SWAMP Newsletter
Sound science for informed water quality management

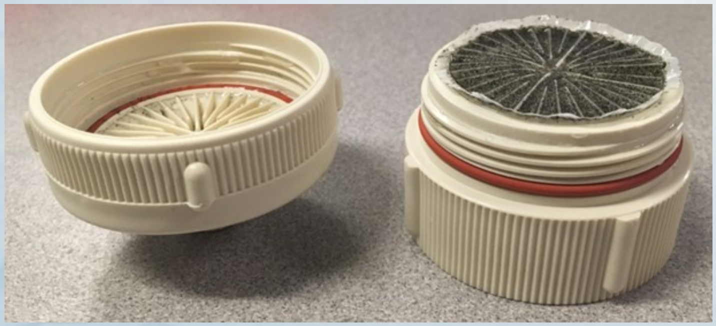
Summer 2016 | Issue 3

Development of Molecular Methods to Identify Stream Algae

by Susanna Theroux, Southern California Coastal Water Research Project (susannat@sccwrp.org)

Surveys of algae and benthic macroinvertebrates (BMI; e.g., insect larvae, snails) are the cornerstones of biological assessments of man-induced impacts on aquatic ecosystems. The California Stream Condition Index (CSCI) relies on BMI community composition to diagnose stream health (Mazor et al., 2016) and has been successfully deployed in bioassessment campaigns throughout the state. Algal communities, which include diatoms, cyanobacteria, and soft-bodied algae, have fast growth rates and quick generation times that allow them to respond rapidly to nutrient and other geochemical stressors and therefore to serve as a valuable complement to BMI bioassessment. The future utility of the algae-based Southern California Index of Biotic Integrity (IBI) (Fetscher et al., 2014) and the forthcoming statewide algal index depends on the ability to generate reliable algal community data. Unfortunately, identifying algae to the species level based on what they look like under the microscope – morphology-based taxonomy – is time consuming, and there is a limited number of available labs that do this work. So algal bioassessment faces prolonged waiting periods for results that prevent a rapid response to changing stream conditions.

To streamline the algal bioassessment process, the Southern California Coastal Water Research Project (SCCWRP) and its SWAMP partners are developing a DNA-barcoding approach. Traditional algal taxonomic analyses rely on species morphology and often on live (i.e., actively-reproducing) specimens to identify species. In contrast, a DNA barcoding approach would eliminate the need for a live sample, allowing longer sample holding times to better accommodate lengthy field excursions. Additionally, with the rapid evolution of DNA sequencing technologies and the increasing availability of sequencing facilities, the cost of DNA barcoding is decreasing rapidly. Data can be generated within days to weeks, as opposed to waiting six months or more to obtain traditional morphology results. DNA barcoding also has the potential to more easily identify elusive algal species that were missed using traditional methods, further improving our understanding of California algae and their relationship to human stressors in the environment.



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Before integrating DNA barcoding into algal bioassessments, three key questions must be addressed:

1. How similar are algal community data derived from DNA- and morphology-based methods?

2. Are all California algae species represented in existing DNA sequence libraries?

3. How well do the California algal stream health indices perform with algal DNA barcode data?

To answer these questions, SCCWRP has initiated a series of pilot projects to collect algal DNA samples throughout the state. The goal of sampling across a wide geographic range is to assess the performance of DNA barcoding and algal stream health indices in a variety of geochemical, physical, and hydrological settings. The DNA sampling approach has already been integrated into existing field protocols, enabling project participants to collect algal biofilm samples efficiently alongside traditional morphology samples.

DNA samples will be collected at 2016 SWAMP sampling locations that are part of the Reference Condition Management Program (RCMP), the Perennial Stream Assessment (PSA), the Southern California Stormwater Monitoring Coalition (SMC), as well as the Bay Area Regional Monitoring Coalition (RMC). Watershed pilot studies are being conducted to complement the pilot DNA barcoding in both statewide and regional ambient assessments. One such study is being conducted in the Santa Margarita River, a watershed in San Diego and Riverside counties that is impacted by nutrient loading and is being used as a test bed for alternative approaches to establishing nutrient water quality goals. By sampling at multiple times throughout the year, the Santa Margarita algal DNA barcoding samples will provide detailed community data throughout an algal boom-and-bust seasonal cycle, informing aspects of nutrient management over time.

These efforts will ultimately pave the way for DNA-based approaches to be incorporated into routine bioassessments, ensuring the future feasibility, affordability, and utility of algal biomonitoring.

References:

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