated regional monitoring programs (https://bight.sccwrp.org/; https://smc.sccwrp.org/; https://empa.sccwrp.org). More recently, SCCWRP has begun integrating automated tool calculators into these data portals, allowing for a seamless transition from measured parameters to the types of indices managers care about, such as the SMC stream quality index (SQI) tool and Stream Classification And Priority Explorer (SCAPE) tool, as well as new index calculators for BMP assessments. SCCWRP has also made headway in integrating data portals with internet-connected field devices that have allowed for the input and review of data in real time.

Priorities for Ongoing and Future Research

Information technology is changing fast, and SCCWRP is updating and upgrading information management systems to incorporate new technology to increase data processing and retrieval efficiency and implementing FAIR data principles (Findable, Accessible, Interoperable, and Reusable). Project priorities include:

Harmonize datasets and develop targeted search tools (ongoing)
In the past, SCCWRP has served Bight and SMC stream survey data separately for each program cycle. While trends in these datasets were included in the analysis sections of final reports, any individual seeking to repeat the analysis would have to synthesize the individual datasets on their own, making it more challenging for outside agencies to reuse Bight and SMC data. This project is focused on harmonizing regional datasets into a single data portal. The data portal includes targeted search tools increasing the findability, accessibility, and

reusability of these valuable datasets. In addition, SCCWRP is working to provide translator tools that harmonize these datasets with CEDEN, increasing the interoperability of these data. Such efforts bring regional monitoring datasets in line with FAIR data principles. SCCWRP is also on the leading edge of developing interoperable data frames for new analytes such as ocean acidification biological impacts metrics (e.g., pteropod and crab shell condition), harmful algal blooms (toxins and species), and microplastics.

Develop automated data analysis and verification tools (ongoing)
SCCWRP is continuing to pursue development of information management tools to streamline the process of submission and analysis of regional monitoring data. We have produced field apps for use during the Bight Program and will continue to improve these tools and train participants in their usage. SCCWRP can also streamline data analysis and interpretation tools. Despite the tremendous value of raw data collected by field probes and sensors, the data are not easily utilized in assessments because of the intermittent steps necessary to QA/QC the data and the challenges of reducing the large volumes of data generated. Therefore, SCCWRP is developing automated data analysis tools to qualify the field-collected data and translate the raw data into indices and metrics necessary for assessments. These calculated metrics can then be visualized in key graphics which form the cornerstones of synthesized reports. When successful, these automated calculations of key metrics standardize the practice and help save valuable data analysis time. SCCWRP has already begun developing automated data processing and visualization tools for use in the Bight, SMC stream survey, and SMC BMP monitoring programs and is continuing to develop calculators to be available in data portals (e.g., calculators for SQO scores incorporated into the data portal). This effort can also be expanded to include automated reports and data frames, with standard data visualization products (tables and figures), further streamlining the data analysis and reporting process.

New Measurement Methods and Technology

Accomplishments

Incorporating new measurements methods and technology are what helps keep regional monitoring programs current. New methods and technologies piloted in regional monitoring can make monitoring better, faster, and cheaper. SCCWRP has been on the leading edge of incorporating molecular methods into bioassessment applications. SCCWRP's piloting of qPCR in beach water quality monitoring demonstrated the vast improvement in the speed and accuracy of enterococci assessments using this technology compared to culture-based methods (Haugland et al. 2016). SCCWPR is now extending the reach of targeted, species-specific assays to invasive and endangered species monitoring in streams. Additionally, SCCWRP is leading the effort to incorporate microplastics monitoring into regional assessments, paving the way for this work by conducting laboratory methods standardization and inter-calibration exercises (De Frond et al. 2022) and risk-based management frameworks (Mehinto et al. 2022).

Priorities for Ongoing and Future Research

Regional monitoring programs will continue to serve as important platforms for capturing the breadth and depth of natural variability in habitats, and for cross-training member agencies. Development of new technologies is a fundamental part of most of SCCWRP's research and regional monitoring is where these new technologies are field-tested. The proposed technologies are those SCCWRP has determined hold promise for improved speed, accuracy, and cost. Project priorities include:

Adopting molecular methods in regional monitoring (ongoing)

Environmental DNA (eDNA) and DNA metabarcoding have the potential to revolutionize how we monitor species distributions and targeted taxa in regional monitoring. Development of these tools is incorporated within the SCCWRP Thematic Research Plan for Bioassessment (2021). With continued advancements in DNA barcode and metabarcode sequencing, which identify species by their DNA sequences, taxonomic analysis in aquatic systems can be faster and cheaper than ever before. The State of California's Water Quality Monitoring Council Molecular Methods Workgroup has crafted specific recommendations for incorporating molecular methods into monitoring programs and SCCWRP is well-poised to implement these recommendations in regional monitoring. This research builds on regional monitoring successes in streams and continues to develop molecular tools for estuarine, coastal, and marine systems. This effort includes developing species-specific probes to investigate regional distributions of sensitive indicator taxa as well as rare, endangered, or invasive taxa . Likewise, this effort includes the development of DNA-based approaches for stream algae bioassessment, including the development of novel DNA-based biological indices. Furthermore, SCCWRP is working with partners to further develop molecular approaches to better understanding biological responses to ocean acidification, contaminant exposure, and climate change.

Incorporation of Contaminants of Emerging Concern (CECs) in regional monitoring

The list of chemical contaminants is long and growing, and managers need to know what to prioritize and where. Research for developing the methods and technology to measure these CECs is included in the SCCWRP Thematic Research Plan for Contaminants of Emerging Concern (2022). The regional monitoring programs are where these methods can be applied to gather regional extent and magnitude data. Recently, SCCWRP hosted an expert panel to help determine which targeted chemicals which should be prioritized in regional monitoring. Candidate analytes include polyfluorinated alkyl substances (PFAS), current-use pesticides such as neonicotinoids, tire-wear chemicals, and pharmaceuticals. The panel also recommended the use of untargeted methods, such as cell bioassays, for a more efficient and comprehensive screening of CECs based on their toxicity potential. SCCWRP is well-positioned to incorporate some or all recommendations for priority CECs monitoring in the Bight Program, where sediments are already collected for regional assessments of legacy contaminants. These contaminants can be assessed via targeted analysis or via screening tools such as cell line assays. Regional monitoring programs are easily leveraged to

provide insight into the depth and breadth of variability in concentrations and toxicity potential of priority CECs. For example, fipronil pesticides were included in the Bight '18 program and based on this effort, a key recommendation was to deprioritize them in monitoring because concentrations of fipronils in sediments were generally low in embayments, with the exception of a few local hotspots. In addition, one cell bioassay endpoint was also successfully applied in Bight '18, the aryl hydrocarbon receptor assay, leading to the recommendation to consider these tools for rapid screening of new sites or strata. These efforts can be replicated for newly prioritized CECs and novel cell bioassay endpoints by the Bight Planning Committees.

Investigation of regional extent and magnitude of microplastics

SCCWRP's regional monitoring of trash and marine debris has demonstrated that macroplastic is both pervasive and abundant in southern California watersheds and coastal habitats. However, little is known about the extent and magnitude of microplastics in these environments. SCCWRP is on the leading edge of standardizing laboratory analysis of microplastics and developing risk assessment frameworks for the interpretation of microplastic data (Thematic Research Plan for Contaminants of Emerging Concern 2022), but standardized field collection methods is a critical missing step in inclusion of microplastics assessments into regional monitoring programs. Our regional programs have often served as a test bed for development of field standard methods and can provide that platform for microplastics.

Application of in situ sensors in regional monitoring

Some constituents are highly variable in time and as such, one-time measurements are not adequate to characterize the site exposure. Automated sensors can provide high temporal resolution measurements which can be used to characterize the temporal variability in these constituents and develop more robust assessments (e.g., time-based averages). Sensor technology continues to advance at a rapid pace, increasing in the accuracy and types of parameters which can be measured. Such sensors are being incorporated into assessments of BMP performance, where accurate measurements of influent and effluent flows and volumes are critical to the assessments. In addition, automated sensors are being incorporated into coastal moorings and in streams throughout the region to capture high temporal resolution trends in shifting baselines including temperature, dissolved oxygen, chlorophyll, pH and pCO_2, which are critical to understanding how these variables are changing at timescales at higher resolutions than quarterly water quality measurements.

Regional Integration

Accomplishments

Regional monitoring is large and complex, and the many facets require time to implement. However, between regional monitoring cycles are opportunities to conduct studies and projects that address issues identified by regional monitoring. These spin-off, integrative studies often include more intensive site-specific monitoring, adaptive studies that ask new but related

questions, and causal assessment projects that go beyond the assessment phase to identify specific remediation actions. Sometimes, these integrative studies can consist of linking separate regional monitoring programs which generate different data sets at the similar spatial scales, or these integrative studies can link regional and local monitoring programs which measure the same constituents at different spatial scales. Regardless, these linkages enhance environmental assessments by blending data of different types to enhance the understanding that neither monitoring program could achieve on its own. SCCWRP has been enormously successful in creating partnerships with other local and regional monitoring programs. Five years ago, regional monitoring was limited to two flagship programs: the Bight Program and the SMC stream surveys. Today, SCCWRP has partnered with nearly two dozen other monitoring programs enhancing understanding at the local level and generating super-regional datasets that span the entire U.S. West Coast.

Priorities for Ongoing and Future Research

SCCWRP is committed to forging new relationships and continuing to enhance regional monitoring programs, especially by improving integration with related monitoring programs. SCCWRP is interested in linking management actions back to the findings of condition assessments, data mining to elucidate additional insights, improving the understanding of relationships between condition bioindicators and beneficial-use endpoints and compiling integrated reports on the state of aquatic systems. Project priorities include:

Integration of multiple regional climate-change indicator datasets (ongoing)
Within the State of California and throughout the U.S. West Coast more generally, there are many local and regional monitoring programs which measure similar indicators, but at different spatial scales. Integrating these different datasets can allow for analysis of status and trends at greater spatial or temporal densities than any one program could accomplish alone. Such integration could be particularly effective for climate change indicators; analytes which have high variability in space and time which require large datasets to interpret changes with statistical confidence. SCCWRP is uniquely positioned to do this data integration. SCCWRP has established partnerships with multiple monitoring programs and has the expertise needed for data analysis. By integrating climate trends data, from multiple agencies, global scale changes can be differentiated from Pacific Basin level decadal variations. For this later effort, the timing is right to begin such analysis as local member agency datasets have several decades of dissolved oxygen, temperature and fish and benthic community composition data which can be integrated with multi-decade offshore datasets for a comprehensive, super-regional assessment of climate trends.

Development of Coastal Ocean Report Cards (ongoing)
Managers need consensus on regional condition to be motivated to take decisive action to mitigate impacts. Integrated condition assessments, such as the West Coast Ocean Alliance Report Card and the California Ocean Protection Council report card, seek to combine data from multiple indicators into a comprehensive, synthesized reporting of coastal condition. Such report cards are an important communication tool to drive conversations about mitigation and/or restoration. SCCWRP is uniquely positioned to work with both of these groups to develop

similar indicators and evaluation criteria, providing a unified path forward for the U.S. West Coast and allowing for continued reporting of coastal condition into the future.

Assessment Frameworks for Regional Monitoring

Accomplishments

SCCWRP has been a leader in developing seminal assessment frameworks and tools that have enabled regional monitoring participants to synthesize and interpret huge volumes of data in meaningful ways that resonate with management audiences. SCCWRP co-developed a sediment quality triad scoring tool to quantitatively score sediment condition using a multiple-lines-of-evidence approach (Bay and Weisberg 2012). The sediment quality triad was subsequently adopted by the State Water Board to regulate sediment quality in California embayments (SWRCB 2009). In an effort to expand the environments in which such tools can be used, SCCWRP led the development of a new assessment tool for benthic infauna in lower salinity, estuarine environments: the Multivariate AZTI Marine Biotic Index (M-AMBI) tool, which has been successfully piloted in both the San Francisco Bay (Gillet et al. 2019) and the Bight Program (Gillett et al. 2022) and is used in the national coastal assessment in estuaries across the country (Pelletier et al. 2018). On the freshwater side, SCCWRP co-developed the California Stream Condition Index (CSCI), scoring tool to quantitatively assess the condition of wadeable streams. The CSCI predicts benthic invertebrate community composition and metrics at a site based on natural factors such as gradients in rainfall and temperature, then compares the prediction to what actually exists at that site (Mazor et al. 2016). Rooted in this success, SCCWRP has also developed and implemented the Algal Stream Condition Index (ASCI) a predictive stream algal index with statewide applicability (Theroux et al. 2020). Both the CSCI and ASCI form the technical backbone of a proposed California biological integrity and biostimulatory substances policy intended to govern the health of wadeable streams statewide. SCCWRP has also helped to combine stream assessment tools into a multiple lines of evidence approach (similar to the SQOs) called the Stream Quality Index (Beck et al. 2019) and have developed the science to include causal assessment in stream surveys (Gillett et al. 2019). Regional monitoring data has provided the backbone to develop many of these assessment frameworks and was the proving ground for the final products.

Continuing Efforts

Collection of regional data in support of assessment framework development and validation is a priority for Regional Monitoring. SCCWRP is interested in both expanding the utility of existing assessment tools, creating new assessment tools, or finding ways to combine assessment tools, all in order to provide more robust assessments of environmental condition. Development of assessment tools are integral to several SCCWRP research plans (Bioassessment, Chemistry, Climate Change, Stormwater BMP), and are thus not included in the Regional Monitoring Research Plan. Regional Monitoring is where these assessment frameworks and tools are implemented. Regional Monitoring is the source of data to support of the development or expansion of assessment tools or the validation of these tools in routine monitoring and will continue to do so into the future.

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