The Importance of Switching to Probability Surveys for Aquatic Monitoring Programs

The States and Tribes are required by the Clean Water Act (CWA) to periodically report on the condition of *all* their waters. The States and Tribes typically monitor at targeted sites and can make scientifically-defensible statements about the condition of their waters only at these sites. Typically, this covers only a small percentage of the total waters. There are currently only two approaches that will provide coverage of *all* waters of a State or Tribe: a census of all waters or a probability survey can be used (as laid out in the OW CALM Guidance). In the census approach every single waterbody or stream segment within a state or tribal nation has to be visited and the condition measured. Probability surveys use a statistical approach (similar to opinion polls) to provide a cost-effective, scientifically-defensible alternative to periodically determine the condition of *all* waters of a State or Tribe.

Probability survey designs provide a scientifically rigorous way to sample a subset of all waters and then provide an estimate of the quality of all waters along with a statement about the uncertainty surrounding that estimate. In a probability survey, a subset of waters is randomly selected (this ensures the "representativeness" or unbiased nature of the samples). The efficiency of a probability survey can be further increased (but still maintain its unbiased nature) by ensuring the sample is spatially distributed and that important sub-classes of streams, lakes, or coastal waters are included. For example, to determine the condition of lakes in the Northeastern U.S. with respect to phosphorus levels that may cause algal blooms, NE States selectively sampled 4219 lakes (out of approximately 11,076) and their findings could not be applied to the remaining lakes that were not sampled. Using a probability survey, only 344 lakes had to be sampled to make an estimate of the condition of *all* 11,076 lakes, and provide the statistical uncertainty for the estimate. By the States' admission, their estimates were biased toward problem lakes, applied only to the lakes reported, and were not directly comparable from state-to-state. The probability survey estimates were objective, representative, accurate, and cost-effective (only 8% as many lakes needed to be sampled). Another example of the utility of the probability surveys is Alabama's use for determining the condition of their estuaries. By switching to a probability design, Alabama was able to estimate the condition of *all* their estuarine waters with known confidence (which they were unable to do before) and at a cost savings of approximately 33% (some of which they then used for additional monitoring of problem areas).

Newer probability survey designs, developed specifically for aquatic resources, can be 30-50% more efficient than even the probability survey designs from ten years ago, and can give States and Tribes enormous flexibility when developing their monitoring program to include not only condition, but ways to deal with non-point source criteria development and the listing of impaired waters for TMDL development. Additionally, if States and Tribes use probability survey designs, comparable indicators and methods, then state data can be aggregated to provide a national picture of the condition of

aquatic ecosystems. If the practice is continued through time then the changes and trends in aquatic ecosystem conditions can be determined. These results will significantly improve the quality of performance-based reporting to Congress, and will better inform EPA national and regional decisions on priority issues and areas. States and tribal nations that do not conduct probability surveys or census all their waters can not provide scientifically-defensible information for *all* waters as required by the CWA. By adopting probability survey designs, they not only will be able to provide that information but also will be able to do so without the cost of a census of all waters.

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