SCCWRP's fact sheet series

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Commission Meeting

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Background

- We're producing fact sheets every quarter for you
  - Each fact sheet is about a timely topic of relevance/interest to you
  - They're designed to supplement conversations you're having with your board, staff, partners, etc.

- Last quarter, you approved the first 2 fact sheets in our new series
  - We distributed the fact sheets to you via email
  - They're also posted to our website: **Home > Publications > Fact Sheets**

Rapid beach testing methods

SCCWRP FACT SHEET

Using DNA technology to protect beachgoers from fecal contamination

DNA-based methods provide faster, more insightful information about when it's safe vs. risky to enter the water

For decades, the public health community has tested beach water for fecal contamination using established bacterial culturing methods. But advances in DNA technology are paving the way for faster, more insightful ways to assess water quality and warn beachgoers when it's potentially unsafe to enter. In 2022, San Diego County became the first coastal community in the nation to end reliance on bacterial culturing in favor of a DNA-based method.

Key advantages of DNA technology

The traditional way to test beach water for fecal contamination is via cell culturing, where bacteria cells from a water sample are grown in a laboratory overnight and then analyzed. DNA-based methods, by contrast, focus on analyzing the bacteria cells' DNA.

» **Faster:** Whereas cell culturing typically takes 24-72 hours after beach water samples reach a laboratory, DNA methods can provide same-day results. Speed is of the essence when it comes to protecting the health of beachgoers, especially following unexpected, transient sewage spills. Public health agencies need to close beaches and/or post warning signs as soon as a potential risk to human health has been confirmed – and then reopen beaches and/or rescind advisories as soon as the risk has passed.

» **More insightful:** Cell culturing cannot determine if fecal contamination originated in the gut of a human or another animal, such as a bird or dog. By contrast, DNA methods can make this distinction. These additional insights help the environmental management community prioritize remediating sources that represent the greatest threat to public health. (It is primarily human feces that sickens swimmers and surfers.)

A ddPCR instrument on a laboratory benchtop uses DNA technology to test water for fecal contamination.

DNA methods are ready for prime time

Scientists have spent the past two decades working to adapt and transition DNA technology for routine use in beach water-quality testing across Southern California:

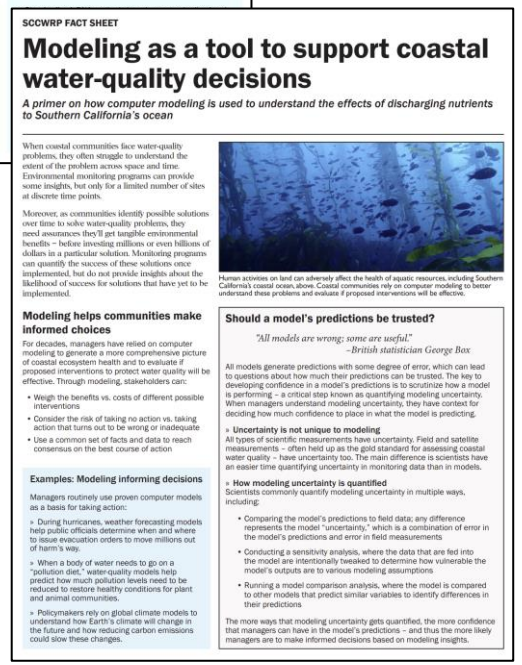
» **Evaluated side by side:** DNA methods have been evaluated side by side with traditional culture methods to show that results are consistently equivalent.

» **Predictive of health risk:** Epidemiology studies have confirmed that DNA methods are more reliable as a predictor of illness risks for beachgoers who enter contaminated water.

DNA methods agree with culturing methods

For DNA methods to be approved as a replacement for culturing methods, the two methods must produce results that lead public health agencies to take consistently similar actions to close beaches and/or post warning signs. Scientists have conducted extensive side-by-side testing of the two types of methods across Southern California. The testing found about 90% agreement in the beach closure and notification decisions that public health agencies make based on the two methods.

When decision-making differs for a beach, scientists have multiple ways to probe why and determine which set of results is the more appropriate predictor of illness risk.



SCCWRP FACT SHEET

Modeling as a tool to support coastal water-quality decisions

A primer on how computer modeling is used to understand the effects of discharging nutrients to Southern California's ocean

When coastal communities face water-quality problems, they often struggle to understand the extent of the problem across space and time. Environmental monitoring programs can provide some insights, but only for a limited number of sites at discrete time points.

Moreover, as communities identify possible solutions over time to solve water-quality problems, they need assurances they'll get tangible environmental benefits – before investing millions or even billions of dollars in a particular solution. Monitoring programs can quantify the success of these solutions once implemented, but do not provide insights about the likelihood of success for solutions that have yet to be implemented.

Human activities on land can adversely affect the health of aquatic resources, including Southern California's coastal ocean, above. Coastal communities rely on computer modeling to better understand these problems and evaluate if proposed interventions will be effective.

Modeling helps communities make informed choices

For decades, managers have relied on computer modeling to generate a more comprehensive picture of coastal ecosystem health and to evaluate if proposed interventions to protect water quality will be effective. Through modeling, stakeholders can:

- Weigh the benefits vs. costs of different possible interventions
- Consider the risk of taking no action vs. taking action that turns out to be wrong or inadequate
- Use a common set of facts and data to reach consensus on the best course of action

Examples: Modeling informing decisions

Managers routinely use proven computer models as a basis for taking action:

» During hurricanes, weather forecasting models help public officials determine when and where to issue evacuation orders to move millions out of harm's way.

» When a body of water needs to go on a "pollution diet," water-quality models help predict how much pollution levels need to be reduced to restore healthy conditions for plant and animal communities.

» Policymakers rely on global climate models to understand how Earth's climate will change in the future and how reducing carbon emissions could slow these changes.

Should a model's predictions be trusted?

"All models are wrong; some are useful."
–British statistician George Box

All models generate predictions with some degree of error, which can lead to questions about how much their predictions can be trusted. The key to developing confidence in a model's predictions is to scrutinize how a model is performing – a critical step known as quantifying modeling uncertainty. When managers understand modeling uncertainty, they have context for deciding how much confidence to place in what the model is predicting.

» **Uncertainty is not unique to modeling**
All types of scientific measurements have uncertainty. Field and satellite measurements – often held up as the gold standard for assessing coastal water quality – have uncertainty too. The main difference is scientists have an easier time quantifying uncertainty in monitoring data than in models.

» **How modeling uncertainty is quantified**
Scientists commonly quantify modeling uncertainty in multiple ways, including:

- Comparing the model's predictions to field data; any difference represents the model "uncertainty," which is a combination of error in the model's predictions and error in field measurements
- Conducting a sensitivity analysis, where the data that are fed into the model are intentionally tweaked to determine how vulnerable the model's outputs are to various modeling assumptions
- Running a model comparison analysis, where the model is compared to other models that predict similar variables to identify differences in their predictions

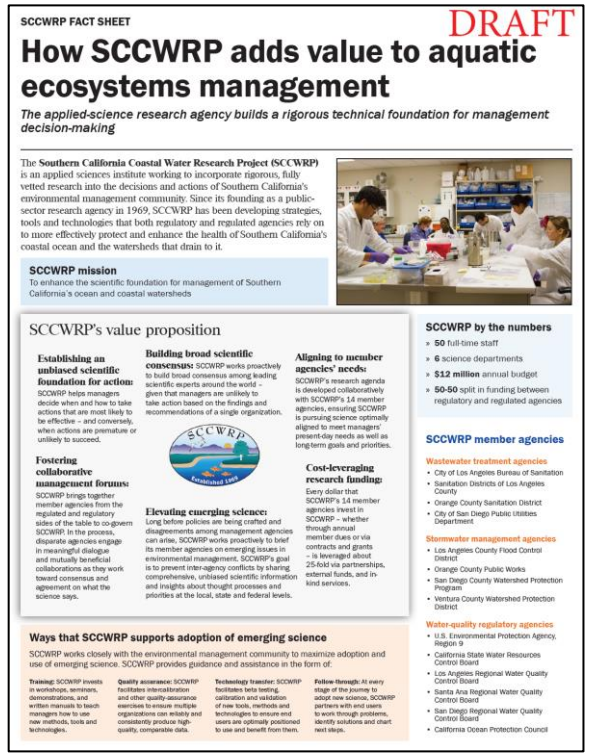
The more ways that modeling uncertainty gets quantified, the more confidence that managers can have in the model's predictions – and thus the more likely managers are to make informed decisions based on modeling insights.

Water-quality modeling

Third fact sheet

- Last quarter, you asked for a fact sheet about SCCWRP's value to managers
  - It's our most succinct effort to date to summarize our value proposition
- CTAG already has reviewed/signed off on this fact sheet
  - We will publish it as soon as you approve it

SCCWRP's management value



SCCWRP FACT SHEET

DRAFT

How SCCWRP adds value to aquatic ecosystems management

The applied-science research agency builds a rigorous technical foundation for management decision-making

The **Southern California Coastal Water Research Project (SCCWRP)** is an applied sciences institute working to incorporate rigorous, fully vetted research into the decisions and actions of Southern California's environmental management community. Since its founding as a public-sector research agency in 1969, SCCWRP has been developing strategies, tools and technologies that both regulatory and regulated agencies rely on to more effectively protect and enhance the health of Southern California's coastal ocean and the watersheds that drain to it.

SCCWRP mission
To enhance the scientific foundation for management of Southern California's ocean and coastal watersheds

SCCWRP's value proposition

Establishing an unbiased scientific foundation for action: SCCWRP helps managers decide when and how to take actions that are most likely to be effective – and conversely, when actions are premature or unlikely to succeed.

Building broad scientific consensus: SCCWRP works proactively to build broad consensus among leading scientific experts around the world – given that managers are unlikely to take action based on the findings and recommendations of a single organization.

Aligning to member agencies' needs: SCCWRP's research agenda is developed collaboratively with SCCWRP's 14 member agencies, ensuring SCCWRP is pursuing science optimally aligned to meet managers' present-day needs as well as long-term goals and priorities.

Fostering collaborative management forums: SCCWRP brings together member agencies from the regulated and regulatory sides of the table to co-govern SCCWRP. In the process, disparate agencies engage in meaningful dialogue and mutually beneficial collaborations as they work toward consensus and agreement on what the science says.

Cost-leveraging research funding: Every dollar that SCCWRP's 14 member agencies invest in SCCWRP – whether through annual member dues or via contracts and grants – is leveraged about 25-fold via partnerships, external funds, and in-kind services.

Elevating emerging science: Long before policies are being crafted and disagreements among management agencies can arise, SCCWRP works proactively to brief its member agencies on emerging issues in environmental management. SCCWRP's goal is to prevent inter-agency conflicts by sharing comprehensive, unbiased scientific information and insights about thought processes and priorities at the local, state and federal levels.

SCCWRP by the numbers
- **50** full-time staff
- **6** science departments
- **$12 million** annual budget
- **50-50** split in funding between regulatory and regulated agencies

SCCWRP member agencies

Wastewater treatment agencies
- City of Los Angeles Bureau of Sanitation
- Sanitation Districts of Los Angeles County
- Orange County Sanitation District
- City of San Diego Public Utilities Department

Stormwater management agencies
- Los Angeles County Flood Control District
- Orange County Public Works
- San Diego County Watershed Protection Program
- Ventura County Watershed Protection District

Water-quality regulatory agencies
- U.S. Environmental Protection Agency, Region 9
- California State Water Resources Control Board
- Los Angeles Regional Water Quality Control Board
- Santa Ana Regional Water Quality Control Board
- San Diego Regional Water Quality Control Board
- California Ocean Protection Council

Ways that SCCWRP supports adoption of emerging science

SCCWRP works closely with the environmental management community to maximize adoption and use of emerging science. SCCWRP provides guidance and assistance in the form of:

Training: SCCWRP invests in workshops, seminars, demonstrations, and written manuals to teach managers how to use new methods, tools and technologies.

Quality assurance: SCCWRP facilitates intercalibration and other quality-assurance exercises to ensure multiple organizations can reliably and consistently produce high-quality, comparable data.

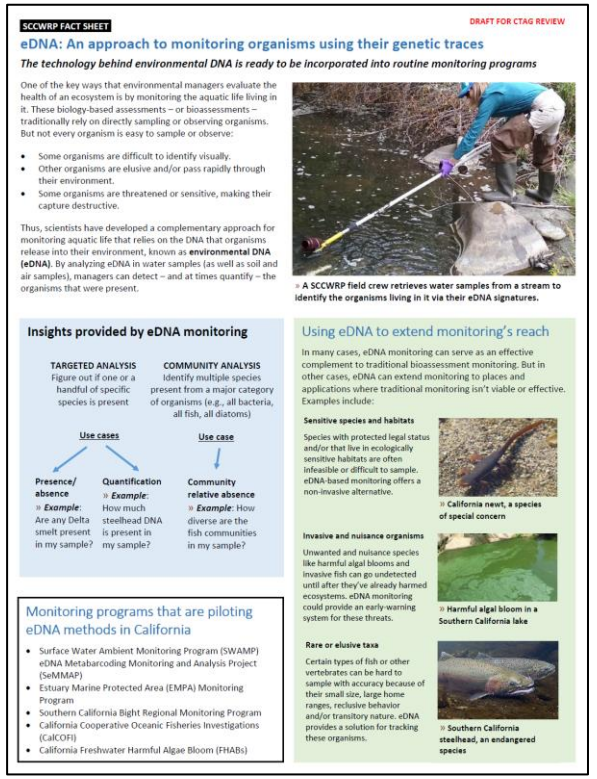
Technology transfer: SCCWRP facilitates beta testing, calibration and validation of new tools, methods and technologies to ensure end users are optimally positioned to use and benefit from them.

Follow-through: At every stage of the journey to adopt new science, SCCWRP partners with end users to work through problems, identify solutions and chart next steps.

Production process

- CTAG is playing a key role in developing every fact sheet
  - Sometimes we're iterating with CTAG over 2-3 quarters
- We've also begun inviting other partners to review a near-final draft
  - The fact sheets are essentially "mini" scientific manuscripts
  - Each fact sheet can help us develop consensus among our scientific partners about how + what we communicate on a topic

eDNA monitoring



SCCWRP FACT SHEET

DRAFT FOR CTAG REVIEW

eDNA: An approach to monitoring organisms using their genetic traces

The technology behind environmental DNA is ready to be incorporated into routine monitoring programs

One of the key ways that environmental managers evaluate the health of an ecosystem is by monitoring the aquatic life living in it. These biology-based assessments – or bioassessments – traditionally rely on directly sampling or observing organisms. But not every organism is easy to sample or observe:

- Some organisms are difficult to identify visually.
- Other organisms are elusive and/or pass rapidly through their environment.
- Some organisms are threatened or sensitive, making their capture destructive.

Thus, scientists have developed a complementary approach for monitoring aquatic life that relies on the DNA that organisms release into their environment, known as **environmental DNA (eDNA)**. By analyzing eDNA in water samples (as well as soil and air samples), managers can detect – and at times quantify – the organisms that were present.

» **A SCCWRP field crew retrieves water samples from a stream to identify the organisms living in it via their eDNA signatures.**

Insights provided by eDNA monitoring

TARGETED ANALYSIS Figure out if one or a handful of specific species is present

COMMUNITY ANALYSIS Identify multiple species present from a major category of organisms (e.g., all bacteria, all fish, all diatoms)

Use cases

Use case

Presence/ absence » ***Example***: Are any Delta smelt present in my sample?

Quantification » ***Example***: How much steelhead DNA is present in my sample?

Community relative absence » ***Example***: How diverse are the fish communities in my sample?

Monitoring programs that are piloting eDNA methods in California

- Surface Water Ambient Monitoring Program (SWAMP) eDNA Metabarcoding Monitoring and Analysis Project (SeMMAP)
- Estuary Marine Protected Area (EMPA) Monitoring Program
- Southern California Bight Regional Monitoring Program
- California Cooperative Oceanic Fisheries Investigations (CalCOFI)
- California Freshwater Harmful Algae Bloom (FHABs)

Using eDNA to extend monitoring's reach

In many cases, eDNA monitoring can serve as an effective complement to traditional bioassessment monitoring. But in other cases, eDNA can extend monitoring to places and applications where traditional monitoring isn't viable or effective. Examples include:

Sensitive species and habitats

Species with protected legal status and/or that live in ecologically sensitive habitats are often infeasible or difficult to sample. eDNA-based monitoring offers a non-invasive alternative.

» **California newt, a species of special concern**

Invasive and nuisance organisms

Unwanted and nuisance species like harmful algal blooms and invasive fish can go undetected until after they've already harmed ecosystems. eDNA monitoring could provide an early-warning system for these threats.

» **Harmful algal bloom in a Southern California lake**

Rare or elusive taxa

Certain types of fish or other vertebrates can be hard to sample with accuracy because of their small size, large home ranges, reclusive behavior and/or transitory nature. eDNA provides a solution for tracking these organisms.

» **Southern California steelhead, an endangered species**

Next steps

- You'll review our eDNA fact sheet next quarter
- We'll begin working on our next fact sheet on HAB toxins
- We want your feedback on how you use these fact sheets
  - We are producing these documents for your benefit