Bibliography of Indicator Reports

1. Andreasen, James K., Robert V. O'Neill, Reed Noss and Nicholas C. Slosser. 2001. Considerations for the development of a terrestrial index of ecological integrity. Ecological Indicators, 1(1): 21-35.
   Abstract: Ecological systems are composed of complex biological and physical components that are difficult to understand and to measure. However, effective management actions and policy decisions require information on the status, condition, and trends of ecosystems. Multiple levels of information are needed to make effective decisions and the ideal indicators for measuring integrate concerns from aquatic and terrestrial ecology, and that it be flexible and measurable.

   The objective ecosystem integrity will incorporate information from multiple dimensions of the ecosystem. A terrestrial index of ecological integrity would be a useful tool for ecosystem managers and decision makers. The ideal requirements of the terrestrial index of ecosystem integrity (TIEI) are that it be comprehensive and multi-scale, grounded in natural history, relevant and helpful, able to of this research is to investigate if an index, or indices, could be developed that would summarize the condition of ecosystems so that changes can be tracked over time and this information utilized as a tool to support environmental decision making.

2. Battelle. 2003. Usefulness of National Estuarine Program (NEP) Data as National Environmental Indicators. Draft Report Submitted to Oceans and Coastal Protection Division, USEPA.

3. Caughlan, Lynne and Karen L. Oakley. 2001. Cost considerations for long-term ecological monitoring. Ecological Indicators, 1:123-134.
   Abstract: For an ecological monitoring program to be successful over the long-term, the perceived benefits of the information must justify the cost. Financial limitations will always restrict the scope of the monitoring program; hence the program's focus must be carefully prioritized. Clearly identifying the costs and benefits of a program will assist in the prioritizing process, but this is easier said than done. Frequently the true costs of monitoring are not recognized and are, therefore, underestimated. Benefits are rarely evaluated, because they are difficult to quantify. The intent of this review is to assist the designers and managers of long-term ecological monitoring programs by providing a general framework for building and operating a cost-effective program. Previous considerations of monitoring costs have focused on sampling design optimization. We present cost considerations of monitoring in a broader context. We explore monitoring costs, including both budgetary costs what dollars are spent on, and economic costs, which include opportunity costs. Often, the largest portion of a monitoring program budget is spent on data collection, and other, critical aspects of the program, such as scientific oversight, training, data management, quality assurance, and reporting, are neglected. Recognizing and budgeting for all program costs is therefore a key factor in a program's longevity. The close relationship between statistical issues and cost is discussed, highlighting the importance of sampling design, replication and power, and comparing the costs of alternative designs through pilot studies and simulation modelling. A monitoring program development process that includes explicit checkpoints for considering costs is presented. The first checkpoint occurs during the setting of objectives and during sampling design optimization. The last checkpoint occurs once the basic shape of the program is known, and the costs and benefits, or alternatively, the cost-

effectiveness, of each program element can be evaluated. Moving into the implementation phase without careful evaluation of costs and benefits is risky because if costs are later found to exceed benefits, the program will fail. The costs of development, which can be quite high, will have largely wasted. Realistic expectations of costs and benefits will help ensure that monitoring programs survive the early, turbulent stages of development and the challenges posed by fluctuating budgets during implementation.

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5. Dale, Virginia H. and Suzanne C. Beyeler. 2001. Challenges in the development and use of ecological indicators. Ecological Indicators, 1(1): 3-10.
Abstract: Ecological indicators can be used to assess the condition of the environment, to provide an early warning signal of changes in the environment, or to diagnose the cause of an environmental problem. Ideally the suite of indicators should represent key information about structure, function, and composition of the ecological system. Three concerns hamper the use of ecological indicators as a resource management tool. (1) Monitoring programs often depend on a small number of indicators and fail to consider the full complexity of the ecological system. (2) Choice of ecological indicators is confounded in management programs that have vague long-term goals and objectives. (3) Management and monitoring programs often lack scientific rigor because of their failure to use a defined protocol for identifying ecological indicators. Thus, ecological indicators need to capture the complexities of the ecosystem yet remain simple enough to be easily and routinely monitored. Ecological indicators should meet the following criteria: be easily measured, be sensitive to stresses on the system, respond to stress in a predictable manner, be anticipatory, predict changes that can be averted by management actions, be integrative, have a known response to disturbances, anthropogenic stresses, and changes over time, and have low variability in response. The challenge is to derive a manageable set of indicators that together meet these criteria.

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8. EPA. 2001. National Coastal Condition Report. EPA Report No. EPA-620/R-01/005. Available at: http://www.epa.gov/owow/oceans/nccr/downloads.html.

9. EPA. 2000. Evaluation Guidelines for Ecological Indicators. EMAP Environmental Monitoring and Assessment Program. Edited by L.E. Jackson, J.C. Kurtz, and W. S. Fisher. EPA/620/R-99/005.

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18. International Symposium in Paris, France. Quantitative Ecosystem Indicators for Fisheries Management. March 31-April 3, 2004. See the following website: http://www.ecosystemindicators.org

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20. Kurtz, Janis C., Laura E. Jackson and William S. Fisher. 2001. Strategies for evaluating indicators based on guidelines from the Environmental Protection Agency's Office of Research and Development. Ecological Indicators, 1(1): 49-60.
Abstract: The Environmental Protection Agency's Office of Research and Development (ORD) has prepared technical guidelines to evaluate the suitability of ecological indicators for monitoring programs. The guidelines were adopted by ORD to provide a consistent framework for indicator review, comparison and selection, and to provide direction for research on indicator development. The guidelines were organized within four evaluation phases: (1) conceptual relevance; (2) feasibility of implementation; (3) response variability; (4) interpretation and utility. Three example indicators were analyzed to illustrate the use of the guidelines in an evaluation. The examples included a direct chemical measurement (dissolved oxygen concentration), an estuarine benthic community index, and a stream fish community index of biotic integrity. Comparison of the three examples revealed differences in approach, style and types of information used to address each guideline. The Evaluation Guidelines were intended to be flexible within

a consistent framework and the various strategies used in the examples demonstrate that the process can be useful for a wide variety of indicators and program objectives.

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Abstract: Describes the process used in the H. John Heinz III Center for Science, Economics and the Environment's "State of the Nation's Ecosystems Report" which was released in 2002. The Design Committee (20-25 members) for the report started by describing the information needs of decision makers, opinion leaders, and the public based on the criteria that the information should be: policy relevant, technically credible, and have political legitimacy. The Design Committee (and all of the other committees) had representatives from corporations/trade groups, environmental organizations, academia, and local/state/federal governments (multiple constituencies to encourage ownership of the product).Technical Working Groups were established for each of the ecosystems (Coasts & Oceans, Farmlands, Forests, Fresh Waters, Grasslands & Shrublands, and Urban & Suburban) covered in the report. These working groups developed 18 or so indicators for each of these ecosystems that provided useful information on the state of these ecosystems (ignoring cause and effect relationships and qualitative evaluations of these state indicators- i.e. pressure and response indicators avoided). They developed the indicators before deciding on whether the supporting data existed at the national level. Thus out of 103 indicators in the report: 58 (56%) could be reported on nationally, while 45 indicators could not be reported (30% due to inadequate data and 10% need further development) in the initial report. The state indicators utilized included measures of: system dimensions; chemical & physical conditions; biological components; and human use. They also developed 10 "core national indicators" which provided aggregated indices of the conditions of the nation's ecosystems, with many of these requiring further development or lacking supporting data.

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Abstract: The ecological evaluation index (EEI) was designed to estimate the ecological status of transitional and coastal waters. Marine benthic macrophytes (seaweeds, seagrasses) were used as bioindicators of ecosystem shifts due to anthropogenic stress, from the pristine state with late-successional species (high ecological status class (ESC)) to the degraded state with opportunistic species (bad ESC). The relation of EEI to function and to resilience of the marine ecosystem, and its possibility for comparing and ranking at local, national and international levels are some of its main management implications.

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Abstract: One of the many debates about sustainability centers on how a natural resource stock (e.g. a forest) generates flows of desired human services (such as lumber and recreation). Should resources be sustained as they currently exist or should the services

that they provide be sustained? This is a difficult question to address since there is very little quantitative information available. The purpose of this study was to address this question by using information from an empirical study that was able to look at sustainability when there is one output and extend that framework to a multi-objective setting. We then discuss the framework by using a multi-objective resource, the Neuse River in North Carolina.

We identified several concepts from the single objective study, including that there are at least three important types of resource stocks, two types of goals, substitutes for natural resources, and a need to consider uncertainty and reversibility. An index of resource quality was used in a production model, which also allowed substitution of manufactured inputs to achieve the sustainability objective over long periods of time. The relationship between resource quality, manufactured inputs and output over time proved critical to meeting sustainability definitions and varied from one resource to another. When we expanded the framework, we found that constructing indices for one resource output might reveal that it is positively or negatively correlated to another output. For example, an index for drinking water might be made better through an indicator that is a positive, or negative, input into another index such as fishability.

26. Ribaudo, Marc O., Dana L. Hoag, Mark E. Smith, Ralph Heimlich. 2002. Environmental indices and the politics of the Conservation Reserve Program. Ecological Indicators, 1(1): 11-20.
Abstract: Environmental indicators can be used to target public programs to provide a variety of benefits. Social scientists, physical scientists, and politicians have roles in developing indicators that reflect the demands of diverse interest groups. We review the US Department of Agriculture's Conservation Reserve Program (CRP), the largest agricultural conservation program the United States, to determine how a set of environmental indicators were developed and used, and assess results of their application. The use of such indicators has helped the CRP increase and broaden the program's environmental benefits beyond erosion reduction, which was the primary focus of early program efforts, to meet other demands. This case study provides an example about how integration and assessment for the purpose of managing public resources requires more than natural science disciplines. Social science can help explain how public values influence what information is collected and how it is interpreted. Examples are given to show how the indices used for the CRP integrated science, politics and social values. In the end, the environmental benefits index (EBI) used to target US$ 20 billion of CRP funds reflect compromises made between science and policy considerations. It is our intention that studying this index will yield ideas and understanding from the natural science community that develops ecosystem indices about how to better plug in to programs in the future.

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