# SCCWRP's new fact sheet series

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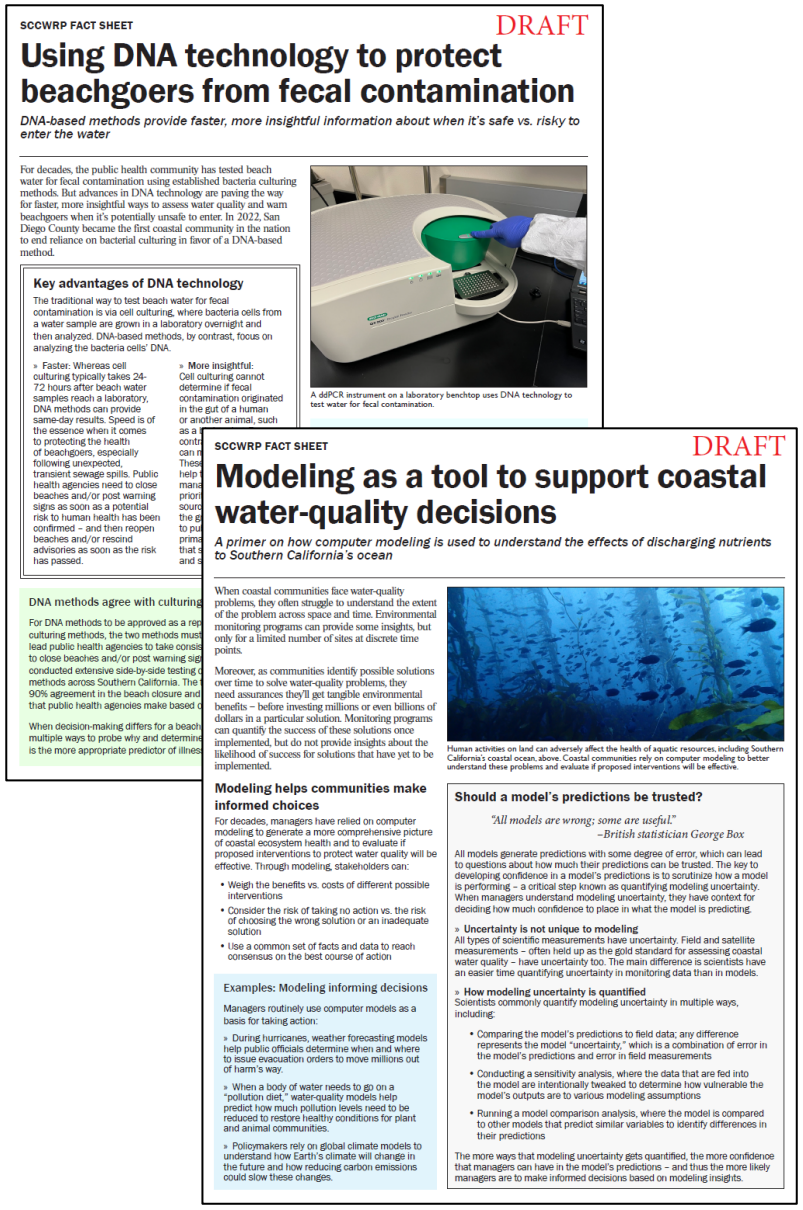
SCCWRP Commission Meeting

December 2, 2022

# Background

- You asked us to produce fact sheets about timely topics we're working on
  - The target audience is your board members
  - Information is presented from a manager's perspective, not a scientist's
- We've developed our first two fact sheets
  - You reviewed a draft of the beach testing fact sheet last quarter



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.

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**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.

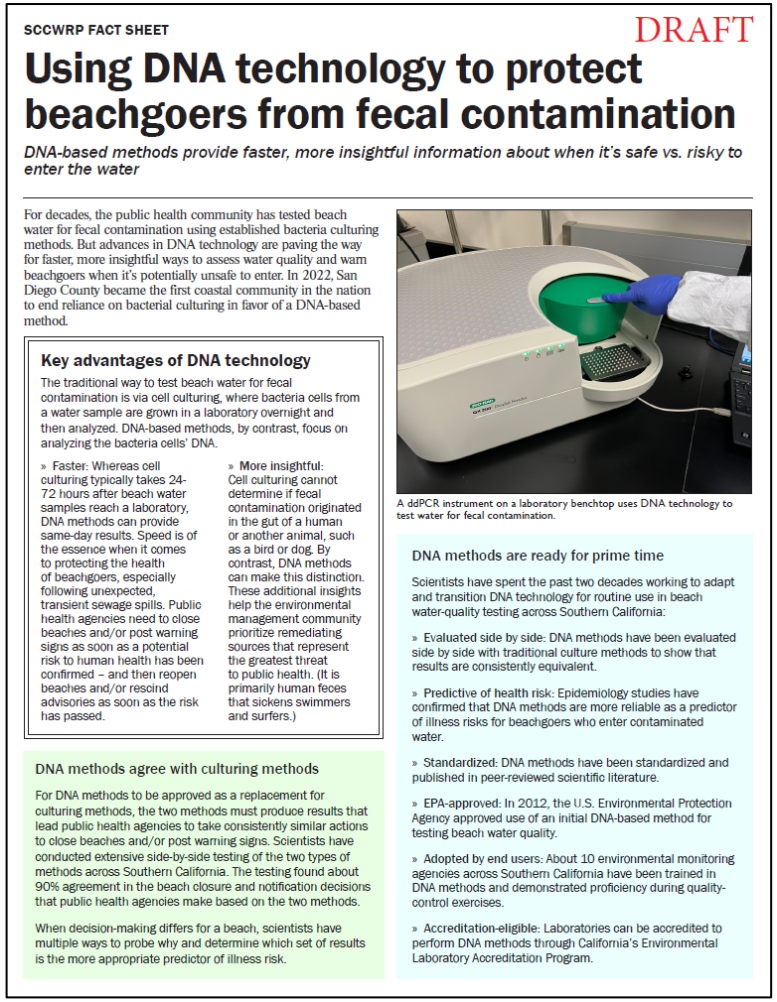
# Review process

- Commission review of these fact sheets is important
  - You're planning to personally distribute these fact sheets
  - You already helped us improve the first one

- We'll publish each fact sheet after both you + CTAG sign off
  - CTAG also has been providing valuable feedback

# First fact sheet

- Topic: “Using DNA technology to protect beachgoers from fecal contamination”
  - CTAG has reviewed it twice + approved it
- Key questions for you
  - Did we address your comments from September?
  - Is it ready to be published?



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## Using DNA technology to protect beachgoers from fecal contamination

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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.

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### 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.)

### 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.

### 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.

» **Standardized:** DNA methods have been standardized and published in peer-reviewed scientific literature.

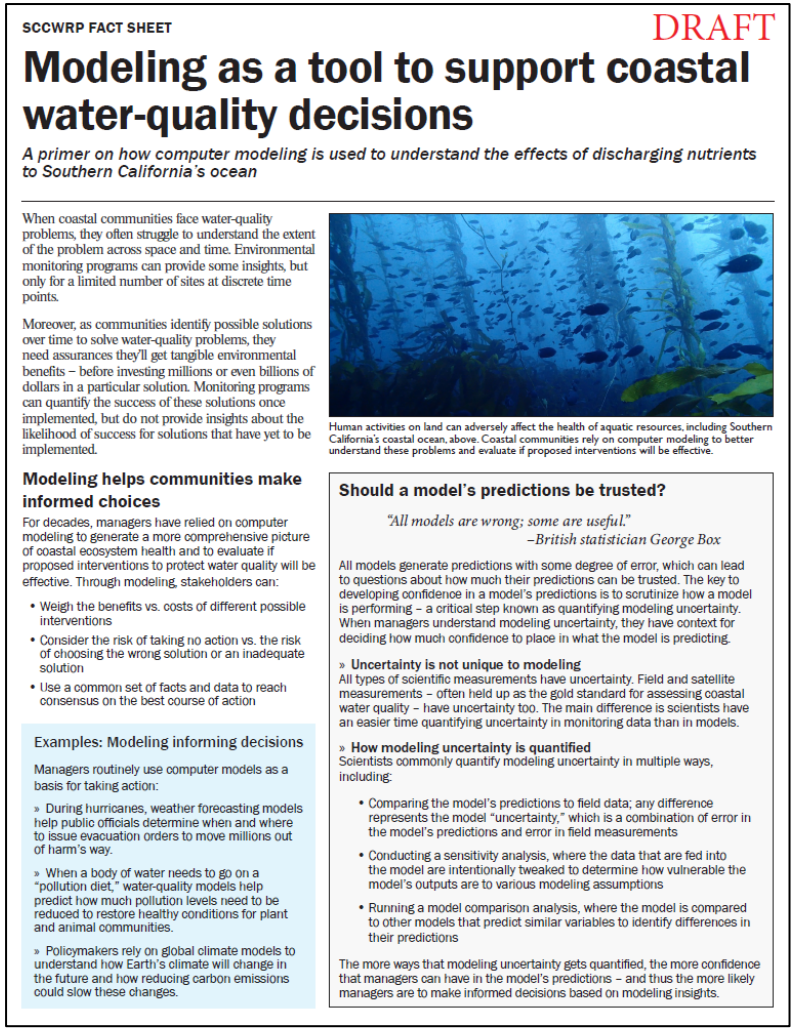
» **EPA-approved:** In 2012, the U.S. Environmental Protection Agency approved use of an initial DNA-based method for testing beach water quality.

» **Adopted by end users:** About 10 environmental monitoring agencies across Southern California have been trained in DNA methods and demonstrated proficiency during quality-control exercises.

» **Accreditation-eligible:** Laboratories can be accredited to perform DNA methods through California's Environmental Laboratory Accreditation Program.

# Second fact sheet

- Topic: “Modeling as a tool to support coastal water-quality decisions”
  - CTAG is still completing a final review of this fact sheet
- Key questions for you
  - Does the messaging resonate?
  - Does it improve awareness + understanding of our modeling work?
  - When will you be ready to publish it?



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# Third fact sheet

- You will review the next fact sheet for your March meeting
  - We'll decide the topic once your next Commission agenda comes into focus