

**Summary Minutes of the
U.S. Environmental Protection Agency (EPA)
Science Advisory Board (SAB) Ecological Processes and Effects Committee
Augmented for the Advisory on EPA's Ecological Research Program
Multi-year Plan**

Meeting, April 9 -10, 2008

Committee Members: See Committee Roster – Appendix A

Date and Time: Wednesday, April 9, 8:30 a.m. - 5:30 p.m.; Thursday April 10, 8:00 a.m.
- 2:00 p.m. Eastern Daylight Time

Location: EPA Science Advisory Board Conference Center, 1025 F Street, N.W.,
Washington, D.C.

Purpose: The purpose of this meeting was to provide advice on EPA's draft
Ecological Research Program Multi-Year Plan (Plan)

Attendees: Committee Chair: Dr. Judith Meyer

Committee Members: Dr. Fred Benfield
Dr. Gregory Biddinger
Dr. Ingrid Burke
Dr. G. Allen Burton
Dr. Peter Chapman
Dr. Loveday Conquest
Dr. Terry Daniel
Dr. Wayne Landis
Dr. James Oris
Dr. Charles Rabeni
Dr. Amanda Rodewald
Dr. James Sanders
Dr. Kathleen Segerson
Dr. Ivor van Heerden

EPA SAB Staff: Thomas Armitage, Designated Federal Officer
Vanessa Vu, Director, SAB Office
Daniel Cronin, SAB Office

EPA Staff: Tiffany Crawford, EPA/OW
Chris Faulkner, EPA/OW
Iris Goodman, EPA/ORD
Rick Linthurst, EPA/ORD

Deborah Mangis, EPA/ORD
Edward Ohanian, EPA/OW
Mary Reiley, EPA/OW
Kathryn Saterson, EPA/ORD
Anne Sergeant, EPA/ORD
Rita Schoeny, EPA/OW
Michael Shapiro, EPA/OW
Brett Snyder, EPA/NCEE

Others Present: Maria Hegstad, Inside EPA
Milton Roney, International Dark Sky
Association

Meeting Summary

The discussion followed the issues and timing as presented in the meeting agenda (Appendix B).

Convene Meeting

Dr. Thomas Armitage, Designated Federal Officer (DFO) for the SAB Ecological Processes and Effects Committee convened the meeting at 8:30 a.m. on April 9. He stated that the EPA Science Advisory Board (SAB) is a chartered federal advisory committee whose meetings are public by law. He reviewed the Federal Advisory Committee Act (FACA) requirements and the Committee's compliance with federal ethics and conflict-of-interest requirements. Dr. Armitage stated that as DFO, he would be present during Committee business and deliberations. He stated that summary minutes of the meeting would be prepared and certified by the Chair.

Welcoming Remarks

Dr. Vanessa Vu, Director of the EPA SAB Office, welcomed the Committee members and thanked them for providing advice to EPA on the Ecological Research Program Multi-Year Plan.

Introduction of Members, Purpose of Meeting, and Review of the Agenda

Dr. Judith Meyer, Chair of the SAB Ecological Processes and Effects Committee provided introductory remarks. She stated that during the next two days, the Committee would discuss the EPA Ecological Research Program Multi-Year Plan and deliberate on six charge questions that had been included in the information packages provided to each Committee member. She stated that, following the discussion of responses to the charge questions, the Committee would have time to begin developing the advisory report to EPA. She reviewed the charge questions to the Committee (Appendix C), the meeting

agenda (Appendix B). She thanked members for providing preliminary responses to the charge questions and noted that these responses were also included in the Committee member information packages. Dr. Meyer also briefly described a recent National Academy of Sciences Report, *Evaluating Research Efficiency in the U.S. Environmental Protection Agency* and asked members to bear in mind some of the findings in that document as they discussed the Ecological Research Program Multi-Year Plan. Dr. Meyer also noted that on the second day of the meeting, time had been reserved to discuss EPEC's self-initiated work to identify key emerging issues of ecological concern. Dr. Meyer then asked Committee members to introduce themselves. Following Committee introductions Dr. Meyer asked Dr. Rick Linthurst and Ms. Iris Goodman of EPA's Office of Research and Development (ORD) to present an overview of EPA's Ecological Research Program Multi-year Plan.

Overview of EPA's Ecological Research Program Multi-year Plan

Dr. Rick Linthurst and Ms. Iris Goodman presented an overview of the EPA Ecological Research Program Multi-Year Plan. They discussed the Program's strategic direction, goals, objectives, implementation approach, and challenges. Slides of their presentation are included in Appendix D. Dr. Linthurst discussed the importance of considering social, technical, administrative, political, and economic factors in environmental decision making. He discussed the Millennium Ecosystem Assessment findings and recommendations concerning ecosystem services and their relationship to human-well being. Dr. Linthurst described the overarching Ecological Research Program goal of transforming the way people understand and respond to environmental issues by making clear the ways in which choices affect the type, quality, and magnitude of services received from ecosystems (e.g. services such as clean air, clean water, productive soils, and generation of food and fiber).

Ms. Goodman presented examples to show how the overall program goal could be accomplished by translating services into quantifiable spatial metrics. Specific examples were presented showing alternative futures scenario evaluations in the Willamette Basin and an evaluation of ecosystem services at multiple scales. An example was also presented illustrating how available data for Michigan rivers had been used to map fisheries habitat. Ms. Goodman discussed how choices affecting various ecosystem services require trade-offs. She noted that better methods must be developed to: maximize bundled ecosystem services, understand interactions among related services, quantify trade-offs, identify and predict thresholds that affect ecosystem services, and develop approaches to managing risks to ecosystem services. Ms. Goodman also discussed the importance of understanding positive and negative interactions among various regulating, provisioning, and cultural ecosystem services, and how these interactions change under different scenarios.

Dr. Linthurst then described the components of the Ecological Research Program and how they would provide information and tools to enable local watershed, state, regional, and national managers to make choices based on gains and losses of ecosystem services. He noted that the program was developed to build on EPA's strengths in economic

analysis and ecological risk assessment. He stated that the Ecological Research Program would undertake: pollutant based research to understand how regulated pollutants affect ecosystem services at multiple scales; ecosystem-based research to understand how the suite of ecosystem services provided by a single ecosystem type change under alternative management options at multiple scales; and place-driven research to understand how the suite of ecosystem services within a defined area change under alternative management options and/or drivers. He described the five long-term program goals that had been developed and indicated that more detailed implementation plans were being developed. In addition, Dr. Linthurst described partnerships that were being developed to implement the research program. He also discussed how the Ecological Research Program was being coordinated with other ORD programs.

Questions from the Committee

Committee members asked questions about the planned research and how the program would be implemented. The Chair asked whether funding would be available through EPA's Science to Achieve Results (STAR) program to support the Ecological Research Program. EPA staff responded that STAR funding had not been made available to support the Program. However, some STAR funding was available to support economic research. A member noted that the annual performance goals for the program were very broad. He asked whether more specific plans and objectives were under development. EPA staff responded that the Agency would develop more detailed implementation plans.

A member stated that the Ecological Research Program would need to provide various kinds of information and tools to decision makers to enable them to understand tradeoffs (biophysical as well as other kinds of tradeoffs) associated with decision options. She expressed concern that EPA's National Center for Environmental Economics (NCEE) was not conducting the kind of research needed to understand such tradeoffs. Staff from the National Center for Environmental Economics responded that several NCEE economists would be working on the planned Ecological Research Program place-based projects. NCEE staff also stated that several other NCEE economists had experience in valuing ecosystem services and could provide assistance to ORD in a consulting role. In addition, NCEE staff noted that a limited amount of STAR funding would be available for NCEE work, and a portion of that could be used to fund projects that would support the ORD Ecological Research Program.

A Committee member stated that there was a need for research to address uncertainty in ecological risk assessment. He noted that this kind of work was being conducted by investigators outside of EPA and that the Agency should partner with these other organizations on this work. He also stated that the Ecological Research Program Multi-year Plan did not provide much information on how EPA would undertake public education programs. EPA staff responded that more details concerning this issue would be included in implementation plans.

EPA Program Office Perspective

Dr. Michael Shapiro, Deputy Assistant Administrator in EPA's Office of Water (OW) presented remarks on how the Ecological Research Program Multi-Year Plan meshed with key programmatic issues of importance to the Office of Water. (Dr. Shapiro's presentation slides are included in Appendix E.) He noted that EPA's Office of Research and Development had developed nine multi-year plans and that the Office of Water drew upon work conducted under all of these plans. Dr. Shapiro talked about how the ORD research can be used by the Office of Water in five programmatic areas: water quality standards; effluent guidelines; wastewater-residual management support; watershed restoration and decision making; and wetlands protection, improvement, restoration, and creation.

Dr. Shapiro mentioned a number of challenges facing the Office of Water programs. These challenges include: changing water use patterns and flows; continued population growth and concentration; emerging contaminants (including pharmaceuticals and personal care products); climate change impacts on current ecosystems, and developing more sensitive metrics, indicators, measures, and ecological assessment tools.

Dr. Shapiro talked about how the Ecological Research Program can support the Office of Water. He mentioned that water quality management must be undertaken at several scales, (e.g., local, state, and regional). He noted that the ORD research program could support development of metrics, measures, and assessment tools at all of these scales. He stated that the Office of Water could benefit from the ORD research on wetlands, coral reef ecosystems, and nutrient processes and impacts, but he noted that explicit effort was needed to connect the Multi-Year Plan concepts to regulatory and non-regulatory programs.

Questions from the Committee

A Committee member noted that it was not clear how the ORD program would influence the development of water quality permits. He asked whether the Office of Water might use ORD's research to develop a different conceptual model for permits. Dr. Shapiro responded that a major part of the decision concerning how permits are to be developed occurs when water quality standards are promulgated. He noted that the ORD research program focus on ecosystem services might influence decisions made through the water quality standards process.

The Chair thanked Dr. Shapiro, Dr. Linthurst, and Ms. Goodman for their presentations. She then called for public comments and noted that there would be additional time for more questions from the committee following the public comment period.

Public Comments

Comments were provided by Stephen Davis, Ft. Edwards, NY; Milton J. Roney, International Dark Sky Association, Washington, D.C.; and Robert Wagner, Kansas City,

MO. Their comments, addressing the issue of light pollution, are available on the SAB website at:

<http://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/B8D02B3596DA3550852573C90073C793?OpenDocument>.

Additional Committee Questions on the Ecological Research Program

Several members stated under the new Multi-Year Plan, it appeared that EPA/ORD would not continue to support the Environmental Monitoring and Assessment Program (EMAP). They asked how the EPA would obtain data needed to support the ecological services research without EMAP. ORD staff responded that continued support for some of the EMAP program would be provided by the Office of Water. Staff from the Office of Water stated that some EMAP resources would be shifted into the Water Quality Multi-Year Research Plan. OW would coordinate the logistics of collecting and analyzing samples. Another member asked how ORD would “retool” its program to shift from ongoing research into proposed new areas. ORD staff responded that retooling would be difficult. However, they stated that ORD expertise was available to conduct much of the research and ORD was planning to partner with outside experts in other areas of proposed research.

A member stated that there were many controversial issues associated with valuation of ecological services and he noted that this could impede research progress. He asked how the findings of the report of the SAB Committee on Valuing the Protection of Ecosystems and Services (CVPESS) would be folded into the Plan. ORD staff responded that the Agency was looking at the recommendations in the CVPESS report and planned to consider them as implementation plans were developed. Another member stated that it was important to avoid becoming “bogged down” in some of the controversial issues related to valuation. She noted that there was a great need for continued research on the role of biophysical processes in ecological production functions, and that ORD should focus on this research.

Another member agreed but he stated that there were many references in the Plan to mapping ecosystem services and, in this regard, the biophysical research must line up with valuation research. ORD staff responded that the primary focus of the research program would not be to undertake the valuation but to develop ecological production functions needed to predict the effects of stressors on flows of ecosystem services. The Chair stated that in general, the focus on ecosystem services seemed to be appropriate, but the research program was very ambitious. Other Committee members agreed with this point. The Chair then again thanked the EPA presenters and stated that the Committee would begin discussing the response to the first charge question.

Discussion of Charge Question #1 – Appropriateness of the Strategic Direction

After a break, the Committee discussed the response to Charge Question #1. A Committee member began the discussion by stating that he supported the new strategic direction. However, he stated that one of the biggest problems to be addressed in the new

program would be the valuation of ecosystem services. He stated that, for a program with very limited resources, this would be difficult. He stated that it would be helpful to further prioritize the work to be undertaken. He also noted that the general questions to be addressed by the program were not completely reflected in the long-term goals articulated in the Plan. He stated that it was particularly important to focus on how multiple ecosystem stressors affect human well-being, and that this was not clearly articulated in the Plan.

A member stated that the Plan set forth an ambitious program of proposed research. However, because of constraints imposed by limited resources, it was not clear how far program outputs could advance the science.

Another member stated that the strategic vision articulated in the Plan was appropriate. However, he noted that EPA appeared to be developing the Decision Support Platform (DSP) before all of the necessary implementation tools were available. He noted that the empirical linkages needed to develop and use the DSP were not yet in place. He noted that EPA should not pull back from an aggressive research schedule, but the Agency needed to identify and conduct some important basic research before the DSP was “rolled out” for use by decision makers. He stated that the Plan discussed tool development but lacked a discussion of some important basic research. He also stated that the audience of the Plan was not clearly identified. He noted that decision makers in industry and business were an important audience not recognized in the Plan. In addition, he pointed out several missing elements in the Plan (e.g., a connection to contaminated land). EPA staff responded that outputs should be scheduled appropriately so that decision makers could use the DSP. They stated that EPA was aware of research needs and did not want to build a DSP without providing information to implement it. They noted, however, that available resources supporting research to build the DSP were limited. The Chair stated that EPA should consider changing the percentages of resources allocated to various projects as needs changed over time.

A member stated that there was a need to include in the Plan more discussion of planned interactions among EPA ORD research programs and other research partners. Another member stated that, she strongly supported the new strategic direction. However she noted that the plan did not seem to be hypothesis driven. She stated that, although the plan outlined a program to develop tools, it did not focus on research to understand why stressors resulted in changes in ecosystem service flows.

Another member commented that the new emphasis on ecosystem services was very important. She noted, however, that some Committee members seemed to be concerned about a research program that focused on human well-being. She noted that it was important to protect all ecosystem services including those that could not be as clearly linked to human well-being. Another member commented that, through consideration of the “sense of place,” the importance of such services could be identified.

A member commented that EPA should more explicitly describe the purpose of the Plan. He stated that the Plan appeared to be a vision document, not a research plan. He stated

that more detailed information was needed in a research plan. He specifically recommended that additional information be provided to more clearly describe an operational scheme for the research program and how the Plan related to ORD's other multi-year plans.

A Committee member stated that EPA should link the plan more closely to the ecological risk assessment process. In this regard, the Committee briefly discussed whether "sense of place" was an ecosystem service that appropriately captured the notion of ecological risk and its relationship to human well-being. A member commented that "sense of place" might not be a good ecosystem service to consider because it was difficult to measure. Another member noted that sense of place may be most important to people who rely on the environment for food. Another member stated that EPA might consider a sense of place analysis that is a map of use of place. He stated that the CVPESS referred to this as "what matters to people." He noted that, unfortunately, analysts often start with a risk assessment approach and derive an endpoint that is useless to people. He noted that it was important to start with "what people value" and use this to inform a risk assessment.

At 12:00 p.m., following the discussion of Charge Question #1, the Committee recessed for lunch. The Committee reconvened at 1:00 to discuss Charge Question #2.

Discussion of Charge Question #2 – Goals and Research Questions

The Committee discussed the adequacy and appropriateness of each of the long-term goals and associated research questions in the Plan.

Long-term Goal 1 – Decision Support Platform (DSP)

Committee members expressed support for Long-term goal #1 but raised some concerns. A member raised the following questions and issues: 1) Is it feasible to develop the DSP? He noted the challenges of developing a tool to be used for a variety of applications at different scales. 2) Where will EPA find the expertise to develop the DSP? He noted that additional social science input would be needed to develop the DSP. 3) Sequencing and timing of DSP development may be a problem. He stated that the Plan suggested that the DSP would be developed before all of the empirical research needed to use it. 4) It will be challenging to complete the necessary valuation work for the DSP. He stated that, to develop the DSP it would be necessary to bring together information about the demand for ecosystem services and the biophysical processes involved in ecosystem service flows. 5) How will human well-being and the ecological production functions be integrated? He stated that this was not clearly addressed in the Plan. 6) He stated that education and outreach were very important to ensure that the DSP was appropriately developed and implemented. He noted, however, that ORD had not typically been involved in education and outreach. EPA staff agreed that these were challenging issues.

Another member stated that it was hard to envision how a generic DSP could be developed and used, although she noted that it would be valuable to bring together useful

information in one place. Several members stated that articulating the ecological production functions would be very valuable, even if a DSP were not immediately available for use by decision makers. Another member noted that a relatively simple DSP could initially be developed and expanded as more information became available.

Long-term Goal 2 – National Inventory, Mapping, and Modeling

Members discussed the goal of developing an inventory of ecosystem services and mapping them. Members stated that it would be useful to develop models to evaluate changes in ecosystem service flows. Members expressed support for Long-term Goal 2. They noted that EPA had extensive experience in the area of monitoring. Several Committee members indicated that it would be very useful to bring the agencies in the “federal family” together to determine what programs and data bases were currently available, and to coordinate future monitoring, mapping, and modeling work.

Several members stated that it would be useful to provide more concrete examples in the Plan to illustrate how ecosystem services would be monitored and mapped. Several members noted that it would be difficult to develop information and tools that could be used for decision making at various scales. A member questioned whether EPA would be able to provide useful information for decisions at the local management scale. EPA staff provided several examples of site-specific information that could be used for decision making. EPA staff indicated that the EMAP program had generated both regional and national data. A Committee member stated that one of the useful products of EMAP was REMAP (regional EMAP). REMAP was useful because it provided data for small jurisdictions.

Another member stated that the Ecological Research Program should conduct research to understand the sustainability of ecosystem services. He noted, however, that developing maps to show where the ecosystem services were did not seem to be the job of the research program. Another member questioned whether maps with national coverage were appropriate for some ecosystem services. She noted that each service should be considered separately to determine the appropriate level of coverage.

Long-term Goal 3—Nitrogen Assessment

The Committee discussed Long-term Goal 3. A member stated that, based on their initial responses to the charge questions, many of his colleagues on the Committee seemed to think that the proposed approach to accomplishing a nitrogen assessment was tractable. However, they also thought that the effort was quite small relative to the scope of the project that would be needed. He noted, however, that starting small and growing might be a good approach. He also stated that many people were studying nitrogen, and that EPA should partner with others to conduct this research. He questioned why EPA chose to conduct a nitrogen assessment and not to investigate other nutrients. He also noted that focusing on ecosystem services and their relationship to human well-being could actually encourage more use of nitrogen fertilizer.

EPA staff responded. They stated that a nitrogen assessment was of interest to the Agency. Such an assessment would provide information to support Clean Air Act programs and to evaluate the effects of biofuel production. With limited resources, EPA chose to undertake a place-based “bottom up” approach rather than starting to look at the problem on a national scale.

Several members agreed that a nitrogen assessment was very important. However, they noted that the scope of the effort was severely limited by lack of resources. They noted that nitrogen assessment should be conducted on a global scale. Another member stated that he was concerned that the focus on human well-being might lead to degradation of non-human dominated ecosystems. A member asked EPA how many scientists would be available to work on the nitrogen assessment. EPA staff responded that the Agency planned to have 7 - 10 people working on this research. A member stated that the fundamental question to be answered in by the nitrogen assessment was not clear. Available resources might not be sufficient to answer the fundamental question to be posed. He indicated that EPA might consider framing a question that could be answered with available resources.

Long-term Goal 5 – Place Based Demonstration Projects

The Chair indicated that the Committee would reverse the order of discussion of the next two long-term goals (goals 4 and 5). The Committee first discussed the proposed place-based demonstration projects (goal 5). A member indicated that work on the demonstration projects, particularly the Willamette, could provide useful information but it was not clear what criteria ORD used to select the sites for place-based research. He stated that it might be useful to consider sites in additional northern locations. The Chair noted that a more detailed explanation of how sites were selected should be provided in the Plan. EPA staff responded, explaining how sites were chosen. They stated that the Agency wanted to choose sites where data were available or where an important problem could be addressed. Data were available for the Willamette site. In Tampa Bay work had already been undertaken to understand ecosystem services. The biofuel issue was important in the Midwest, and the proximity of EPA’s laboratory in North Carolina was a factor in selecting the coastal Carolina project.

The Committee discussed whether the Midwest was too large an area for a useful demonstration project. EPA staff indicated that the Agency wanted to look at the effects of ethanol production over the entire region. EPA staff also stated that the Office of Water was particularly interested in the issue of hypoxia in the region.

The Committee discussed the need to consider transboundary issues in the place-based research. A member stated that it would be important to draw upon Great Lakes information developed by the Canadians. Another member noted that national boundaries should not be considered in ecological research. EPA staff responded, indicating that the idea of scaling up and down was very important. They agreed that geopolitical boundaries were not appropriate for dealing with ecological issues. The Chair expressed some concern that it might not be easy to generalize and use knowledge

obtained from some of the place-based sites in other areas. She noted that in selecting sites, EPA should consider whether the information to be developed could be used for decision making in other areas of the country. She noted that in the Plan it was not clear that sites were selected to provide information at different scales. She stated that the Plan should more clearly articulate why sites were selected.

Long-term Goal 4 – Ecosystem Assessments

The Committee next discussed Long-term Goal 4. A Committee member stated that EPA's introductory presentation answered some his questions about the ecosystem assessments. However, he stated that additional information was needed to completely understand why and how work would be undertaken for the assessments of wetlands and coral reefs. A member stated that the implementation plans to be developed should be reviewed by experts. Another member stated that there was a need for additional resources to support the planned ecosystem assessments, and that it would be very important for EPA to partner with others to complete this work. He indicated that it would be important to receive "buy-in" from partners and decision makers early in the process. Therefore, EPA should undertake work that could produce early results (in 2-3 years) and build on those results to continue the assessments. He noted that ORD should build linkages to other EPA programs (e.g., the Office of Water) to ensure success.

The Chair and others on the Committee indicated that it was clear that wetlands were important systems that should be included in the ecosystem assessment part of the Plan. However, they questioned why EPA had chosen to conduct research on coral reef systems. Committee members noted that although coral reef systems were globally important, they did not seem to be as important as other systems in the U.S. Furthermore, EPA's expertise seemed to be focused in other areas. EPA staff responded that there was regional interest in studying coral reefs and there was expertise at the Agency's Gulf Breeze laboratory. Several members stated that it was difficult to justify studying coral reefs when other systems could offer more useful information for decision making in the U.S. A member stated that it might be more useful to study a terrestrial system as well as an aquatic system. A member stated that coral reefs might be viewed as a fractured landscape. He suggested that EPA might pick a research topic that focused on fractured landscapes. Others stated that more justification was needed for the selection of coral reef ecosystems.

Following a break at 2:45 p.m. the Committee reconvened at 3:00 p.m. to discuss the response to Charge Question #3.

Discussion of Charge Question #3 – Logic Model Approach

The Committee provided comments on the logic model approach proposed to implement the Ecological Research Program Multi-year Plan.

Members stated that the logic model approach in the Plan made sense. They noted that the model illustrated how inputs would lead to outcomes. A member stated, however,

that no guidance was presented in the Plan to indicate how EPA would use the model to drive the program implementation. The member stated that a feedback loop was important and should be included.

Another member stated that the logic model appeared to be internal to EPA. He noted that linkages to activities outside of the Agency should be provided. Another member stated that the “externalities” identified in the logic model were not really externalities in the economic sense and that this should be noted. Members also discussed a recent National Research Council report on evaluating research efficiency in the U.S. EPA. Members stated that the NRC report contained a logic model and that EPA should incorporate various parts of the NRC model into the Ecological Research Program Multi-Year Plan.

Discussion of Charge Question #4 – Challenges to Achieving Overall Program Success

The Committee discussed a number of challenges to achieving success of the Ecological Research Program. A member stated that one challenge for the Program would be dealing with different kinds of uncertainty. Several members indicated that another challenge would be developing a better operational or tactical plan to implement the Program. Many Committee members also stated that the greatest challenge facing the program was insufficient resources and institutional capacity to complete the proposed research within the planned time frame. Members stressed that these challenges were not fatal flaws in the Program.

The Chair noted that EPA should link proposed research in the Plan to risk assessment. Another member stated that EPA might want to consider changing the title of the Plan to indicate that it was really a “vision” document. Members then further discussed the challenge of accomplishing the vision articulated in the Plan with limited resources. A member stated that ecological risk assessment had evolved over 20 years and it was reasonable to expect that a new research program would not be completely accomplished in a short period of time. Another member noted that one of the overarching goals of the Plan was to address the effects of multiples stressors, and this would be challenging.

Several members stated that successful outreach efforts would be important to overall Program success. Furthermore, EPA would have a limited window of opportunity to produce useful products that could generate support for the Program. Members stated that EPA should identify some intermediate products that could be developed in the short-term. Members stated that the entire program could not be accomplished within the proposed time frame.

Discussion of Charge Question #5 – Suggestions for Measuring Progress of the Program

The Committee discussed measuring progress of the Ecological Research Program. A member suggested that EPA could adopt an adaptive management model for

implementing the Program. He noted that such a model used feedback loops to identify resources needed for various program components at different stages of the program. A member stated that EPA should think more strategically about how to evaluate the Program. Members noted that some of the goals and objectives articulated in the Plan were outside of EPA's control. If these goals and objectives were the basis for evaluating the Program, EPA would run the risk of a less than successful evaluation. Other members suggested that EPA evaluate the program on the basis of research products, not on the basis of achieving program goals for environmental protection. Members suggested that EPA work with the Office of Management and Budget to identify a new set of appropriate objectives that could be used to evaluate the Program.

Members discussed relevant points in the National Research Council Report on evaluating research efficiency in the EPA and suggested that EPA consider them in evaluating Program success.

Discussion of Charge Question #6 – Recommendations to Enhance the Ability to Leverage Resources

The Committee discussed suggestions to enhance EPA's ability to leverage Program resources. A member stated that the proposed plan for implementing the Program appeared to be a "top down" approach. He stated that EPA should develop partnerships with external groups from the "bottom up." Several suggestions were offered in this regard. One suggestion was that memoranda of understanding be developed to clearly indicate how external groups would work with EPA.

Members suggested several ways to obtain additional financial support. These included working with nonprofit foundations, reaching out to nongovernmental organizations, organizing workshops, and taking advantage of opportunities available through professional societies, other federal agencies and the National Science Foundation.

Committee members discussed other suggestions to enhance leveraging of resources. It was suggested that EPA might consider reallocation of resources. A member stated that EPA might include in the Plan a specific section on leveraging resources. Other suggestions included using STAR fellowships, and working on outreach activities with textbook companies and educational television networks.

Following the discussion of Charge Question #6 the chair reviewed plans for the next day. She stated that the Committee would convene the following morning at 8:00 a.m. for a two-hour writing session to develop responses to the charge questions. She asked each of the discussion leaders to develop the responses to the questions. From 10:00 - 11:30, the Committee would then discuss the responses to the charge questions. Following this discussion, a working lunch would be held to discuss the EPEC self initiated project on issues of emerging ecological concern. In preparation for that session, the Chair asked each member to identify ten issues of concern. The Chair stated that the issues would be compiled by the DFO and discussed at lunch.

The meeting was then recessed for the day at 5:30 p.m.

Thursday, April 10, 2008

The Chair convened the meeting at 8:00 a.m. Before beginning the writing session, the Committee discussed major issues and themes to be included in the advisory report issues.

Major Themes and Issues to be Addressed in the Committee Report

A member asked whether the issue of light pollution should be specifically addressed in the Committee's report. Several members stated that, although light pollution was an important issue, it could be addressed as EPA developed implementation plans. They stated that this issue did not have to be specifically mentioned in the Committee's report.

The Committee discussed the issue of limited resources to support research. Several members stated that the transmittal letter with the Committee report should recommend additional grant funding. A member also stated that the report should indicate that coral reef research may be less important than work on other ecosystem types.

A member stated that the Committee report should indicate that EPA did not have the resources to complete all of the proposed work within the planned time frame.

A member stated that the report should indicate that transboundary work was needed. Another member stated that the report should question whether the limited resources for the nitrogen assessment call into question the effectiveness of that part of the Plan.

The Committee discussed the need for outreach and education. Several members noted that the report should indicate that outreach and education had not traditionally been a strength of ORD and that additional expertise was needed in this area.

Following the discussion Committee members began drafting responses to the charge questions.

Discussion of the Responses to the Charge Questions

At 10:00 a.m. the Committee summarized and discussed the responses that had been developed for each of the charge questions. Highlights of the responses to each question are presented in Appendix F.

Following the discussion of charge question responses, the Chair thanked the Committee members for their comments and also thanked EPA staff for responding to the Committee's questions. She stated that the meeting had been very productive and then reviewed the schedule for developing the Committee report. She stated the DFO would send the first draft of the report to the Committee for review by May 13th. The DFO would work with the Chair to incorporate comments and send the second draft to the

Committee by June 5th. The Committee would hold a teleconference the second week in June to discuss the report, and a final draft would be sent to the Committee with a request for concurrence to send it to the Chartered Science Advisory Board for quality review and transmittal to the EPA Administrator.

Discussion of Other Ecological Processes and Effects Committee Business

Following the discussion of the Ecological Research Strategy Multi-year Plan, EPEC members participated in a working lunch and identified issues of emerging ecological concern. EPEC is preparing a list of these issues for EPA's future consideration. The Committee discussed the issues of concern and developed the list provided in Appendix G. Following the discussion the Chair thanked members for their participation and adjourned the meeting.

Respectfully Submitted:

Certified as True:

/Signed/

/Signed/

Dr. Thomas Armitage
Designated Federal Officer

Dr. Judith L. Meyer, Chair
SAB Ecological Processes and Effects
Committee

APPENDICES

Appendix A: Committee Roster

Appendix B: Meeting Agenda

Appendix C: Charge to the Committee

Appendix D: Office of Research and Development Presentation Slides

Appendix E: Office of Water Presentation Slides

Appendix F: Highlights of Responses to the Charge Questions

Appendix G: Key and Emerging Issues of Ecological Concern

Appendix A – Committee Roster

U.S. Environmental Protection Agency Science Advisory Board Ecological Processes and Effects Committee

Augmented for the Advisory on the EPA Ecological Research Program Multi-Year Plan

CHAIR

Dr. Judith L. Meyer, Distinguished Research Professor Emeritus, Institute of Ecology, University of Georgia, Athens, GA

ECOLOGICAL PROCESSES AND EFFECTS COMMITTEE MEMBERS

Dr. Fred Benfield, Professor of Ecology, Department of Biological Sciences, Virginia Tech, Blacksburg, VA

Dr. Ingrid Burke, Professor, Department of Forest, Rangeland and Watershed, Stewardship, Colorado State University, Fort Collins, CO

Dr. G. Allen Burton, Professor and Chair, Department of Earth and Environmental Sciences, Wright State University, Dayton, OH

Dr. Peter M. Chapman, Principal and Senior Environmental Scientist, Environmental Sciences Group, Golder Associates Ltd, North Vancouver, BC, Canada

Dr. Loveday Conquest, Professor and Associate Director, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA

Dr. Wayne Landis, Professor and Director, Institute of Environmental Toxicology, Western Washington University, Bellingham, WA

Dr. James Oris, Professor, Department of Zoology, Miami University, Oxford, OH

Dr. Charles Rabeni, Leader of Missouri Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, University of Missouri, Columbia, MO

Dr. Amanda Rodewald, Associate Professor of Wildlife Ecology, School of Environment and Natural Resources, The Ohio State University, Columbus, OH

Dr. James Sanders, Director and Professor, Skidaway Institute of Oceanography, Savannah, GA

Dr. Ivor van Heerden, Associate Professor and Director, Department of Civil and Environment Engineering, LSU Hurricane Public Health Research Center, Louisiana State University, Baton Rouge, LA

OTHER SAB COMMITTEE MEMBERS

Dr. Gregory Biddinger, Coordinator, Natural Land Management Programs, Toxicology and Environmental Sciences, ExxonMobil Biomedical Sciences, Inc, Houston, TX

Dr. James Boyd, Senior Fellow, Director, Energy and Natural Resources Division, Resources for the Future, Washington, DC

Dr. Terry Daniel, Professor of Psychology and Natural Resources, Department of Psychology, Environmental Perception Laboratory, University of Arizona, Tucson, AZ

Dr. Otto C. Doering III, Professor, Department of Agricultural Economics, Purdue University, W. Lafayette, IN

Dr. William Moomaw, Professor of International Environmental Policy and Director of the Center for International Environment and Resource Policy, The Fletcher School of Law and Diplomacy, Tufts University, Medford, MA

Dr. Kathleen Segerson, Professor, Department of Economics, University of Connecticut, Storrs, CT

Appendix B – Meeting Agenda

U.S. ENVIRONMENTAL PROTECTION AGENCY

SCIENCE ADVISORY BOARD

Ecological Processes and Effects Committee Augmented for Advisory on EPA's Ecological Research Program Multi-year Plan

Public Meeting, April 9-10, 2008

SAB Conference Center, Suite 3700
1025 F Street NW, Washington DC

AGENDA

Wednesday, April 9, 2008

- 8:30 - 8:45 a.m. **Meeting Convened by the Designated Federal Officer**
Dr. Thomas Armitage
EPA Science Advisory Board Staff Office
- Welcome**
Dr. Vanessa Vu, Director
EPA Science Advisory Board Staff Office
- 8:45 - 9:00 a.m. **Purpose of the Meeting and Review of the Agenda**
Dr. Judith Meyer, Chair
- 9:00 - 9:45 a.m. **Overview of EPA's Ecological Research Program Multi-Year Plan**
Dr. Rick Linthurst, National Program Director for Ecology
U.S. EPA Office of Research and Development
- 9:45 – 10:15 a.m. **EPA Program Office Perspective**
Dr. Michael Shapiro
Deputy Assistant Administrator for Water
U.S. EPA Office of Water
- 10:15 – 10:30 a.m. **Public Comments**
- 10:30 – 10:45 a.m. **BREAK**

- 10:45 – 12:00 p.m. **Committee Response to Charge Questions – Strategic Direction of the Ecological Research Program**
Dr. Meyer and Committee
- Charge Question 1 – Appropriateness and utility of strategic direction in offering contributions to ecological science and providing research useful to decision makers.
- 12:00 – 1:00 p.m. **Lunch**
- 1:00 – 2:45 p.m. **Committee Response to the Charge Questions – Program Goals and Research Questions**
Dr. Meyer and Committee
- Charge Question 2. Adequacy and appropriateness of goals, objectives, and research questions in contributing to overall purpose of the program.
- 2:45 – 3:00 p.m. **BREAK**
- 3:00 – 5:15 p.m. **Committee Response to the Charge Questions - Ecological Research Program Implementation Strategy**
Dr. Meyer and Committee
- Charge Question 3. Logic model approach
 - Charge Question 4. Challenges to achieving overall Program goal
 - Charge Question 5. Suggestions for measuring progress of Program
 - Charge Question 6. Recommendations to enhance ability to leverage resources
- 5:15 – 5:30 p.m. **Plans for the Following Day**
Dr. Judith Meyer, Chair
- 5:30 p.m. **Recess for Day**

Thursday, April 10, 2008

- 8:00 – 10:00 a.m. **Writing Session to Develop Responses to Charge Questions**
- 10:00 – 11:30 a.m. **Review Responses to the Charge Questions**
Dr. Meyer and Committee

- 11:30 – 11:45 a.m. **Summary of Ecological Research Program Discussion and Next Steps**
Dr. Meyer
- 11:45 – 2:00 p.m. **Working Lunch - Discussion of Other Ecological Processes and Effects Committee Business**
- Advice to EPA on Key/Emerging Risks to Ecosystems
- 2:00 p.m. **Adjourn**

Appendix C – Committee Charge

Charge to the SAB Ecological Processes and Effects Committee for the advisory on EPA’s Ecological Research Program Multi-Year Plan

Background

1. The focus of the EPA Office of Research and Development (ORD) Ecological Research Program for the past 10 years has been on:

- Developing monitoring tools and indicators to determine the status and trends of ecological resources and the effectiveness of national programs and policies.
- Developing diagnostic tools and methods to determine the causes of ecological degradation.
- Developing tools and methods to forecast the ecological impacts of actions taken by states, tribes, and EPA Offices.
- Developing environmental restoration tools and methods to improve the ability of states, tribes, and EPA Offices to protect and restore ecological condition.

2. How is the direction of EPA/ORD ecological research changing?

The EPA/ORD ecological program is taking a new strategic direction that is intended to fill the need for better understanding the implications of human impacts on ecosystems and the services they provide. This new program direction recognizes that even though the nation’s health, security, economic potential, and much of its culture are directly and intimately tied to ecosystem characteristics and quality, environmental policy decisions have failed to take these relationships into account. The redirected Ecological Research Program intends to build on past research efforts and existing expertise in ecosystem monitoring, restoration, and functioning to develop operational methods for routinely incorporating quantitative information on the type, quality and magnitude of changes in ecosystem services and their value into decision making. Programs developed by ORD to monitor ecosystem conditions (e.g., Environmental Monitoring and Assessment Program – EMAP, one of the largest components of the past program) will be passed to the EPA Program and Regional Offices for implementation.

3. Why is ORD focusing on ecosystem services?

The Ecological Research Program Multi-Year Plan describes the creation of an integrated, systems-based approach to identify, inventory, monitor, map, and model ecosystem services and to quantify these services, their value, and how they contribute to human health and well-being. This new approach takes the focus of EPA’s Ecological Research Program beyond traditional ecological endpoints, e.g., biological, chemical, and physical condition. This new approach will be useful for many reasons, for example:

- It better serves EPA Programs. Using ecosystem services as a lens to evaluate and respond to environmental issues will enable EPA to expand its influence on environmental stewardship at all levels of governance, in both the public and private sectors. Because ecosystem services are more easily valued than are traditional endpoints in the context of environmental decisions, system level trade-offs will be more apparent and thus become more a part of decision making beyond media specific regulations. Further, understanding the linkages between ecosystem services and human well-being offers the potential for framing the management of risk in new and productive ways that cut across environmental media and scientific disciplines.
- It responds to recommendations of the EPA Science Advisory Board Committee on Valuing the Protection of Ecological Systems and Services (C-VPSS). The C-VPSS has advised EPA that understanding human well-being and valuation of environmental benefits are critical to the success of the Agency's Ecological Research. The Ecological Research Program will therefore bring social scientists and natural scientists together at the outset of the Program. Doing so creates significant challenges for the Program initially, but should spur innovations in research and efficiencies in implementation as the program continues.
- It responds to recommendations of EPA's Board of Scientific Counselors (BOSC). All programs in EPA's Office of Research and Development undergo a program review every 4 to 5 years by representatives of its BOSC, a review panel similar to the SAB, focused solely on ORD research issues. In 2005, the BOSC reviewed the Ecological Research Program and noted that:

The research, tools, and analytical technologies developed under the Ecological Research Program represent the most comprehensive federal government research program examining the provision of ecosystem services and the communication of these to decision makers.

...The goal and sub-questions form a body of work that should proceed as a whole. Because the ongoing work focuses on the delivery of tools to understand societal benefits of ecosystem services, new research on the provision of these ecosystem services is essential.

- It addresses findings of the United Nations' Millennium Ecosystem Assessment (MEA). In 2005, the United Nations released the MEA which documented declines in 15 of 24 ecosystem services worldwide. These include the provision of fresh water, maintenance of wild fisheries, and natural processes that cleanse air, control regional climate, constrain outbreaks of pests and disease, and mitigate natural hazards. Publication of the MEA has drawn attention to these alarming trends of ecosystem service losses. However, one underlying barrier to the reversal of these trends, of particular interest to EPA as a science and regulatory agency, was reflected in the MEA statement:

Even today's technology and knowledge can reduce considerably the human impact on ecosystems. They are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless, and their full value is taken into account.

4. *What are the ORD Ecological Research Program long and near-term goals?*

ORD's Multi-Year Plan describes long-term and annual goals of the Ecological Research Program, the scientific questions to be answered, and the general research approach chosen to answer the questions. The vision for the Program is that a comprehensive theory and practice for characterizing, quantifying, and valuing ecosystem services, and their relationship to human well-being is incorporated into environmental decision making at all levels of governance. In the near term, the Program will improve the science for mapping, modeling and monitoring ecosystem services. Beyond this traditional role, the Ecological Research Program will also advance awareness and acceptance of the value of ecosystem services and their influence on human well-being. The two scientific questions driving the plan are: 1) What are the effects of multiple stressors on ecosystem services at multiple scales over time? 2) What are the impacts of changes in these services on their societal value and human well-being?

Using internal resources, and a suite of unique partnerships with outside organizations (academia, nongovernmental organizations, other governmental agencies, etc.), the Ecological Research Program will conduct research designed to answer multiple questions about ecosystem services and develop multiple measures of services, including biophysical and monetary measures, to estimate incremental changes to ecosystem services. The focus will be on individual services as well as suites of bundled services associated with land, air, and water systems over explicitly defined spatial and temporal scales. This research will inform a wide range of issues related to questions of social choice, with a special focus on informing evaluation of trade-offs involving ecosystem services provided under alternative management and policy decisions. The Ecological Research Program, through its own work and that of partners, will create products in three categories: 1) measurements and dynamic maps of ecosystem services; 2) predictive models relating to the response of stressors; and 3) tools for analysis of management options.

Overarching Charge to the SAB

The overall goal of the Ecological Research Program is to change the way decision makers understand and respond to environmental issues by making clear the ways in which our policy and management choices affect the type, quality, and magnitude of the goods and services we receive from ecosystems. In 2005, research on conserving ecosystem services was a small part of EPA's Ecological Research Program. The Agency began planning additional research on ecosystem services immediately following the 2005 BOSC review of the program. The 2008 Ecological Research Program Multi-Year Plan is the result of that planning. ORD requests that the Science Advisory Board provide advice on the program focus, research questions, and implementation approach

articulated in the Agency's proposed Ecological Research Program Multi-Year Plan. Specifically, ORD asks the SAB to respond to the following charge questions.

Specific Charge Questions

Focus of the Program

1. The strategic direction of the Ecological Research Program is to: a) characterize and quantify the type, quality, and magnitude of services that ecosystems provide, b) develop new methods to quantify and forecast how services respond to stressors, and c) combine these and existing tools for assessing the benefits of alternative management decisions. Please comment on the appropriateness and utility of this strategic direction in: 1) offering meaningful contributions to the ecological sciences and 2) providing research that will be useful to decision makers at EPA and other levels of governance.

Research Goals and Questions

2. The Ecological Research Program includes five long-term goals, associated objectives, and research questions. Please comment on the adequacy of the goals, objectives, and questions in contributing significantly to meeting the overall purpose of the program. In reviewing each research goal please consider the following:
 - Are the research questions appropriate? If changes are needed in the research questions, please indicate how they should be changed.
 - Are the descriptions of planned research adequate to characterize the intended results, and is the planned research appropriate for accomplishing the goals?
 - Please comment on needed improvements in and clarification of the goals and objectives as well as additions or eliminations to be considered in future program development.

Implementation Strategy

3. The Ecological Research Multi-Year Plan lays out the process by which ORD intends to accomplish research. Please comment on the logic model approach and provide any recommendations that should be considered in developing implementation plans.
4. Please comment on anticipated challenges to achieving the overall goal of the Ecological Research Program Multi-Year Plan based on the Program as presented. What recommendations does the Committee have to overcome the most significant of these challenges?
5. What suggestions does the committee have for measuring annually over the next five years the progress, productivity, efficiency, and effectiveness of the Ecological Research Program?

6. Does the Committee have any recommendations on how EPA can better enhance its ability to leverage available resources within and outside the Agency?



The Ecological Research Program: MYP Overview

For the Ecosystems Processes and Effects Committee of the EPA
Science Advisory Board

By

Rick A. Linthurst and Iris Goodman
National Program Director and Acting Deputy for Ecology
Office of Research and Development
USEPA

U.S. Environmental Protection Agency
Office of Research and Development



Presentation Outline

- Setting the stage: Visions of “a” future
- Ecological Research Program Goal
- What does it all mean?
 - The science behind the proposal
- Highlights of the ERP Multi-Year Plan
- Research coordination and partnerships

As an ecologist, do you ever wonder?

- Is it the science or the will that is missing from our actions (e.g., regulations, environmental stewardship, incentives, enforcement) ?

2

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You decided to do what? S.T.A.P.L.E.

- Social
- Technical—Science and Technology
- Administrative
- Political
- Legal
- Economic

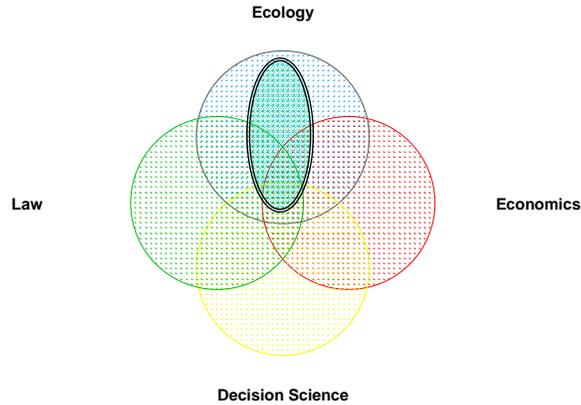
S+T+A+P+L+E = 100% of the Decision

3

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Transdisciplinary Approach to Conserving Ecosystem Services



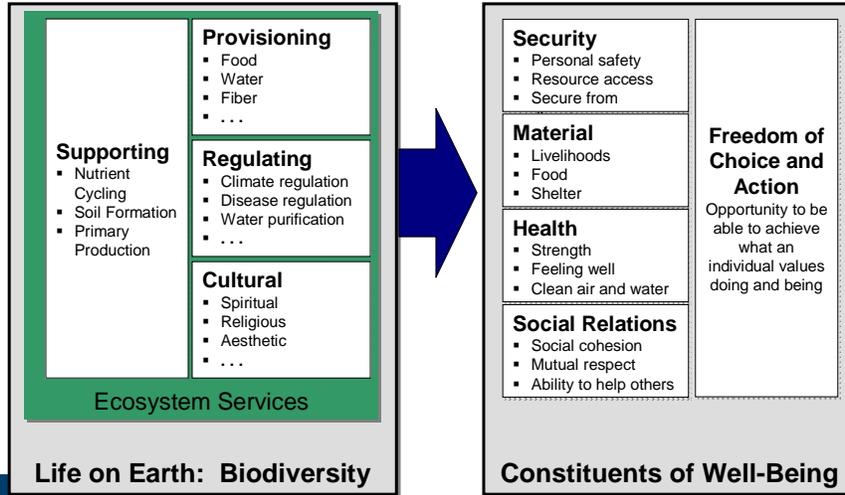
LIVING BEYOND OUR MEANS



NATURAL ASSETS AND HUMAN WELL-BEING

Statement from the Board

Consequences for People



6

Two key MEA findings greatly influenced the Ecological Research Program

- “Everyone in the world depends on nature and ecosystem services to provide the conditions for a decent, healthy, and secure life.”
- “Even today’s technology and knowledge can reduce considerably the human impact on ecosystems. They are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless, and their full value is taken into account.”

ERP’s role is to provide the science to (1) clarify this dependence, (2) describe the full range of values, (3) quantify what we know about the limited v. limitless nature of different services.

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How can ecology help?

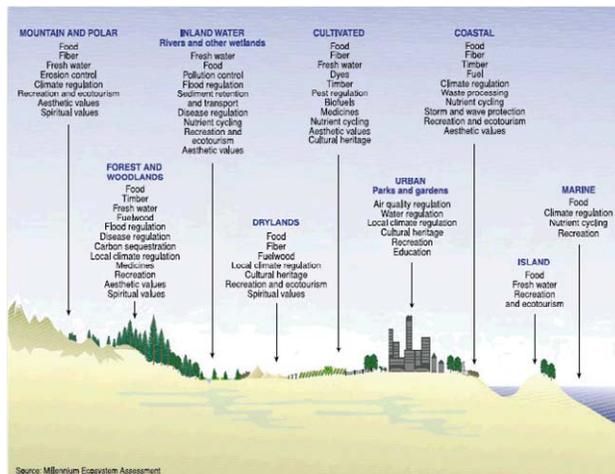
- Supporting the “art of the possible”
- Examples from previous research by ERP, grantees, and partners.

11

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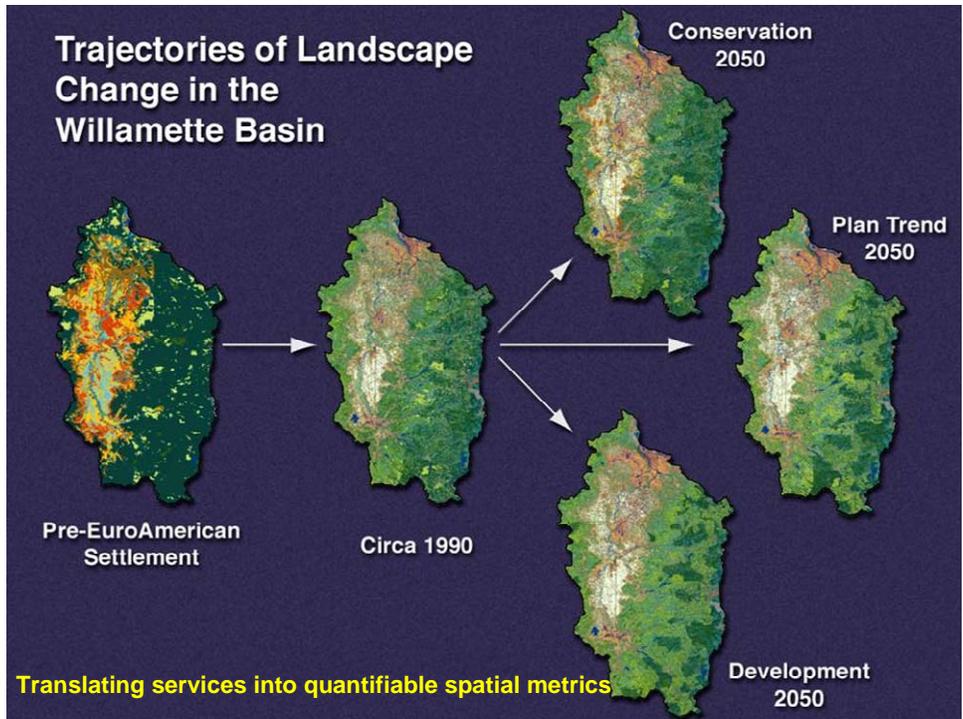
An Intuitive View of Ecosystem Services. . .

but of little help to decision-making

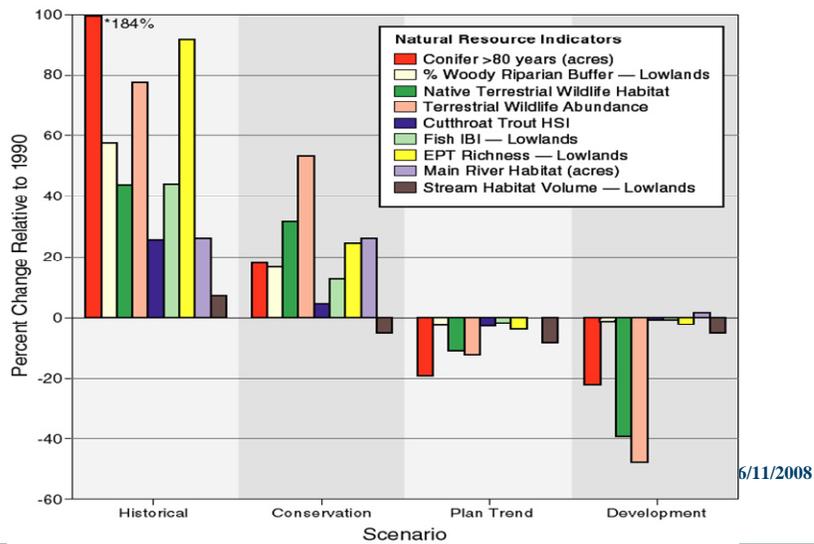


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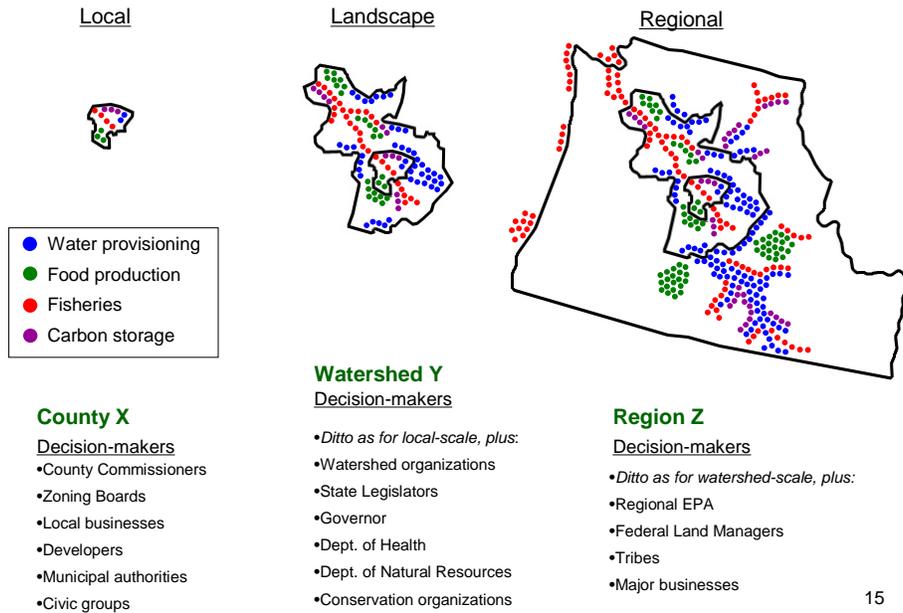
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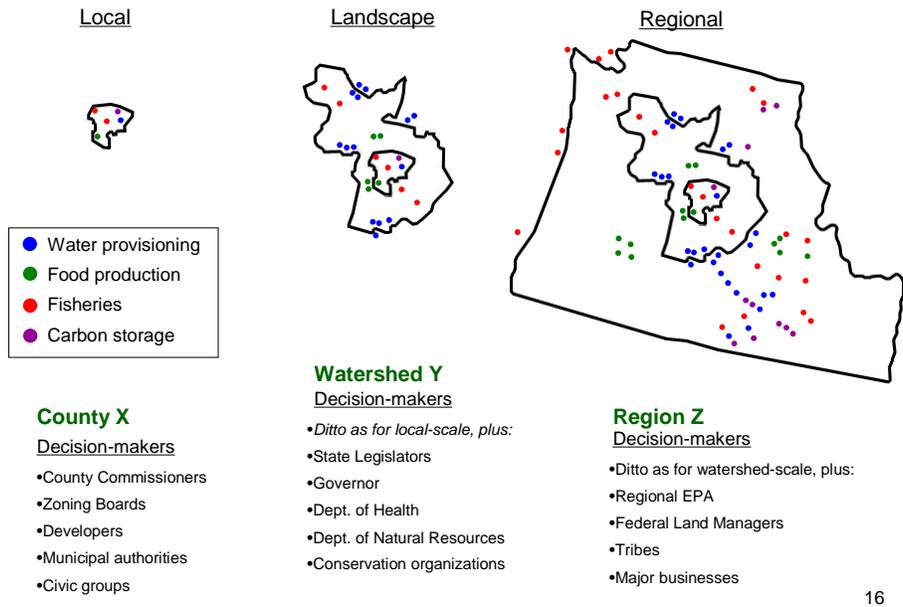
Willamette Basin Alternative Futures Scenario Evaluations

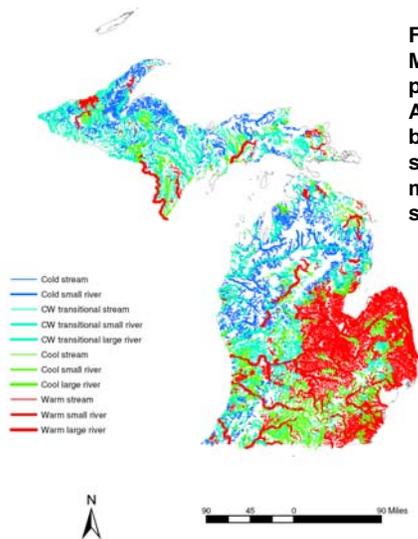


Systems Approach at Multiple Scales “Time 1”



Systems Approach at Multiple Scales “Time 2”



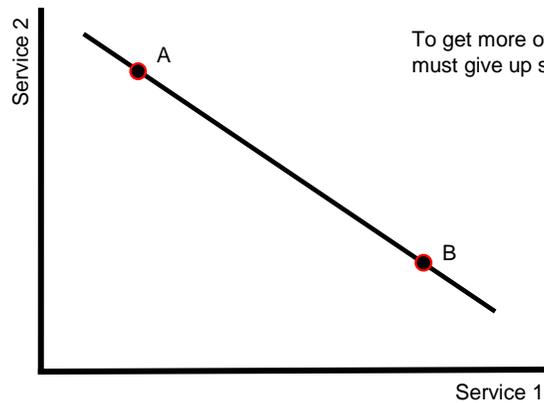


Fisheries classification of Michigan river systems used in the proposed Water Withdrawal Assessment Tool. Classification is based on catchment area and summer temperature criteria, and mapped for ~8,000 ecological river segments.

Basis of map and fisheries classification was funded by EPA STAR grant program for Ecology



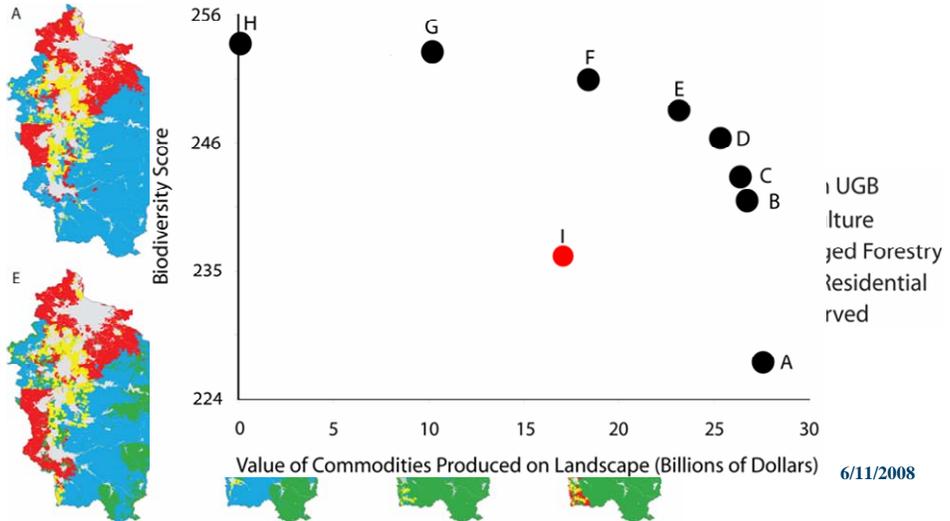
Many choices affecting services require trade-offs



To get more of service # 2 must give up some service # 1

This trade-off example limited to two services

Willamette Valley, Oregon

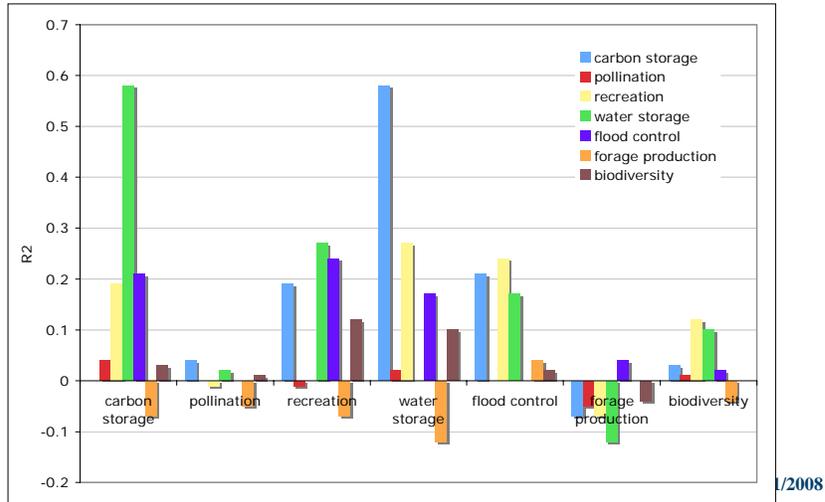


Source: Steve Polasky, et al. Applied Economics, Univ. of Minn. "Conservation of working landscapes." Unpublished data.

Still, much work remains. We need better methods for:

- 1) Opportunities to maximize bundled services
- 2) Interactions among related services
- 3) Methods to quantify trade-offs
- 4) Identifying, quantifying, and predicting "tipping points" and subsequent effect on services
- 5) Ecological approaches to managing risks to ecosystem services

Correlations of Ecosystem Services: Central Coast, California

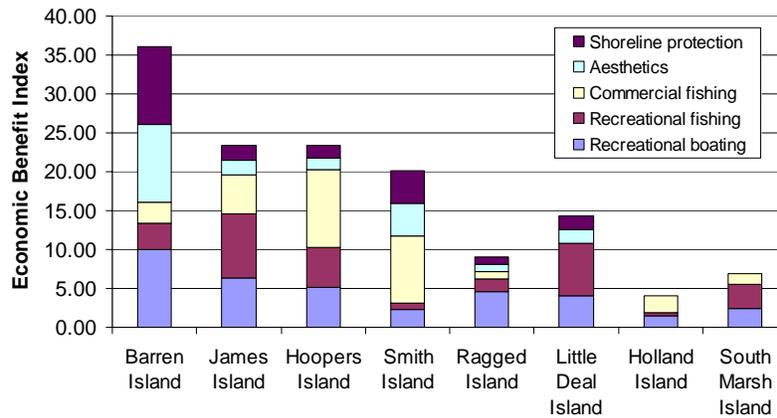


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Source: Garry Peterson (McGill Univ.), based on data of Chan et al. PLOS Biology (2006)

**Bundling Services
Economic Benefit Indicators for
Chesapeake Bay Island Sites**

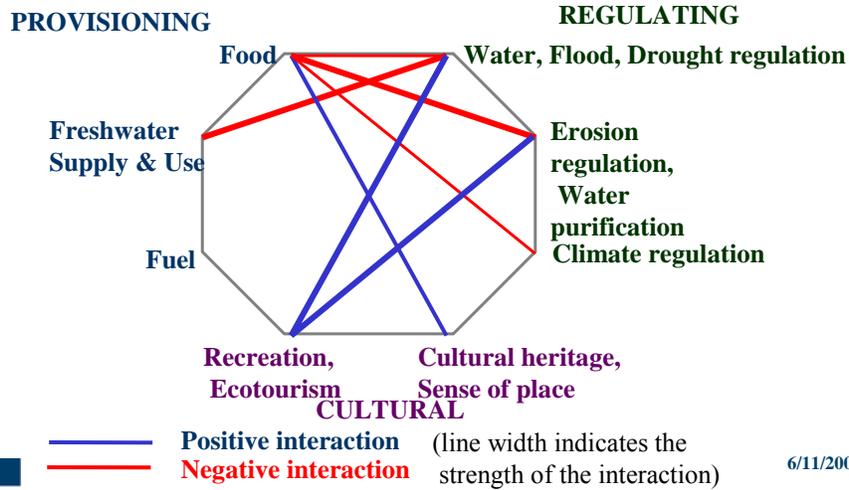


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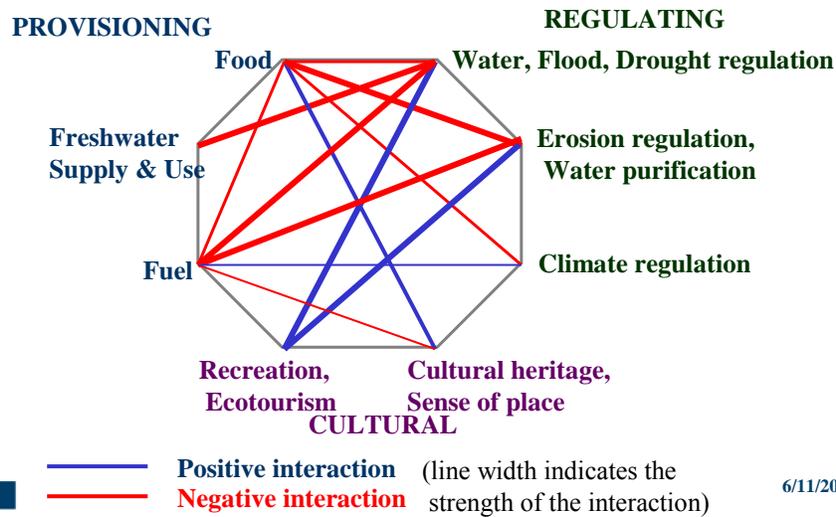
Source: Wainger et al., University of Maryland. Study of the Chesapeake Bay Islands.

Interactions of Ecosystem Services: Current Conditions



S.R. Carpenter, Northern Temperate Lakes LTER Program, unpublished data, <http://lter.limnology.wisc.edu>

Interactions of Ecosystem Services: Add Corn Biofuel



S.R. Carpenter, Northern Temperate Lakes LTER Program, unpublished data, <http://lter.limnology.wisc.edu>

1. Background: "Threshold" 6

"The separation between two distinct system behaviors."

$x_{crit} \equiv \text{threshold, iff } \frac{d^n f(x)}{dx^n} \Big|_{x \rightarrow x_{crit}^-} \neq \frac{d^n f(x)}{dx^n} \Big|_{x \rightarrow x_{crit}^+}, \text{ for any } n$

Source: D. Collins, et al., "Eutrophication Thresholds – Assessment, Mitigation, and Resilience in Landscapes and Lakes." STAR grant G4K10778. In *Understanding Ecological Thresholds in Aquatic Systems*, Progress Review, June 7 – 8, 2007. 26

2. Bayesian Analysis: Results 12

There's a 3.4% chance Lake Mendota is uni-stable
 90.3% reversibly bi-stable
 6.3% irreversibly bi-stable

There's a 32% chance that L_E has been exceeded
 15% loads have not dropped below L_O

Source: D. Collins, et al., "Eutrophication Thresholds – Assessment, Mitigation, and Resilience in Landscapes and Lakes." STAR grant G4K10778. In *Understanding Ecological Thresholds in Aquatic Systems*, Progress Review, June 7 – 8, 2007. 27



World Resources Institute: Steps in a corporate ecosystem services review

Step



Key activity

Choose boundary within which to conduct ESR

- Business unit
- Product
- Market
- Landholdings
- Customer
- Supplier

Systematically evaluate degree of company's dependence and impact on ecosystem services

Determine highest "priority" services—those most relevant to business performance

Evaluate conditions and trends in priority ecosystem services, as well as drivers of these trends

Identify and evaluate business risks and opportunities that might arise due to the trends in priority ecosystem services

Outline and prioritize strategies for managing the risks and opportunities

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THE Ecological Research Program

Highlights of the Multiyear Plan

Where are we headed and why?

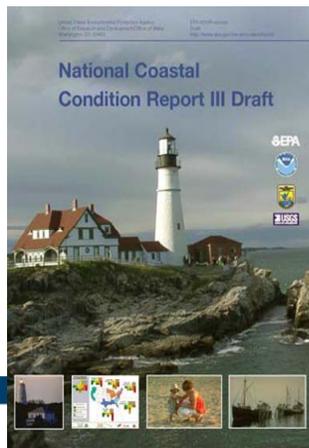
- We depend upon ecosystem services for our health, our well-being, and our economy.
- We know how to do better manage, even today.
- 15 of 24 ecosystem services are in decline worldwide.
- Ecological risks are currently managed in piecemeal fashion, i.e., by single media, single stressor, at one scale of analysis.
- Decisions affecting ecosystem services often require trade-offs.
- A proactive systems-approach shows promise for enhancing the resilient, long-term supply of services.
- Innovative use of new ecological knowledge can inform governance, laws, and policies; can spur innovations in private sector; and can increase the nation's effective environmental protection budget.

30

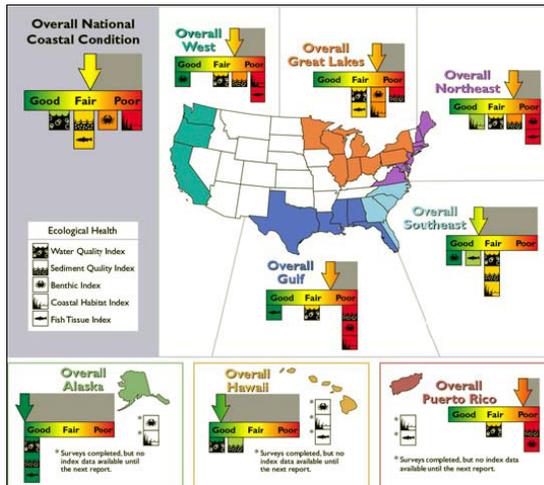
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Trends in ecosystem services for coastal areas are assessed in light of population growth and climate change

Services include: storm surge/ flood protection, nutrient cycling, fisheries, recreation, and resilient human communities

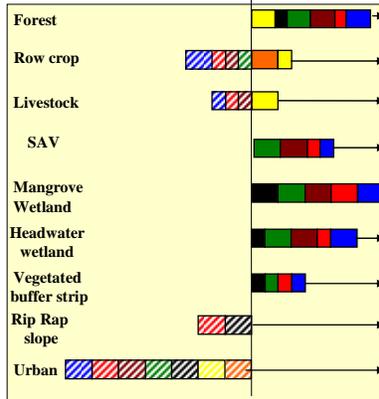


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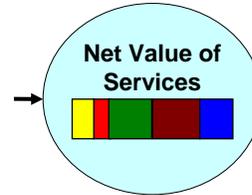
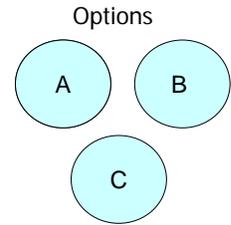
End Product

Relative Ecosystem Services
Within an Ecosystem District



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Scaling and
Aggregation
Under
Alternative
Management
Scenarios



Management
Option X

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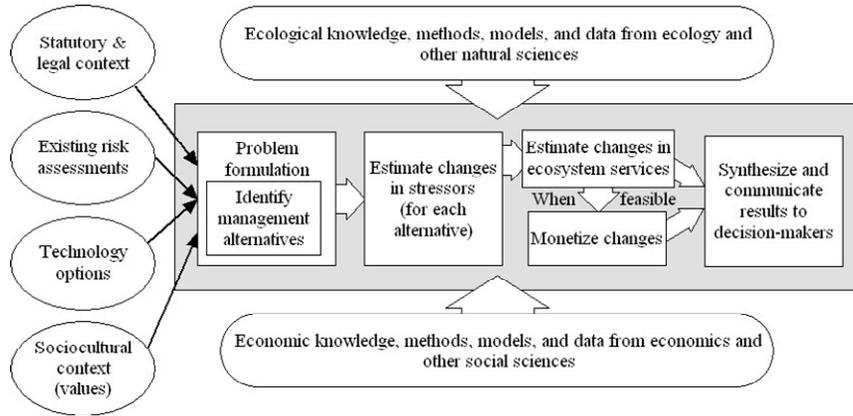
Keeping the End in Mind

- Effective Decision Support
 - Information/models/mechanisms..... to help local, watershed, state, regional and national managers make environmental management choices based on gains and losses of ecosystem services.
 - Timing—72 existing DS systems, considerable ground work to do, later development

33

6/11/2008

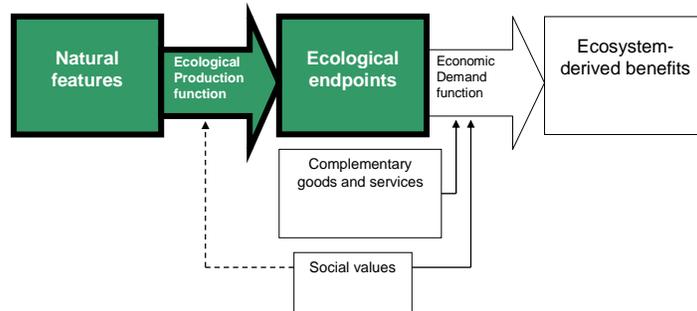
Building on Strengths of Economic Analysis and ERA



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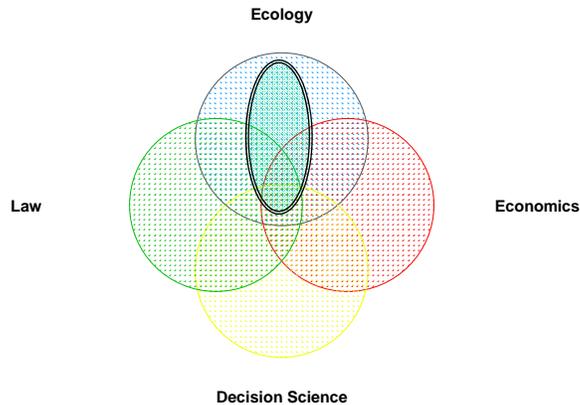
Source: EPA Environmental Benefits Assessment Strategic Plan, 2006.



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Wainger and Boyd

6/11/2008

Transdisciplinary Approach to Conserving Ecosystem Services

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Regional Centers of Excellence?

6/11/2008

ERP Elements: a three pronged approach to research on ecosystem services

- **Pollutant-based research**
 - How does a regulated pollutant affect, positively and/or negatively, the suite of ecosystem services at multiple scales?
- **Ecosystem-based research**
 - How does the suite of ecosystem services provided by a single ecosystem type change under alternative management options at multiple scales?
- **Place-driven research**
 - How does the suite of ecosystem services for within a defined area change under alternative management options/drivers?

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Projects and Long term Goals →		Eco-system Specific Studies: LTG 4—23%		Community Based Demonstration Projects: For National, Regional, State and Local Decisions (includes Nitrogen and Wetlands services) LTG 5—28%				Theme Leads
	Cross Program Themes and Research Objectives	Wetlands (19%)	Coral Reefs (4%)	Willamette (5%)	Tampa Bay (7%)	Mid-West (7%)	Coastal Carolinas (9%)	
Inventory, Map, and Forecast Ecosystem Services at multiple scales (National Atlas) LTG 2 38%	Landscape Characterization and Mapping (10%)	Ric Lopez	Anne Neale	Don Ebert	Taylor Jarnagin	Megan Mehaffey (New Hire in the future)	Deb Chaloud	Anne Neale
	Inventory and Monitoring of Services (21%)	Jack Kelley	Bill Fisher	Spence Peterson	John Macauley	Joe Flotemersch	Darryl Keith	Mike McDonald
	Modeling for Scenarios and Forecasting for different management options (7%)	Brenda Rashleigh	Susan Yee	Bob McKane	Sandy Rimondo	Russ Kreis	Steve Kraemerr	John Johnston
Integration, Decision Support and Outreach LTG 1 8%	Ecosystem Services and Human Health (2%)	Kevin Summers	Kevin Summers	Steve Klein	Lisa Smith	Betsy Smith	Deb Mangis sending name	Laura Jackson
	Valuation of Ecosystem Services (2%)	Chuck Lane	Dan Campbell & Suzanne Ayvazian	Dennis White	Sharon Hayes	Alex Macpherson	Alex Macpherson	Sabrina Lovell
	Decision Support Platform Created to Integrate Findings from Entire Program (3%)	Tim Canfield	Pat Bradley	Dave Burden	Marc Russell	Vasu Kilaru	Drew Piliant	Ann Vega
	Outreach & Education to (1%)	Janet Nestlerode	Pat Bradley	Bill Hogsett	Jim Harvey	Brenda Groskinsky	Walt Galloway	Suzanne Marcy
Eco-system Specific Studies LTG 4	Wetlands (23%)				Janet Nestlerode	Chuck Lane		Steve Jordan
Pollutant Specific Studies LTG 3	Nitrogen (5%)	Steve Jordan	Jim Latimer	Bill Hogsett	Richard Devereaux	Ken Fritz	Brent Johnson	Jana Compton
Project Area Leads	Rick Linthurst And Iris Goodman	Mary Kentulef Virginia Engle	Bill Fisher	Dixon Landers	Marc Russell	Randy Bruins/ Betsy Smith	Dorsey Worthy	Rick Linthurst Iris Goodman
				Megan Mehaffey Place Based Coordinator				

Research Activities	Applied Uses	Partners for implementation * = in progress, ** = potential
LTG 2: Framework to <i>inventory and monitor</i> selected ecosystem services nationwide	Potential inclusion in Report on the Environment or State of the Nations Ecosystems	NEON ** ROE ** Heinz Center **
LTG 2: <i>Mapping</i> selected ecosystem services nationwide	ERP clients can see distribution for existing services, use in planning	National Geographic * USGS, Geography Div.*
LTG 2: <i>Modeling</i> key interactions among services; ecological production functions; tipping points	-- optimizing service "bundles" -- standards of practice -- expert knowledge for Decision Support Platform	Gund Institute for Ecological Economics * Natural Capital Project ** Smithsonian Institution *
<i>Matrix theme leads: Cross-theme analyses</i> to identify emergent properties for <i>place-based, ecosystem-based, and pollutant-based</i> studies [LTGs 3, 4, & 5]	--cross-scale issues & dynamics --test alternative methods --identify attributes that confer ecosystem resilience	Stakeholders * EPA Regions 5,7,8, 10* Other federal agencies * Non-gov'tl. organizations
LTG 1: <i>Valuation & Tradeoffs</i> ▪ Quantitative classification of services, spatial metrics ▪ methods to depict trade-offs	-- foster interaction of "suppliers" & "users" -- foster investments to conserve, sustain services; foster markets	EPA's National Center for Environmental Economics*
LTG 1: <i>Decision support</i> ▪ Decision science ▪ Behavioral theory ▪ Business theory	-- participatory, deliberative decision-making -- engaging business community	World Resources Institute* Packard Foundation ** 6/11/2008



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In Conclusion

- It is a human centric approach
 - Guided by valuation and well-being, not constrained by it
 - Required to increase the relevance of ecology to decision-making
- Transdisciplinary approach is the ideal
 - Should funds become available, Regional Centers would be established
- It is bigger than we alone can accomplish
 - Defining the whole, however, assists in knowing where to invest
 - New partnership approaches are essential
- ORD scientists will focus on the ecological production functions.
 - Quantifying trade-offs
 - Again, accepting the challenge of the trade-offs
- The implementation plans are next critical hurdle
 - ERP scientists are preparing these plans now
 - Plans describe the "how" and "when"



Thoughts from the Office of Water on the Strategic Direction of ORD's Ecological Research Program

Mike Shapiro, DAA
Office of Water

Presented to the SAB
April 9, 2008

Potential Links to Drinking Water and CWA Program Decision Making

- Standards
- Effluent Guidelines
- Wastewater-Residual Management Support
- Watershed Restoration and Decision Making
- Wetlands Protection, Improvement, Restoration, Creation

Key Water Program Issues and Opportunities

- Changing water use patterns and flows
- Continued population growth and concentration
- Emerging contaminants including PPCPs
- Climate change impacts on current ecosystems
- Common and more sensitive metrics, indicators, measures, and ecological assessment tools

Ecological Research Program MYP

- Benefits to the Office of Water:
 - Support development of metrics, measures, and assessment tools
 - Focus on wetlands and coral reef ecosystems and on nutrients processes and impacts
 - Improve federal, state and local water program decision making
- Explicit effort needed to:
 - Connect MYP concepts to regulatory and non-regulatory programs
 - Establish common terminology

Anticipated Links to Water Program Implementation

- National Water Quality Assessments (MYP LTG 2: National Mapping, Inventory, and Modeling)
- Watershed Management (MYP LTG 1: Effective Decision Support; LTG 4: Ecosystem Assessment and LTG 5: Place-based Demonstration Projects)
- Nitrogen Pollution (MYP LTGs 3: Nitrogen Assessment, LTG 4: Ecosystem Assessment, and LTG 5: Place-based Demonstration Projects)
- Place-based Approaches (MYP LTG 5: Place-based Demonstration Projects)

Progress and Next Steps

- Endorsement of the direction – continued collaboration on the details
- ORD and OW (headquarters and Regions) have come a long way toward understanding each others' mandates
- We need to continue:
 - To identify and address terminology that impedes understanding the new paradigm, its strategic outputs and outcomes, and its potential to impact the program.
 - To complete implementation plans and APMs

Appendix F – Highlights of Responses to the Charge Questions

Charge Question #1 -- Highlights of Discussion

The Committee was unanimous in its support for the conceptual framework for the plan; ecosystem services represent the ideal integration of ecological processes and human welfare. The focus on ecosystem services provides a justification for environmental decisions/regulation based upon the dependence of humans upon ecological condition and processes. The conceptual framework for the program is thus tightly linked to the mission and agenda of the agency, as well as representing the leading ideas of the international ecological community. The vision outlined is a plan to develop the next generation of environmental management support technologies that build on risk assessment; the resulting knowledge and tools will more completely support effective evaluation of management alternatives and improved communication of benefits to the public.

That said, the Committee had a number of concerns. Most of these were related to the tension between stating an important and ambitious vision and producing a practical implementation plan for a future that includes a limited and uncertain budget. Our suggestions are related to maintaining the vision while finding the most pressing questions, scales, variables, and geographic locations.

We have 8 major recommendations related to the overall adequacy and appropriateness of the strategic direction, to improve the potential for contribution to ecological science and providing research useful to decision makers.

- The vision and direction are sufficiently important to merit substantial investment by EPA. The long-term goals of the program cannot be accomplished with current resources (funding and personnel) dedicated. We recommend that STAR and other EPA resources be directed toward this program. A great deal of research will be needed to accomplish the important goals of the program, and it is appropriate that extramural funding be focused here. The plan is closely related to all 5 Agency goals, and the Committee advises that those connections be communicated clearly to support substantially increased EPA investment.
- The vision is ambitious and important, and we would like to see the title of the document reflect this. As a challenge, we recommend that long-term goals (stretch goals) might be presented first, followed by a sequence of short-term priorities and measurable outcomes (i.e. an implementation plan). These will be the program evaluation metrics.

- The priorities should include the logic as it leads to initial goals for first efforts at addressing ecosystem services, geographic locations, and scales of the efforts. The priorities should be clear and honest about current resources and leveraging past investments.
- The program cannot be accomplished without basic science; knowledge gaps need to be identified and basic research planned to fill them. In particular, empirical data are needed to test hypotheses regarding why changes in ecosystem services are occurring, and at which scales. This will allow the key basic science questions to be elaborated in the separate sections, and provide both the rationale for and the intellectual construct for contributing to ecological science.
- A related recommendation is that the “science questions” later in the documents focus more on the basic ecological science questions.
- The intended audience and range of decision types should be more clearly described up front. A matrix or table of decision types vs. decision makers would be helpful. The issues of scale are particularly important to elaborate (local vs. regional).
- A scientific community assessment (similar to the IPCC assessments) of the status and trends of ecosystem services in the U.S. would be an appropriate and very important output from the research that is described, and a high impact, visible product from EPA that could have a large influence on decision-makers.
- We recommend an organizational plan in the document for inter-institutional collaboration (perhaps participation in the assessment would provide this opportunity). This issue arose again and again in our discussions, and while we understand the challenges associated with such cooperation, if EPA were to lead such an effort, the payoff would be large for science and management, and a visible contribution to a national initiative. One venue for such an assessment would be a collaboration with the National Center for Ecological Analysis and Synthesis, which could provide data analysis support, as well as support services for a series of workshops.
- There is a strong connection of the current vision to the long history of risk assessment that EPA has been engaged in. We recommend that this connection be explicitly discussed in the plan. The relationship between ecological risk assessment and its application and ecosystem service valuation needs to be described. Ecosystem services assessment will bridge risk assessment and selection of management strategies to achieve performance in line with a sustainable future.

Long-term Goal 1—Effective Decision Support

Effectiveness of Decision Support

- Goal is appropriate and essential
- Important to recognize and incorporate need for outreach and education (OE), ecosystem service valuation (ESV), and decision support (DSP)

Structure of Meeting the Goal

- 4 elements (HHWB, ESV, OE, DSP) are important, but not logically structured
- HHWB and ESV are not logically distinct
→ should be combined/integrated
- As conceived in plan, OE is part of development of DSP (identifying needs of users) → should be combined/integrated

Means of meeting goal: Valuation

- Valuation is a major research undertaking by itself (CVPESS)
- ORD doesn't have in-house capacity to do this
- Commitments from internal (NCEE) and external (NGO) partners are not sufficient
- MYP should focus its efforts on ecological production functions (not assessment of valuation methods)
- Still requires interdisciplinary approach throughout to identify *services* (contributions to human populations)

Means of meeting goal: DSP

- Need better identification of target audience/users (OE part critical)
- Specific decision-aiding tool vs. clearinghouse?
- If decision-aiding, problem with site-specificity (both ecology and values)
- Timing and nature of coordination with other work products?

Means of Meeting the goal: OE

- Assessment of needs of decision makers is critical
- Broad education about ES could be very useful
- Participatory (deliberative) processes and “teaching teachers” require specific expertise
- ORD has not historically been involved in OE
- A significant move in this direction would require a new set of skills if done in-house
- Opportunity for partnering

Feasibility of meeting goal

- Wide variation in context/needs → difficult to develop decision-aiding tools that can apply to all
- Design of DSP could be very time-consuming and costly
- ORD does not have internal capacity
- Commitments from other units (e.g., NCEE and NGOs) not sufficient
- Overall allocation of resources within ORD to this goal are not commensurate with the central role it is given in MYP
- Timing of coordination with other goals is unclear and potentially problematic

Feasibility of meeting goal

Not likely to be able to achieve this goal in 5 years

Major concern if success/failure of MYP is defined in terms of meeting this goal *within 5 years* (and metrics focus on use of DSP)

Long-term Goal 2—Mapping, Modeling, and Monitoring Ecosystem Services

- ERP should develop forecasting models to predict how human activities result in changes to ecosystem services

- Atlas should link to models.
- Review all current NIMM programs by “the Federal family.”
- Regular, high visibility account of ecosystem services (the IPCC model).
- “Community of Practice for Modeling:--where will modelers come from? Need to invest in next generation of modelers.

Long-term goal 3—Pollutant Specific Studies (nitrogen assessment)

- Background information informative and convincing.
- Description of research too general-should improve in implementation phase.
- What is fundamental research question?
- Case for including N Assessment not clear or convincing.
- Nr assessment is a cross-media approach.
- ORD should partner with rather than duplicate research by others.
- Both positive and negative effects of Nr must be examined.
- Why choose N rather than P or some wholly negative ion like Hg?
- Concentrate on widely distributed ecosystems like wetlands and terrestrial systems.

Long-term Goal 4—Ecosystem Studies

- Clarify purpose of this effort by incorporating some of Wednesday's powerpoint presentation, including "visionary- big picture" focus, vs. addressing the complex details in follow-up Implementation Plans. Show nice Oregon examples.
- Acknowledge the 2007 SAB report advancing ecological risk assessment and the issues of spatial and temporal scaling.
- Critical to establish "baselines" and "pre-" conditions to evaluate and validate the ecoservices/valuation models. If biophysical relationships with effects/services are weak (e.g., spatial/temporal uncertainties), then predictions of services/valuation will be meaningless. These details will be in the implementation plans which should be hypothesis driven with experimental designs that allow for model development and improvement.

- Build on the risk assessment process.
- Provide justification for selection of endpoints and their relationship to services.
- Suggest coral reefs be replaced with a terrestrial or urban dominated ecosystem or just deleted with focus on wetlands only, but freshwater to coastal.
- For success, there will need to be basic/applied research, which will require increased ORD funding, partnerships with NSF, and better defined linkages with NOAA and key DoI agencies. This includes research on linking ecosystem attributes with services, valuation determinations, and ecosystem processes modeling. EPA should spend significant up-front energy in building and defining these important partnerships and building a case for increased research funding. This cannot be done with EPA scientists alone.
- Better describe the iterative, feed-back component of this approach which will be critical, given the infancy of this field and the need to continual adapt the process/approach.

Long-term Goal 5 – Place-Based Demonstration Projects

- Organizing principles have been proposed by the Committee for choosing specific project areas
- The choices made by EPA need to be transparent, based on these organizing principles
- Clarity is required regarding why project scales differ
- There must be coordination and attention paid to interrelationships
- Transboundary issues must be considered

Charge Question # 3 – Logic model Approach

- The Committee considers the logic model approach to be a reasonable way to address the questions that comprise the MYP
- By placing efforts into the structure of a logic model, the ERP can in essence work backward, from desired outcomes, and can improve the potential that research efforts will be appropriately framed.

- The outputs and outcomes listed are very general, and considerable thought and attention must be put into ensuring that the appropriate specific outcomes are formulated.
- It will be critical that careful analysis and oversight of these outputs and outcomes occurs through time, and that feedback from outcomes is used to reevaluate both the necessary inputs and the activities, thus completing the loop suggested in the ERP's Figure 4.
- It will be important to make sure that the outputs lead to useful outcomes; if they do not, then the ERP must address and adjust their activities. Such feedback loops are not explicitly described. In addition, this mechanism will be an important way for the ERP to get feedback on the quality and utility of the research and tools that they are providing.
- The model shown in Figure 4 appears to be internal to the ERP, even though many partners will be collaborating in the research activities. It is important that the transfers to other users be collaborative in nature, and not passive.
- The relatively small investment in outreach and education, only 1% of the total effort overall, will not provide what will be necessary to ensure these collaborations and transfers.

Charge Question #4 – Challenges to Achieving Overall Program Goal

Concerns/ challenges related to question or scope of ERP

- Huge & ambitious goals that are not well-linked to the timeline.
- Redundancy & disconnection with work accomplished or currently underway by other agencies & organizations.
- Emphasis on human health and well-being makes the research plan vulnerable to distortion of research and exclusive focus on utilitarian values
- How to incorporate the impact of multiple stressors in research questions/goals

Challenges related to process/methodological approaches of plan:

- Identification of appropriate spatial and temporal scales of analysis & application
- Availability of data sets
- Adequately & explicitly addressing uncertainty.
- Appropriately valuing ecosystem services
- Lack of specificity in tactical/operational plans & implementation strategy

Challenges in application to decision-making (relevance, outreach, education)

- Difficulty engaging stakeholders due to diverse needs, capabilities, and receptivity to learn
- No clear linkage to risk assessment --- but this approach is different b/c it more explicitly accounts for the benefits

- Conflicting jurisdictional responsibilities
- Difficulty in partnering & promoting interagency interactions.
- Linking directly to policy & regulatory process

Challenges related to resources

- Insufficient resources & institutional capacity to perform necessary work
- Not the correct mix of human capital/ skill sets in the agency
- Very limited budget (1%) allocated to outreach, which is unlikely to be sufficient. Clients are unlikely to self-train on web. This is probably a huge area.

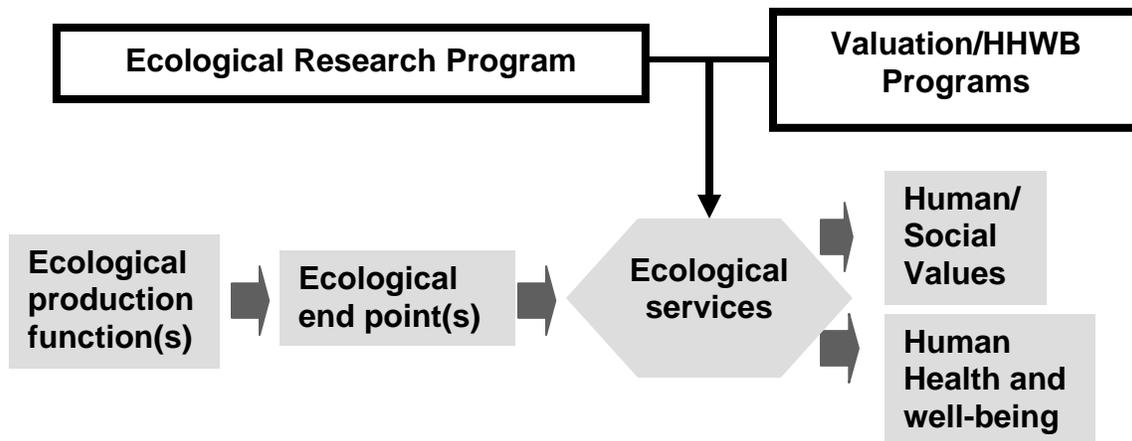
Charge Question #5 – Suggestions for Measuring the Progress of the Program

The goals of the ERP vision and the objectives of the to more detailed research implementation plans should focus on the ecological structures and processes that contribute toward the production of goods and services that contribute to human health and well-being.

- Goals and objectives should be monitored, reevaluated and adjusted as needed to capitalize on evolving and emerging partnerships and other opportunities to leverage the limited resources of the ERP.
- Specific research objectives should be operationally defined so that progress and attainment can be clearly determined and quantified.
- The stated goals and research objectives of the ERP should be focused on the identification and articulation of the ecological processes and structures that that contribute toward ecosystems services that have been identified in collaboration with medical and social scientists in the Agency.
- In the specification of ecological production functions for targeted ecosystems services the ERP should maintain a broader ecosystems perspective to assure that the effects of multiple stressors on the multiple services that arise from these systems are adequately acknowledged and addressed.

Given the visionary intentions of the current document and the lack as yet of detailed research implementation plans, it is premature to prescribe specific measures to evaluate annual performance/progress goals for the program. As development of the research plan goes forward the authors of the plan should specify goals and associated research objectives for the individual projects and for the program as a whole that are within the purview, expertise and control of the ecological research program. Specific objectives should be operationally defined in a way that allows clear determination of whether they have been achieved and that can be subjected to quantitative measures of the extent of accomplishment. At this formative stage of the new ecosystems services paradigm, the program assessment should include monitoring, evaluation and adjustment of objectives as partnerships and collaborations within and outside the Agency evolve. Such an adaptive management approach requires flexibility and vigilance to capitalize on opportunities that arise as the program continues to develop, and an explicit plan for coordinating activities and products across the multiple projects and themes of the ERP.

It is appropriate for the ERP to set research goals and products based on their contributions toward ecological services and through those services toward protection of human health and well-being. However, the ERP should not claim responsibility (or allow itself to be held responsible) for achieving the ultimate goals of the entire EPA research and regulatory mission. As illustrated below, the identification of relevant ecological services must be based on a dialog between ERP ecologists and the medical and social scientists, regulators and decision makers representing EPA programs that are responsible for determining and valuing environmental and human health and well-being goals of the Agency. The key role for the ERP in this context is to research and articulate the appropriate ecological end points and the intermediate ecological structures and processes (ecological production functions) that contribute to identified services. Thus, the evaluation of the success of the ERP should be gauged in terms of progress toward effective specification of relevant ecological endpoints and systems, with special attention to the effects of individual and multiple stressors that come under the purview and regulatory control of the EPA. The ERP has the further responsibility to the Agency and to citizens of the country and the world to investigate and bring to attention ecological processes and structures that contribute to additional, non-targeted ecological services and potential services.



Charge Question #6 – Recommendations to Enhance the Ability of the Program to Leverage Resources

Physics of Implementation:

- Beware of being perceived as top-down; there needs to be more of a bottom-up input. Need to survey a broader community (e.g., municipality land managers to industry).
- MOU with federal partners need to be more than an agreement to cooperate; need to have specifics of who will do what when there is overlap; how to share resources.

- Partner with other agencies within the U.S. (e.g., USFS, NPS).
- If add a terrestrial place-based or ecosystem project, can take advantage of USFS resources and expertise.
- Funding incentives for cross-agency collaborations.
- Utilize SGEs as part-timers to bring expertise to particular issues.
- Need a section in vision paragraphs that outlines how will achieve outreach and education.

Financial Support For Implementation:

- EPA leverage = people, infrastructure, data. Use these to offer in-kind services to collaborate with other groups/agencies.
- Need to consider reallocation of resources.
- Partner with other agencies outside of U.S. (transboundary issues)
- Partner with professional societies, sponsor sessions, symposia (SETAC, NABS, ESA, NAAEE? [enviro ed society]).
- Partner with private business, foundations, NGOs through a non-profit foundation (\$\$\$).
- Make STAR a priority
 - Enhance fellows program.
 - Provide funds for non-targeted, exploratory extramural research to develop tools and procedures for the MYP goals.
 - Develop competitive grants to run summer credit workshops for teachers
- Require leverage from universities to obtain funding.
 - Reduced indirect costs
 - Tuition & fee waivers
 - Provide matching funds and supplements for graduate and teacher education

Education and Outreach:

- Partner with professional societies/NGOs to develop education and outreach.
 - Workshops, symposia, sessions @ meetings
 - WIKI blogs

- Presentation materials
 - Media resources including TV Cable educational networks
 - 10-15 min video clips
-
- Partner with community groups to enhance education & outreach.
 - Take advantage of traditional eco-knowledge and values.

Appendix G – Key and Emerging Issues of Ecological Concern

Key and Emerging Ecological Issues

Water Quantity and Quality

- Water quantity (extremes), and quality (including emerging contaminants, nutrients and solids).
- Water demand and scarcity - drinking and municipal/industrial use – ground and surface waters.

Land Use

- Land-use change (loss of habitat, urban/suburban development and sprawl).
- Within the context of restoration and reconciliation ecology, understanding the interplay between humans and the environment (i.e., how the environment affects human land use decisions and how land use decisions affect the environment) and how that interplay constrains restoration success potential.
- Predicting how economic incentives and policies drive land use change associated with alternative energy sources (especially biofuels and wind farms), determining regional/global ecological consequences of those land use changes, and identifying tradeoffs in energy production and environmental conservation.
- Sustainable management of landscapes at the Urban - Exurban interface 5-10 year growth horizon for city.
- Population growth and distribution: urbanization.

Climate Change

- Anthropogenic climate change.
- Climate change and effects (e.g., sea level rise, severe weather, flooding, drought, and forest fires).
- Predicting responses of ecological communities and ecosystems to climate change and understanding how various/multiple anthropogenic stressors mediate these responses.
- Effects of climate change—sea level rise, severe weather, flooding, drought and forest fires.
- USA carbon and nitrogen management strategies, with the aim of developing lost cost techniques that can be exported globally.
- Global climate change especially as it will alter or change ecosystem values, services or products.

Contaminants

- Contaminants: existing (e.g., mercury) and newly recognized (e.g., pharmaceuticals in water), and emerging (e.g., engineered nanomaterials).

Exotic Species

- Exotic species.
- Invasives.
- Understanding the role of invasive species in ecosystems, how their presence affects ecosystem services and the persistence of those services in the face of global change in climate and land use.

Wetlands

- Enhancement of the areal extent of coastal wetlands through restoration of preexisting wetlands and beneficial use of dredge spoil.
- A dramatic increase in EPA involvement in the restoration of coastal wetlands of Louisiana and other coastal areas where wetlands offer significant protection from wind and surge impacts of tropical cyclones.
- Development of strategies to manage river flooding events by reestablishing the role of wetland and other “sponge” areas from upland alpine bogs to riverine cypress swamps; and the recharge of aquifers, ensuring minimal surface contamination.
- Wetlands and their role in flood control.

Air Quality

- Managing air quality to reduce and eventually stamp out the explosion in respiratory ailments such as asthma from air pollution and contamination from industrial sources. As global warming continues asthma could reach epidemic proportions, especially in the poorer southern states.
- Local to global air pollution.

Education

- Environmental Education of Children to achieve behavioral change which supports a sustainable future.
- Educate the next generation of Scientists and policy experts Sustainability Science (Environmental Science and Engineering).

Other

- Nutrient (primarily nitrogen) inputs.
- Identifying nonlinearities and thresholds of stressors/anthropogenic disturbances/landscape change that when exceeded trigger major and possibly nonreversible ecological change.
- Lack of an extramural research program.
- Habitat loss/alteration/fragmentation.
- Multiple stressors and causality.
- Effects of development—decreasing water supply, air pollution, habitat changes.
- Preservation and restoration of watersheds.
- Lack of causative models for the prediction of change.
- Free Market Environmentalism - Effective integration of ecosystem service markets as alternative strategies to achieve environmental protection.

- Sustainable use and management of natural resources (this includes but is not limited to energy use).
- Disease ecology (i.e., relationships between human disease and ecosystems)