SCCWRP's fact sheet series

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Commission Meeting

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Background

- In June, you asked us to produce fact sheets about timely topics we work on
  - You want to hand them out to your boards, etc.

- We decided to produce one fact sheet per quarter
  - We're ready to publish the first two fact sheets with your approval today

Review process

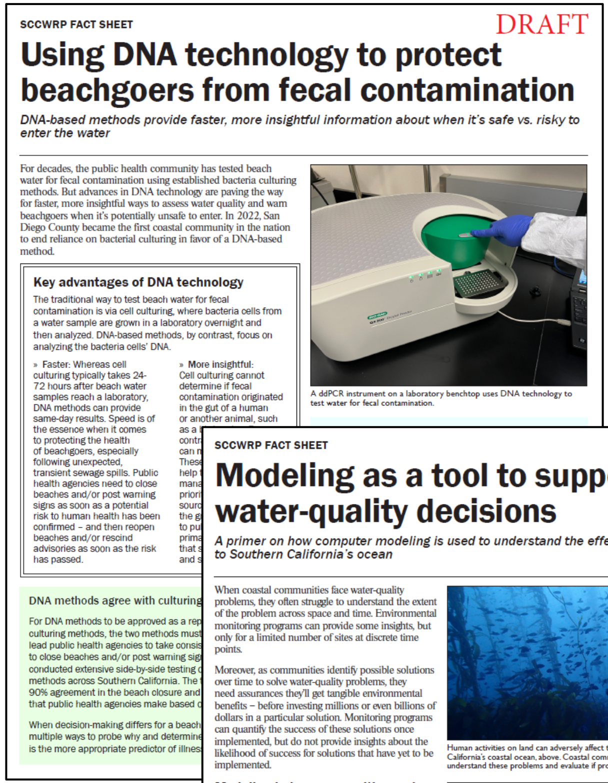
- We’re using a 2-step review process
    1. CTAG reviews the fact sheet – typically 2-3 times
    2. Commission reviews/approves the fact sheet following sign-off from CTAG

- This review process is different than for our other scientific documents
    - You and CTAG don’t approve our other publications
    - But the fact sheets are being produced specifically for you

First 2 fact sheets

- CTAG has signed off on the first two fact sheets
  - Are you ready for us to publish them?
- Our plan is to email the fact sheets to you as PDF files
  - Do you need us to professionally print them as well?

Rapid beach testing methods



SCCWRP FACT SHEET

DRAFT

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 bacteria 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.

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

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.

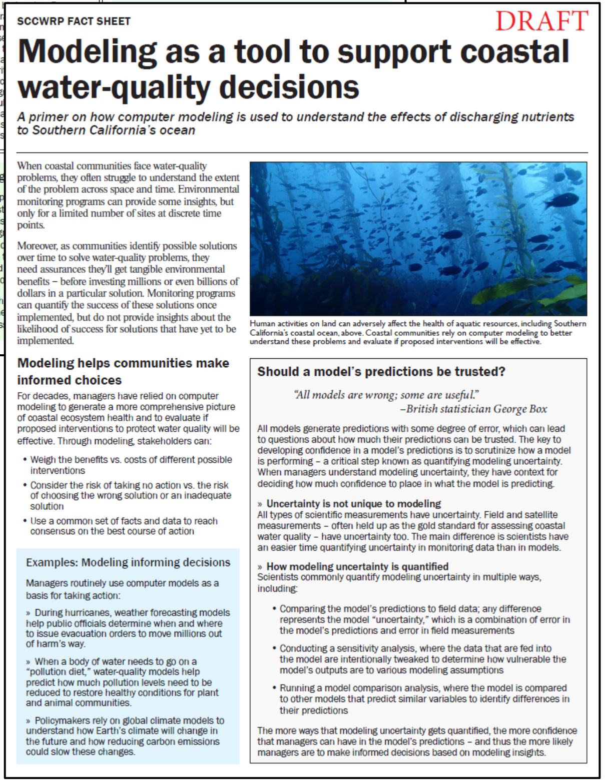
» Faster: Whereas cell culturing typically takes 24-72 hours after beach water samples reach a laboratory, DNA methods can provide same-day results. Speed is of the essence when it comes to protecting the health of beachgoers, especially following unexpected, transient sewage spills. Public health agencies 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 …

DNA methods agree with culturing

For DNA methods to be approved as a rep… culturing methods, the two methods must… lead public health agencies to take consis… to close beaches and/or post warning sig… conducted extensive side-by-side testing… methods across Southern California. The… 90% agreement in the beach closure and… that public health agencies make based…

When decision-making differs for a beach… multiple ways to probe why and determine… is the more appropriate predictor of illnes…



SCCWRP FACT SHEET

DRAFT

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. the risk of choosing the wrong solution or an inadequate solution
- Use a common set of facts and data to reach consensus on the best course of action

Examples: Modeling informing decisions

Managers routinely use 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

- The third fact sheet will be on eDNA
  - eDNA is at an inflection point – it's ready to be transitioned to management
  - This fact sheet will summarize the state of management adoption
- CTAG reviewed the first draft in February
  - We got valuable feedback/comments
  - We're making revisions and will send the fact sheet back to CTAG

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

June 2023

One of the key ways that environmental managers evaluate the health of an aquatic ecosystem is by monitoring the aquatic life living in it. These biology-based assessments – or bioassessment – are traditionally reliant on directly sampling or observing organisms.

But a newer approach known as environmental DNA (eDNA) monitoring focuses on tracking organisms by the DNA that they shed into their environment. By collecting a water, soil or air sample and then analyzing the DNA it contains, managers can detect – and at times quantify – the organisms that have passed through.

» **eDNA can be collected from both marine and freshwater environments via a range of sampling techniques.**

eDNA technology is at an inflection point

The science behind eDNA monitoring has evolved rapidly in recent years. During a national scientific workshop hosted by SCCWRP in 2022, leading experts agreed that eDNA technology has reached a point where it's ready to be incorporated into routine environmental management programs. The scientific community has committed to helping end-user managers rapidly adopt eDNA technology, even as research is ongoing to further extend the utility of eDNA methods.

Advantages of eDNA monitoring

eDNA-based monitoring can serve as a cost-effective complement and/or alternative to traditional bioassessment monitoring in both aquatic and terrestrial environments. Advantages include:

	Traditional bioassessment	eDNA-based bioassessment
Speed	Laborious, manual identification of organisms by a trained taxonomist; results often delayed by weeks or months	Automated identification of organisms using DNA-based laboratory technologies; results typically available within days
Cost	High per-sample costs due to need for a trained taxonomist	Small fraction of the cost due to rapid, large-batch processing methods and automated analysis
Sensitivity	Approach limited to the types of organisms – and organism features – that can be manually observed	Can differentiate among closely related species and species lacking clear distinguishing features; can detect organisms that pass fleetingly through their environment
Sampling footprint	Invasive approach that often requires collecting organisms for analysis in a laboratory	Minimally invasive; no direct sampling of target organisms

Next steps

- You will (likely) be reviewing the eDNA fact sheet next quarter

- We will be monitoring how you use these fact sheets
  - You asked for them – we want to know how you use them