SWAMP
Surface Water Ambient Monitoring Program

Management Memo | Value

VALUE OF SWAMP's STATEWIDE MONITORING PROGRAMS

OBJECTIVE

The objective of this memo is to introduce managers to the underpinnings of probabilistic study design and its value to water quality management in California.

Perennial Streams Assessment: California's Probability-based Sampling Design

One of the key features of probability-based surveys such as the Surface Water Ambient Monitoring Program's (SWAMP) Perennial Streams Assessment (PSA) is their lack of bias in the selection of sample sites. In the case of the PSA, each sampling location represents a known fraction of California's stream network. This allows the State to produce statistically sound and cost-effective estimates of the condition of California's perennial stream network.

There is a long-tradition in environmental monitoring to use sampling designs based on directed or targeted site-selection. Targeted designs are well-suited for documenting condition or trends at a specific location and are commonly used in compliance monitoring. Water Board staff have used this approach to allocate limited monitoring resources toward areas of known or suspected impairment. This tendency to monitor problem areas is extremely useful for identifying candidates for Water Board action.

However, targeted data often are not representative of the overall condition of a resource. Comparisons of results from targeted and probability-based stream surveys indicate that targeted monitoring tends to be strongly biased toward assessing impaired areas (Stein and Bernstein 2007, Rehn and Ode 2009, Figure 1).

CALIFORNIA NPS PROGRAM

CALIFORNIA Water Boards

October 2011

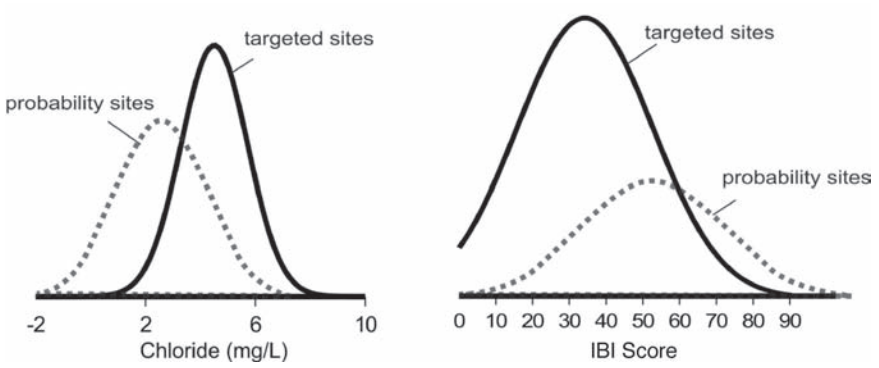

Figure 1. Comparison of distributions of chloride concentrations (values in natural log) and biological condition scores (Southern California IBI) from probability sites and targeted sites in southern coastal California, redrawn from Rehn and Ode 2009.

Probability surveys like the PSA are not designed to supplant targeted monitoring designs but to provide context for their interpretation. For example, the San Gabriel River Watershed monitoring program combines probability and targeted designs to provide managers with information on the condition of the entire watershed and to put local NPDES monitoring results into a watershed perspective. At the statewide level, resource managers can use information from the PSA to identify significant patterns and prioritize restoration and protection efforts. At the local level, PSA summaries allow managers to compare site monitoring data to normal ranges for a region of interest.

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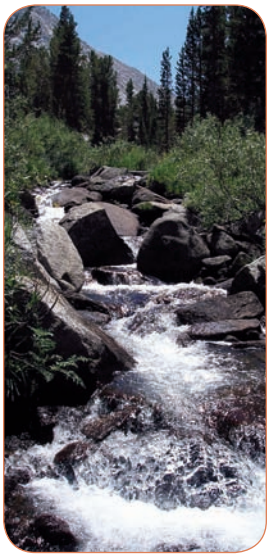
Probability surveys give monitoring programs much more than just objective overall condition assessments (e.g., the condition of California streams). The statistical nature of the data allows us to infer the overall distribution (as in Figure 1 and 2) of a wide range of potential stressor variables, including both local data (e.g., site chemistry, physical habitat, riparian condition) and GIS-based watershed data (e.g., land use, proximity to mines, road density, hydro-modification). Probability surveys also enables us to determine the relative risk of these stressors to aquatic life uses. (See PSA Memo - Biology based Stressor Thresholds).



Accurate information about the distribution of stressors and their impact on aquatic life is essential because it provides a framework for prioritizing resources directed to monitoring, protection, and restoration. Examples of these products are included in the Ecological Condition Assessments of California's Perennial Wadeable Streams: Highlights from the Surface Water Ambient Monitoring Program's Perennial Streams Assessment (PSA) (2000-2007) (Ode et al. 2011). In addition, SWAMP will use PSA results to produce distribution data for a wide variety environmental factors in 2011.

Together, the statewide PSA probability survey and the Reference Condition Management Program (RCMP) provide a framework for evaluating the effects of site-specific projects against benchmark conditions at healthy reference sites, within the context of regional or statewide conditions.

SWAMP's Reference Condition Management Program (RCMP)

Equally important to the concept of the overall distribution is the concept of the reference distribution, which is comprised of sites with low levels of anthropogenic disturbance. Reference distributions are powerful tools for defining the desired condition for a wide range of monitoring subjects, from biology to pollutants. They are essential for establishing objective standards for biology, but could also play a key role in setting standards for pollutants and other stressors. SWAMP has developed a formal strategy for creating and maintaining a pool of reference streams called the Reference Condition Management Program (RCMP) (Ode and Schiff, 2009). SWAMP has been implementing this strategy since 2007 and has identified several hundred reference sites throughout the State. With data from the RCMP it will be possible to compare statewide and regional distributions of stressors and biological condition to those at reference sites (Figure 2).

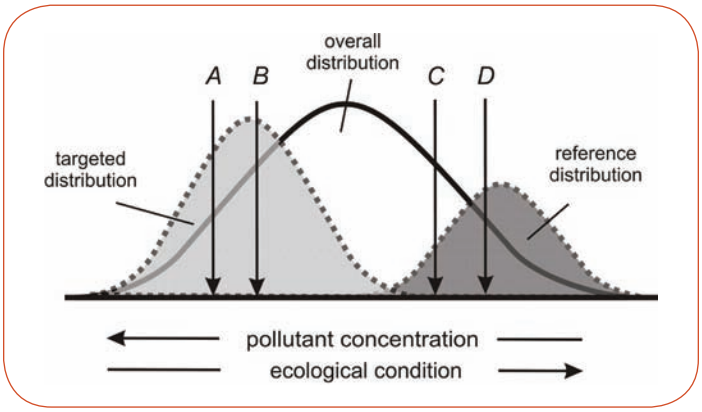


Figure 2. Theoretical distributions of pollutant concentrations and biological condition scores derived from PSA probability surveys (overall distribution), reference site surveys (reference distribution), and the monitoring of targeted sites (typical monitoring distribution).

Measuring and documenting the success of Water Board actions can be a significant challenge. Together, the statewide PSA probability survey and the Reference Condition Management Program provide a framework for evaluating the effects of site-specific projects within the context of statewide or regional conditions. This gives programs the ability to distinguish between relatively small differences in pollutant concentration and environmental condition before and after projects (Figure 2: A-B or C-D), and regionally significant changes (A-C or A-D). In this example, improvement from A to B may be important but fall short of the overall goal as defined by the reference condition. Improvement from C to D may be important, but resources may be better directed to moving pollutant concentrations and biological condition from B to C.

Recommendations for Management

- **The information generated through statewide probability-based surveys should be used as a foundation for prioritizing monitoring, remediation, and protection efforts.** Probability-based surveys are necessary for unbiased assessments of the overall condition of the State's waters.

- **Results from probability-based surveys can and should be used for quantitative interpretation of regional narrative objectives for a variety of potential stressors (e.g., nutrients, fine sediment, water chemistry, etc.).**
- **The assessment tools developed by the SWAMP Bioassessment Program should be used to measure the performance and success of restoration and protection programs implemented by the Water Boards, Department of Fish and Game, and others.**
- **Products and perspective from SWAMP's PSA and RCMP programs should be incorporated into many Water Board and partner agency programs.** Programs already implementing bioassessment tools include: Storm Water (e.g., construction general permit), TMDL, and NPDES permitting. Other Water Board programs which would find value and benefit from the application of SWAMP's bioassessment tools include: Non-Point Source, Water Quality Certification and Wetlands Program, Irrigated Lands Regulatory Program, and many localized Regional Board programs.

Results from probability-based surveys can and should be used for quantitative interpretation of regional narrative objectives for a variety of potential stressors .

Resources

Ode, P.R., T.M. Kincaid, T. Fleming and A.C. Rehn. 2011. ***Ecological Condition Assessments of California's Perennial Wadeable Streams:*** *Highlights from the Surface Water Ambient Monitoring Program's Perennial Streams Assessment (PSA) (2000-2007).*

Rehn, A.C. and P.R. Ode. 2009. Integrating probability and targeted survey designs in regional stream condition assessments: examples from southern coastal California. Report to NPS Program.

Stein, E. and B. Bernstein. 2008. Integrating probabilistic and targeted compliance monitoring for comprehensive watershed assessment. Environmental Monitoring and Assessment 144:117-129.

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