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Research Questions to Identify Ecological Indicators Most Useful for Linking Ecosystems and Human Well-Being

Paul Ringold, Jim Boyd, Alan Krupnick, Matt Weber, Kim Hall, Michael Papenfus, Mary Barber, Robert J. Johnston

The identification of ecological indicators effectively connecting ecosystems to social science interpretation would facilitate analyses important to public deliberation. However, guidelines for developing meeting this need are not well developed. In the past few years, economists have identified principles that serve as a useful guide to identifying ecological indicators that most effectively link ecosystems to human well-being and social analysis. These principles are grounded in the idea that the direct and indirect effect of ecosystems on humans may be characterized using production function theory. The resulting indicators are termed linking indicators or indicators of final ecosystem goods and services (FEGS). The term "linking indicators" reflects the idea that these indicators provide the most immediate link between natural and social systems. The term "FEGS," in contrast, clarifies that these indicators quantify the last steps in ecological "production" before an ecological system affects humans. We have explored these concepts in evaluations of indicators for regional aquatic monitoring and in case studies of benefits analyses. Through this process we have identified provisional indicators. We also suggest research questions. Addressing these questions will help inform indicator development and data collection efforts necessary to link ecosystems to human well-being and social analysis. .

The key questions that we have identified are:

- 1. What are the performance metrics for distinguishing between linking indicators that "work"?
- 2. Do linking indicators more proximate to individual experience perform better than those more distal?
- 3. Are preferences similar enough across beneficiaries that no special targeting of linking indicators for specific groups is necessary?
- 4. For any specific linking indicator, do more aggregate descriptions (e.g., fish) perform better than less aggregate descriptions (e.g., trout)?
- 5. Do indicators that aggregate over multiple categories (*out of category* indicators, e.g. a fishing quality index) perform better than indicators that focus on specific ecological elements (e.g. fish and site appeal)?
- 6. What are the temporal and spatial dimensions of specific ecosystem-beneficiary pairings that matter to people?
- 7. Does the existence value context present any specific complications in indicator design relative to the use context?

We will develop ecological illustrations of some of these questions and suggest that although these are mainly social science questions that they can only effectively be pursued by teams of natural and social scientists.