UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

September 30, 2009

EPA-SAB-09-019

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

      Subject: Consultation on EPA's Implementation of the Ecosystem Services
                 Research Program

Dear Administrator Jackson:

      In 2008, the Science Advisory Board (SAB) reviewed EPA's Ecological Research Program Multi-Year Plan (Plan). The Plan articulated a new strategic direction for ecological research focused on understanding ecosystem services and their contribution to human health and well-being. In its advisory report, the SAB expressed strong support for the Plan but recommended improvements in several areas. In 2009, EPA's Office of Research and Development (ORD) requested an SAB consultation regarding implementation of the Ecosystem Services Research Program. ORD asked the SAB to assess whether the Agency had responded appropriately to the previous SAB recommendations, comment on the scientific merit of ongoing research projects, and offer additional recommendations for meeting the challenges facing the research program as the projects move forward.

      The SAB Ecological Processes and Effects Committee Augmented for the Consultation on EPA's Ecosystem Services Research Program met on July 14-15, 2009, to discuss the research program, and Committee members provided the enclosed written comments in response to the Agency's charge questions. This letter highlights key points resulting from the Committee's discussion. EPA's Ecosystem Services Research Program is bold, innovative, and necessary. The program focuses on research to understand the ways in which policy and management choices affect the type, quality, and magnitude of the goods and services ecosystems provide to sustain human well-being. As such, and because it is taking an integrated multidisciplinary approach to addressing multiple stressors acting within and across media, the research program has the potential, with appropriate support, to transform the way environmental decisions are made within and outside of EPA. Products of the research program should advance the practice of risk assessment by providing information for improved consideration of risks and benefits in environmental decision-making.

As further discussed in the enclosed Committee member comments, ORD has been responsive to many of the SAB's previous recommendations. In particular, Committee members found that EPA has excelled in developing creative research partnerships with U.S. academic scientists and other federal agencies, and has begun to develop international partnerships. The partnership approach is crucial to the success of the research program. It is important that ORD focus on preserving these partnerships and making them even more effective. In particular, accelerating development of international partnerships and consideration of transboundary issues is essential because ecosystem services are not limited by political boundaries. The research program would benefit from additional resources that can be deployed to partners when opportunities exist to leverage work that will meet research program goals; the program has a strong track record in using this approach.

Committee members encourage ORD to take advantage of opportunities to continue developing tools that will allow stakeholders to quantify ecosystem services using local data and to link development of research program products to the immediate needs of EPA programs. For example, the ecosystem services research being conducted by ORD should be of considerable value to EPA's Smart Growth and Sustainability initiatives and would also provide a useful framework for EPA's Report on the Environment.

EPA's Ecosystem Services Research Program has made considerable progress but a number of challenges must be addressed. The considerable potential of the program is unlikely to be achieved with its current level of funding and staff. Additional resources are essential to accomplish planned research and to support activities such as travel to meetings and acquisition of sufficiently powerful computer software for mapping, monitoring, and modeling efforts. It is also crucial to provide a clear indication of the uncertainty associated with ecosystem services maps and models developed by the research program. This will require the continued efforts of EPA staff and outside experts such as those who were instrumental in developing probability sampling schemes for EPA's Environmental Monitoring and Assessment Program. In addition, socioeconomic data should be included in the Ecosystem Services Research Program maps and models in order to begin addressing environmental justice issues.

Because this was a consultation, there will be no formal report from the SAB. Enclosed are my summary of key points discussed by the Committee members and their individual comments. We hope these comments are helpful to EPA and look forward to providing additional advice as the Agency continues to implement the Ecosystem Services Research Program.

Sincerely,

/Signed/

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

cc: Dr. Deborah Swackhamer, Chair
    EPA Science Advisory Board

Enclosures:
  Enclosure 1: Committee Roster
  Enclosure 2: Summary of Key Points Discussed
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U.S. Environmental Protection Agency
Science Advisory Board
Ecological Processes and Effects Committee Augmented for the Consultation on EPA's
Ecosystem Services Research Program

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Dr. Thomas Armitage, U.S. Environmental Protection Agency, Washington, DC

* Unable to attend the July 14-15, 2009 meeting.

Enclosure 2: Summary of Key Points Discussed from Dr. Judith Meyer, Committee Chair

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Current Status and Direction of the Ecosystem Services Research Program

- **The Ecosystem Services Research Program (ESRP) has been responsive to many of the previous SAB recommendations.** However, in some cases it was not possible to comment on EPA's responsiveness because a revised multi-year plan and detailed implementation plans were not provided to the SAB Committee. It appears that EPA has tried to move in the directions recommended by the SAB, where feasible (given resource constraints). The documents and presentations given to the Committee for this consultation provided clearer justifications for the research direction than the previous multi-year plan and also demonstrated research program progress. However, a more transparent explanation of the process for selecting place-based demonstration projects is still needed. As previously recommended by the SAB, EPA has recognized its lack of expertise in the area of ecosystem valuation and has shifted its focus toward ecological research and the development of ecological production functions. The Agency has been able to hire relevant experts as Special Government Employees in disciplines not represented by existing staff. These individuals have added impressive talent to the program. Consultation with EPA program offices has occurred and this appears to have affected the development of implementation plans.

- **Forging additional partnerships between ESRP and other parts of EPA is essential for ESRP's ultimate effectiveness.** An important direction to take will be establishing stronger links between ecosystem services and human health. A clear statement of how assessment of ecosystem services will improve risk assessment and risk management at EPA would also make the benefits of the program more apparent to other parts of the Agency. Showing how the conceptual models in the place-based studies relate to the risk assessment paradigm will further demonstrate the relevance of ESRP activities.

- **The ESRP has the potential to provide a unified approach to the use of spatially explicit data in decision making.** The SAB previously reviewed a number of geographic information (GIS) based tools developed by EPA (i.e., Critical Ecosystem Assessment Model, Regional Vulnerability Assessment Program, Geographic Information System Screening Tool) and commented that EPA did not have a unified single accepted framework for using spatially explicit information for environmental decision-making. The ESRP can provide such a unified framework. However quick and confirmed demonstration of the relevance and utility of the program is needed to build support.

- **The ESRP does not appear to have addressed the SAB's previous recommendations concerning use of life cycle analysis.** The SAB previously recommended that EPA consider the use of life cycle analysis to visualize and assess alternative actions relative to management alternatives. It would be useful for the ERSP to further consider the use of such analyses and to more clearly identify where they are already being done.

- **As previously recommended by the SAB, the ESRP has achieved greater balance between research to develop decision support tools and the other parts of the program.** The ESRP has retained some of the previously proposed work on the decision support platform, but has scaled this back to a more feasible plan with a more realistic timetable. In addition, it has scaled back its overly ambitious goals regarding valuation and contributions to human well-being. In some cases the balance may have shifted too far away from understanding the contributions of ecosystem services to human well-being. In particular, development of an index of well-being holds promise and could receive greater emphasis. In this regard, it may be useful for the ESRP to hire an expert in the relationship between environmental condition and human health. It is appropriate that most of the emphasis in the ESRP is on quantifying ecosystem services, but the research will be incomplete until benefits can also be understood.

- **The ESRP has made considerable progress in the 15 months since the SAB review of the draft Strategic Multi-Year Plan.** Although implementation of the ESRP has been impeded by lack of sufficient funding, good progress has been demonstrated in a number of areas. For example, the ESRP has taken important steps to establish partnerships and leverage resources. In addition, it has hired outside experts to supplement its limited expertise in some areas. ESRP appears to have made progress toward developing the decision support framework, collecting information (data, models, etc.) that might be useful to policy makers concerned about ecosystem services. However, the success of the program is still dependent on expertise that exists outside of EPA. Additional program funding is needed to gain access to outside expertise thorough various mechanisms. In addition, more should be done to publicize the products of the program. Providing a demonstration of the applicability of the program (e.g., to Superfund or wetlands mitigation) should be a high priority.

- **The ESRP is making efforts to form partnerships within and outside of EPA but it will be important to continue developing partnerships with other federal programs (e.g., Long Term Ecosystem Research Program Sites, and the Natural Resources Conservation Service) and international organizations, particularly in collaboration with the Millennium Ecosystem Assessment.** The outreach component of the program, in particular, needs strengthening and additional partnerships should be established in this area. EPA should also clearly identify the parts of the program that the Agency can execute without the additional cooperation of partners, and the parts that require outside assistance. The ESRP is complex and its components are highly interconnected. It is unlikely that all of the various partners are going to be able to fully carry out their planned or promised roles. A realistic assessment of the relative reliability of each partner is needed. This assessment can be accomplished though clear mutually agreed upon statements indicating what the program requires from the partners and what will not be accomplished if their roles are not fulfilled. It would be prudent for the directors of the ESRP to consider contingency plans now.

Implementation of the Integrated Pilot for Reactive Nitrogen

- **The integrated pilot for reactive nitrogen has established linkages with other aspects of the program – wetlands and place-based studies in particular.** Although linkages have been established, there are many relevant research projects on nitrogen that are being supported by the National Science Foundation and the National Oceanic and Atmospheric Administration and additional interactions could be established. In addition, several key issues should be addressed. Since nitrogen cascades chemically through different media and ecosystems, the modeling that EPA is conducting should help identify the most effective point of intervention rather than evaluating reactive nitrogen medium by medium and problem by problem. EPA should also consider which metrics, or combination of metrics, are most effective in setting priorities for managing reactive nitrogen within a framework of ecosystem services. In addition EPA should consider effective ways to enhance denitrification without creating additional amounts of N_2O and focus on managing reduced forms of reactive nitrogen such as NH_3 and NH_4. This program offers the opportunity to illustrate the concept of tradeoffs in decision making. Linkages between this program and the modeling program will be essential as there are real problems with linking models together and the compounding of uncertainties.

- **Nitrogen was a good choice for pilot studies because it can exert both positive and negative impacts, is widely studied, and is important to all media under EPA's purview.** The Long Term Ecosystem Research conceptual framework appears to be appropriate and the roadmap concept for integration also seems appropriate. However, the actual staff time allocated to the effort appears to be too small to accomplish all necessary tasks. Progress has been made but the SAB Committee has not yet seen the implementation plan.

Implementation of Mapping, Monitoring, and Modeling Themes

- **The SAB Committee did not receive enough information to assess how the ESRP modeling program is progressing.** The lack of information about the modeling program is of considerable concern because other parts of the ESRP rely upon models. Given the centrality of models in all other aspects of the program, the apparent lack of progress in this area appears to threaten the success of the ESRP. The modeling program should be one of the areas where program integration is most obvious and is also a part of the program where issues of uncertainty should be addressed.

- **The mapping work being conducted by the ESRP will provide useful products, but socioeconomic information should be incorporated.** The maps that are being developed should be able to show locations, status, and changes in ecosystem services, although it is not clear how they will be able to demonstrate the more dynamic aspects of ecosystem services (i.e., ecological production functions and tradeoffs). To address issues of social equity and social choice, the maps will need to be linked with socioeconomic information, and it is not clear how this is being accomplished. This will require coordinated assessments of what people need/want/care about (and when and

where) and what proximal (and perhaps more remote) ecosystems are capable of sustainably contributing toward meeting those needs/wants/cares. An atlas of ecosystem services requires a joint mapping of ecosystems (in bio-ecological terms) in association with human social values. Most of the examples provided actually map ecological endpoints, ecosystems and/or ecological conditions that contribute to the provision of some services to some human population.

- **The focus on land use decisions in the mapping program seems to be unusual for EPA since the monitoring program is focusing on water-related ecosystem services.** It is not clear when decision-makers will be included in the process. Some understanding of the type of data needed to make decisions would provide important guidance about the structure of an atlas of ecosystem services. The structure and application of an atlas is still relatively general in concept and it is unclear what spatial scale and level of resolution will be used. The mapping group should consider using the place-based studies as the context for developing the atlases.

- **The decision of the monitoring program to focus on water-based services seems to be appropriate given EPA's current monitoring programs.** However, the mapping program emphasizes land use decisions and therefore the linkage to the monitoring program is not clear.

- **EPA should continue to develop the Analytical Tools Interface for Landscape Assessments (AtTILA).** These tools will allow users to calculate ecosystem services using local data and this will lead to a greater level of stakeholder support.

Implementation of Place-Based Studies

- **The conceptual models developed for the place-based studies lack consistency.** The use of completely different conceptual models for each element of the ESRP is confusing. Using similar conceptual models would facilitate cross-comparisons and testing. The national program should therefore exert direction so that the conceptual models have a consistent framework. The diversity of approaches in the different studies is indicative of a young science and may be a reflection of local priorities and needs of decision makers. However, some national direction and consistency is essential. For example, the concept of a base year as used in the Midwest could be applied in other place-based studies. National guidance on stressors and services to be considered in the place-based studies could also be useful. Clearly all of the stressors and services addressed in the program are not applicable to all sites, but they should be considered at each site. All of the place-based studies are also considering how to quantify ecosystem services and develop ecological production functions. National guidance and coordination to assist these efforts would be useful.

- **EPA should consider development of a framework for implementation of place-based analyses of ecosystem services.** Additional work is needed to determine how the specific locations of place-based studies are widely representative of major ecosystems upon which humans rely and the extent to which findings of the place-based

investigations can be generalized to other systems or geographic areas. One concern cutting across all of the projects is that the future scenarios are still to be determined. Currently, there is insufficient information to evaluate the relevance/likelihood of the scenarios. For each demonstration project, the crosscutting themes seem to be explanations of topical areas that overlap rather than descriptions of ways in which the projects will be linked. The decision support framework team should work closely with the place-based studies teams to test approaches for bringing together the mapping, monitoring, and decision-supporting tool development.

- **The place-based studies should include international partners.** EPA must be able to deal with pollutants and other stressors moving across national boundaries. The U.S. transports air pollutants to Canada, and some U.S. watersheds cross the Canadian border. There is evidence that mercury and other persistent pollutants are transported to the U.S. from Asia. Without accounting for these pollutants, estimates of benefits or ecosystem services losses are inaccurate. Work with international partners is necessary to address these issues. Transboundary issues even apply to the Tampa Bay, Willamette, and other case studies because materials from outside the study areas can be transported into the region. Furthermore, it is important that ESRP work with researchers in Europe, Australia, and China who have been making considerable progress in developing the science of ecosystem services.

Implementation of Ecosystem Specific Studies: Wetlands

- **ESRP wetlands research has the potential to provide products currently needed by EPA Program Offices.** The need for assessment of ecosystem services and benefits from wetlands protection and mitigation has been identified in wetlands mitigation rulemaking. Current methods for assessing wetlands services and benefits have fundamental flaws. Therefore, research to develop methods to quantify ecosystem services would have an immediate benefit to those within EPA who write permits and consider the appropriateness of proposed mitigation banks. The wetlands research theme has the possibility of serving as the best ESRP model for demonstrating the advantages of the ecosystem services approach.

- **The benefits that can be derived from wetlands should be more clearly identified.** Wetland services such as fisheries support and wildlife support must be expressed in clear unambiguous terms. Given the importance of understanding the linkage between stressors and wetland ecosystem function, the ultimate research objectives need to be clarified.

Implementation of Decision Support Activities

- **EPA faces a number of challenges to achieving the goals of the Decision Support Framework.** Lack of resources is a general problem hindering ESRP activities. In addition EPA does not have an existing framework for the use of ecosystem services as the basis for regulatory mechanisms such as permits and enforcement of permits. Therefore, early demonstration of the utility of the program is essential. ORD does not

have the expertise to provide complete decision support. However, ORD's strength is in identifying and quantifying ecosystem services and predicting how the provision of these services would change in response to stressors. A key part of this is an analysis of trade-offs. ORD should have the expertise to provide information about these tradeoffs without the need to explicitly value any of the associated changes (for which it does not have the necessary expertise). Information about these tradeoffs (i.e., ways to identify and quantify them) would be an important input that could be provided by ORD to EPA program offices for policy discussions. In the long run, with more resources, ORD could expand its ability to assess or value these tradeoffs. In the short run, with its limited resources, ORD could at least seek to identify the tradeoffs.

- **A key component of decision support is making sure that the information provided is relevant and useful.** Information about what stakeholders care or are most concerned about can be determined through deliberative processes involving decision scientists or the thorough the use of focus groups. This will make the analysis relevant and responsive to stakeholder needs.

- **The role of economics in the current decision support framework is unclear.** There is little, if any, mention of benefits from the provision of ecosystem services, and no references to economics or studies by economists in the briefing material provided to the Committee. ORD does not have the expertise to conduct ecological valuation and there are not economists on the list of ESRP experts, partners, or expertise to be tapped. It is therefore unlikely that ORD will have the expertise to conduct ecological valuation.

- **It is not clear why the decision support framework is closely tied to the Coral Reef Group.** It might be better to try to develop the decision support framework in the context of something that is likely to get greater interest, particularly given the SAB's view that the usefulness of the decision support framework needs to be demonstrated quickly. Other possible applications where the decision support framework might be developed with greater visibility and interest would be one of the place-based studies or the wetlands or nitrogen projects.

- **The organizational scheme of the tools database is confusing.** The categories used to sort tools are unclear. For example, it is not clear how the economic models are distinct from the empirical models or conceptual models. If the database is to be useful to decision makers it should be very transparent and user friendly.

- **It is unclear how the proposed use of social networking tools will further ORD's research agenda.** There seems to be considerable interest in using social networking tools to bring stakeholders and decision makers to a common understanding about a topic. However, the information provided to demonstrate how this would work represents a biased sample of stakeholders along a number of dimensions.

Enclosure 3: Comments from Committee Members

Comments from Dr. Fred Benfield

Charge Question 1.1. Has ESRP been responsive to EPEC comments on Strategic Multi-Year Plan (MYP)?

I think the ESRP has made progress toward satisfying the comments of the EPEC on the MYP (beginning with the name change from Ecological Research Program MYP to the ESRP). The new program has focused the research perspective on three areas to explore how ecosystem services emerge and then how the services interact with a variety of human-based spheres. While admittedly still impeded by a lack of sufficient funding, the three initiatives are a good starting point to produce some tangible results. Things seem to remain largely in the planning stages for most of the other initiatives suggested by EPEC but it is clear that ESRP has taken the suggestions seriously and is making the transition from the ERP to the ESRP.

Charge Question 1.2. Long-term goal 1 (LTG1): valuation, human well being and decision support.

EPEC suggested LTG 1 appears a bit ambitious for multiple reasons and should probably be a long-term objective with more modest time horizons for the various parts. Apparently, the decision to make the switch lies with upper management and has yet to be made. Perhaps the major concern about LTG 1 was the lack of in-house expertise to handle the valuation, human well being and decision support goals of the plan. ESRP has obviously tried to answer this concern by contacting with a few outside experts in these respective fields who have begun to contribute information and advice to the various ESRP teams involved in developing products. Still, the greatest limitation seems to be funding, not just for sufficient in-house FTEs although that continues to be a serious constraint, but for travel and other expenses necessary to make the kind of progress they would like to and need to make if the program is to be successful.

Charge Question 1.3. Progress on the Multi-year Plan (MYP).

 As mentioned above, progress has been impeded by lack of sufficient funds but it seems clear that progress has been made in planning on all fronts. I think it is too early in the game to consider eliminating elements of the program. Some are likely to be less fruitful than others but because most are still in infancy, it is difficult to predict which will be the less successful.

Charge Question 1.4. Partnerships.

The partnerships are a great idea and it appears that the ball is rolling pretty well in that area. I think the partnership program is likely to do well within some divisions of EPA and hopefully between divisions. Partnerships with entities outside the agency may do well at first blush but may eventually fade if new resources are not put toward the effort. This may be especially true in the case of academia where a major key to continued success is funding and publications. I think ESRP may be a hard sell in some divisions within the Agency, especially those with regulatory and enforcement responsibilities. As has been said numerous times in ESRP

documents we have received, the "science of ecosystem services" is pretty new and I know some ecologists who equate the idea with "applied" science and want nothing to do with the idea. However, future investments in the form of funding will very likely lead to a maturing process for ecosystem services as a science. One potential partnership that apparently has yet to be tapped is that of the Long Term Ecological Research (LTER) sites. There are at least 4 sites, Coweeta LTER(NC), North Temperate Lakes (WI), Baltimore Ecosystems Study (MD), and the Central Arizona-Phoenix(AZ), that have made large commitments to integration of social science and ecology. There are also sites on both coasts, in the desert southwest, northeastern forest, and in the mid-west. Additionally, there are sites in coastal and inland wetlands, the tropics, western mountains, and in Antarctica.

Charge Question 5. Implementation of ecosystem specific studies (wetlands).

a. Benefits of wetland research theme? The wetlands research theme provides a tractable framework for developing products that can demonstrate the value of ecosystem services (ES) within and outside the agency. It has the advantage of being included in the new place-based research sites across the landscape, and can incorporate data from a variety of ongoing Agency research in wetland ecosystems as well. Partnering with the EPA Office of Water (OW) water quality monitoring and assessment program demonstrates how Agency divisions can have common goals and targets which should encourage other potential partners for research, e.g., the LTER sites Florida Coastal Everglades and the Virginia Coast Reserve.

b. Have the benefits been made clear? The benefits are more implicit than explicit. There is also a lack of a clear plan of action. The general framework is there, but what will actually be attempted?

c. Will the wetland research theme move the Agency to a national perspective on wetland production functions? The plan covers the "Big 3" most people talk about when considering top priority services provided by wetlands, i.e., C sequestration; N & P removal or stabilization; and flood control/storm surge protection. The general plan is to start small and, presumably, expand over time, but to begin working essentially from coast to coast including the mid-continent region. The Critical Path diagram (Appendix B) certainly suggests the possibility of a national perspective for the Agency provided the critical links among RQ1, RQ2, and Research Applications are developed and sufficient funding becomes available.

d. Missing stressors in the plan? I think they are pretty well covered by the broad categories shown in the various conceptual models pertaining to wetlands although I didn't find an explicit list of specific drivers and stressors.

Comments from Dr. Gregory Biddinger

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

Charge Question 1.1. The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations.

The Ecosystem Services Research Program (ESRP) Status Report and Future Directions (June 24, 2009) clearly lays out how the agency has made a strong effort to accept and integrate the recommendations of SAB Advisory (Sept 30, 2008). The ESRP status report is a good example of how it is easy for SAB to make recommendations but not so easy for the agency to implement when they have significant resource constraints. In general I feel the agency has made and continues to make an effort to incorporate the intent of the SAB advisory and to some degree reasonably address the detail of recommendations. As well, I think they have and are using some creative approaches to meeting the spirit of the SAB advisory. For example, instead of rewriting the overarching report to address many of the recommendation for greater detail on such aspects as planned research and interagency partnerships; or explanations of process and criteria for endpoint selections; they have requested that each of the ESRP component area develop Research implementation Plans which can provide the detailed justification for their work as well as evidence of use of partnerships and process to achieve their objectives. Although not all of these plans are complete they are making good progress in achieving this goal, which as they note is the first time the agency has gone to this level of documentation on planning. So I would say the SAB advice is being heeded and the Agency has adapted to the advice.

Additionally, I think the status report has been open and frank with regards to the challenges they face with regards to staffing and funds for extramural work. But even in the face of this challenge I think they have shown creativity. In the face of lack resources for outreach and education they have in essence made it an objective of all of the components and requested that it be considered in the development of implementation plans. In the absence of staff expertise in decision support area for basic research they are doing their best to document learnings from workshops and projects in the place-based, pollution specific and ecosystem specific project activities.

Charge Question 1.2. In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

To some degree they have made a significant change in LTG 1 in that they have moved away from the end goal being the creation of an on-line analytical platform for doing ecosystem service analysis to creating the technical framework, supporting data and tools to adapt that

framework to decisions at local regional and national scales. One the other hand they are clearly still in a position of some risk in that they are limited on funding for valuation, linkages to human well-being and outreach and education.

The SAB advisory comment that ORD is setting the bar too high is metaphorically incorrect. The agency is trying to build a bridge that gets from the current approach of managing the avoidance of impacts to an approach that manages our interaction with the environment to optimize the sustainable production of ecosystem services in light of their contribution to human well-being. In order to build the needed framework to achieve that objective they have to lay the technical groundwork for the value of ecosystem services in linkage to human well-being and they provide tools to aid decisions regarding the management tradeoffs. In essence you must predicate the ultimate goal of the overall program on being able to fill in this knowledge gap, otherwise you haven't built the bridge.

This is not to say that I am not concerned that these key areas of valuation, human well-being and decision support are significantly underfunded. The result of this lack of resources raises concern for the overall success of this research program or at least makes me want to suggest that in the end the impact of this effort will be delayed significantly. But this said the SAB should not suggest the lack of funding is acceptable and that ORD should do less or other work. Clearly this is the right research agenda for them to be working on and it should be funded adequately.

Noted that there has been some reordering of the approach to the decision science activities in response to funding, so ORD is trying to work with the SAB recommendation. This is a concern as there needs to be alignment between the data that is being developed and the tools being used and the structured approach to the decision. So the conceptual model for a decision framework should not be delayed too long or you run the risk of developing endpoints, monitoring data and models that are not well aligned with the decisions to be made. But as is the case today, in the absence of the right data we will use what we have because the decision often can't wait for the research and data to catch-up.

Charge Question 1.3. Please assess the progress the Program has made in the 15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan, in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?

Yes. They have embarked on a major refocusing exercise in their ecological research efforts. Such a shift in technical focus requires a transition. It seems as if this first 15 months has encompassed that period of transition and as they note in the summary report the work from previous plan is starting to come to completion.

Charge Question 1.4. Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

There are a number of partnership approaches being utilized in this research plan including ORD's internal partnerships with Program offices and Regional offices and externally with other federal and state agencies, universities, regional planning authorities, municipal governments and the private sector. Not clear what "future investments" the charge question is addressing. But will do my best to give a perspective. First it is clear from the status report that establishing these partnerships is possible but that lack of resources is a general problem hindering partnering activities. The value of these partnerships in aligning the research with the decisions that have to be made is clear and accepted by all, but getting resources to get input into the research design or share in the research workload seems to be a constant challenge. Once again this lack of resourcing is a road block to progress.

At the end of the day there is another 800 pound barrier in the room and that is the lack of regulatory authority to directly apply Ecosystem Services as measures of compliance. This barrier is not independent of resourcing. If the traditional use of regulatory criteria and standards based on toxicological risk and engineering proxies is core business for Agency program and regional offices, they must address that base business first. If resources are limited there is not staff left over to engage in the research. If the Agency had a separate policy initiative trying to vision the next generation of regulatory approaches then they would be the champion for additional funding.

With regards to the additional funding described in the appendix F of the Status Report and Future Directions document, It seems to be focused on the right elements and would be the necessary funding to address resourcing for both internal and external partnerships to get the alignment between the research and the regulatory implementation of the vision.

Charge Question 6: Implementation of Decision Support Activities

Charge Question 6.1. Please comment on the defined and anticipated challenges to achieving the goals of the Decision Support Framework. What recommendations does the Committee have to overcome the most significant of these challenges?

The Agency LTG 1 status report has identified most of the principle challenges they face including: (1) Lack of resources and in-house expertise; (2) bounding the effort to make it manageable; (3) technical and administrative challenges and (4) integrating science with human values and judgment. Clearly these are challenges and currently are constraining the progress of the research. In Appendix F there is a clear definition of the scale and type of extra resources that would advance this research plan. So assuming those extra resources don't materialize, what can the Agency do to overcome the listed challenges? They can if they restructure the research to narrower set of objectives or scale of projects. The ESRP plan is currently covering a wide range of community based projects and has even added one for the southwest. As much as I believe these projects are the key to building support for the use of ecosystem services maybe ORD can not progressed all simultaneously. Unfortunately this will require moving funding around in a fashion that will likely not line up with existing staffing. Also the current conceptual model for the DSF included an analytical-deliberative process. Not all decisions will require analytical-deliberative processes; An initial step might be to focus on the process of using ecosystem services in processes that are principally between the agency and a single stakeholder

to demonstrate use of ecosystem services in regulatory applications and then focus on building a more complicated DSF in subsequent demonstrations. The earlier the Agency can successfully demonstrate applicability of the DSF and use of ecosystem services in regulatory context the more likely they will avoid the risk outlined in the following paragraph.

There are at least two other principal challenge they face to full and useful implementation of the management approach. The first is the lack of statutory and regulatory framework for the use of ecosystem services as the basis for regulatory mechanisms such as permits and enforcement of those permits. At this point they are operating under the premise that if they build a usable and obviously better working system they regulatory systems will migrate to this better way. Of course, I think they are on the right path to a better way to manage the environment but there are clear risks in this proactive strategy. First you may build it and there is not political will to migrate current regulations to the better decision process. In that case you are left with principally application of the DSF under voluntary or self-regulating applications. The second risk which is more short-term is that their management loses faith in the ultimate utility of the research and they become even further resource constrained. In either case, what this suggests to me is the need for early demonstrations of the utility. Appendix F of the Status report is intended to provide an indication of what they would do if they had additional funding, but what the ESRP lead may want to try to do is bring some of that vision in under the existing funding. For example in Appendix F they suggest demonstrating the use of ecosystem services approach for Regional projects, alternative energy policy or green infrastructure projects. Such demonstration will lower the risk of lost management support and also would set the example for a better regulatory basis then we have today.

Recommendations: Move elements of demonstration projects from Appendix F forward even if you have to reduce or delay other aspects of research program. This may also build the case for the complete funding of an expanded effort as outlined in Appendix F.

Charge Question 6.2. How does the EPA reconcile Decision Support as a significant need for the Ecosystem Services Research Program with the Program's relative inexperience and minimal resources?

The intent and relevance of this charge question is not clear. The ultimate mission of this research initiative is to provide the information and methods needed by decision-makers to assess the benefits of goods and services to human well-being for inclusion in management alternatives. So by definition what they are all about is creating decision support. The research team has downgraded its objective from the creation of a decision support platform to a decision support framework. As well, they have reduced their initial focus for the framework to Land and resource use decisions and to a degree they have delayed the creation of this the DSF for land and resource use for at least a year. So they have adjusted their initial goals in response to previous SAB comments and in response to limited resources. In addition they have brought in outside expertise from Carnegie Mellon University to supplement their current lack of internal expertise.

In support of continued inclusion of this area in their plan, ORD suggests that the typical decision maker for land resource use is typically individuals, towns, counties and tribes who are

focused on economic outcomes and not human health and/or the environment. Providing the information, tools and framework to aid decisions by local government requires the continued inclusion of a focus on the development of a DSF. Once again in response to limited resources they are currently tapping the other program activities through workshops to gather learnings to build their framework.

Comments from Dr. Ingrid Burke

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

Charge question 1.1. The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations.

The Program has been responsive, in that the reasons for an ecosystem services program have been elaborated.

The elaboration of the Millennium Assessment diagram to include "stressors" was interesting, in two ways. First, it placed the Ecosystem Services framework, which is new and compelling, in the context of the stressors framework. While this connected the old work to new, it constrains the new work in at least one important way, which is that as it is, ecosystem services are only *decreased* by human activity, **not preserved or conserved**. That is, humans only cause negative impacts, and do not behave, or are induced, or motivated, or find incentives, *to maintain or increase ecosystem services, according to this diagram.* It does seem to me that EPA is fundamentally limiting itself to regulation in a sort of pessimistic way, instead of inspiring policies that include incentives and positive action. There are a few inspirational paragraphs in the strategic vision, but ALL of the rest of these documents get back to business as usual, and I fear, mapping the impacts of the stressors in terms of dollars, a superficial exercise at best. I need to incubate slightly longer about this, perhaps in discussion with the committee, but I have the sense that this diagram and approach considerably reduce the richness and ultimate potential success of the ideas, and the usefulness of an ecosystem services approach. Second, the "stressors' box is huge and overwhelms all the other ideas and boxes. This magnifies the effect of the constraint, and suggests that the focus of all the work is the same as it has been in the past.

This is probably my real concern: *in response to budget constraints and trying to maintain continuity in the face of political change and a consistent staff, the Program is leveraging resources and hanging on, rather than really embracing new ideas. The new nuggets in the ecosystem services concept are, I think a) an explicit connection between the environment and human health and well-being, and b) a focus on the optimistic approach of incentives for maintaining the flow of ecosystem services to humans, rather than a focus on the negative impacts of humans.*

Charge Question 1.2. In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

I am concerned that accomplishing these goals is still so dependent on expertise that exists outside EPA. There is basically no expertise for any of those.

The model appears to be selecting individual experts from outside to represent that expertise in the program. I am uncomfortable with the process by which this occurs, with respect to transparency, and have the bias that competition and review result in a justifiable result.

Charge Question 1.3. Please assess the progress the Program has made in the 15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan, in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?

Charge Question 1.4. Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

The difference between centers of excellence..where individuals committed to interaction spend a good deal of time together....and partnerships, is Huge. I suggest some very careful thinking here.

Charge Question 3: Implementation of Mapping, Monitoring, and Modeling Themes

Charge Question 3.1. Focusing specifically on the Mapping theme, please comment on the usefulness of the proposed products. For example, please comment on the potential for ecosystem service atlases to communicate the status, changes, and locations of ecosystem services to EPA clients and the public. Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice; 2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions); and 3) issues related to environmental and land management, including public and private investments to conserve ecosystem services.

The mapping initiative is really coming together; the presentation provided a GREAT deal more information to me. It looks as though this is finally the nexus for federal agencies interacting to bring the data layers together. It's critical to keep up on this effort (more on this in a second).

The connection to Ecosystem Services, as is true with the N work, is weak. That needs to be elaborated in a SIMPLE way (no spaghetti diagrams necessary, I don't think, though: a simple box and arrow would be fine).

There is an enormous opportunity for this program to serve the Report on the Environment, and the EPA Smartgrowth program. Providing somewhat higher resolution to communities can be a superb resource for community planning, particularly areas where land use is changing from rural to exurban, and there may not be a tradition of land use planning.

Finally, it would be a great thing for the metadata include sources of data, dates of the data,

Charge Question 3.2. What advice does the Committee have for the next steps in Monitoring and Modeling? In particular, are there pitfalls that the Office of Research and Development should be sensitive to as it develops this part of the ESRP?

This is a place where there is strong opportunity for connecting with the Report on the Environment.

Additionally, I think that there is enormous impetus for the cross-agency collaboration right now, and while the program is well on its way in developing those, real leadership could be exerted. I think there could probably be funding available now, for EPA to take the lead on an EPA/USGS/NASA/USFS/etc. collaboration. I recommend an aggressive approach to OMB about this.

Comments from Dr. Allen Burton

General response to Charge Question 1: Status Report and Future Directions

1. P. 1: 3 perspective approach (N, wetlands/coral reefs, 5 regions) is excellent
2. P. 3: In addition to state and municipal initiatives, mention NGOs and federal (e.g., NOAA).
3. P. 4: An example of a business case is N trading
4. P. 7: The public-private National Ecosystem Services Research Partnership is great – but are there resources available to make this happen? To foster collaboration?
5. P. 8: The challenges listed are on target – and very daunting. Each are deal breakers if not addressed adequately.
6. P. 13: ESRP Organizational Matrix: Would be good to define the percentages – are these FTEs?
7. P. 15: LTG2 – is this part of the earlier SAB effort on ecovaluation?
8. Overall: Need acronyms defined.
9. Pp. 15-20: The recommendation responses are so general they are difficult to evaluate.
10. P. 17: The Lyme disease and West Nile virus examples seem odd, as they affect so few.
11. Appen. D: This expert explanation is good, BUT, where are remaining weaknesses and gaps in expert needs to accomplish the ESRP goals? Note. Also, these experts MUST be charged with also providing EPA with updates on the works of others. Many good projects are ongoing by NSF, NOAA, and others that are not mentioned and directly support ESRP goals. The experts should be aware of these and should be responsible for educating EPA on the state-of-the-science.
12. Appen. E: The partnership is a great idea and effort. Who was invited? I am curious because I did not hear about it, nor did our NOAA lab, which is active in several related research endeavors. The partnership must include those doing relevant research.
13. Appen. E: CRDAs are quite cumbersome and need a business linkage. Having participated in CRDAs, I cannot envision this being an effective approach. There is little incentive for them to succeed with monetary rewards.
14. Appen. H: These accomplishments need some reference as documentation. Some do not appear related to ecosystem services. The EPA PPCP survey should also be mentioned.

Charge Question 6: LTG 1- Decision Support

1. Fig 1. What is 4. Target research and tools?
2. Lots of good changes and figures are very useful.
3. For APM2, the database should including ongoing and recent research projects by agency, lead contact, project abstract, and web links. A lot is going on which must be considered.
4. How will EPA ensure the toolbox gets used? An education and promotion campaign is needed.
5. Good expert hires.

6. P. 8, bullet 3. The DSF Team's effort on developing interactions and connections with potential outside partners seems weak and destined for failure, as this takes time and would benefit from outside agency expertise, such as noted above.
7. Challenges: Key issue for success: funding and FTEs
8. Human Well-Being Theme conceptual model Fig. 1.2 is good.
9. The focus of roadway vegetation however seems odd and a tough link to prove, given the lack of experimental design control, multiple stressors and extreme spatial/temporal variation.

Charge Question 4: LTG 5 - Site-Specific Demonstration Projects

1. Use consistent nomenclature – Community, Site, Place based?????
2. Good selections of regions and studies.
3. Given the importance of these 5 projects, EPA should ask SAB or an outside expert panel to routinely review their progress on each.
4. The **Midwest project** does not seem to recognize all the relevant studies going on that link to this. This is a serious concern, given EPA's shortage of resources and apparent willingness to partner on these complex issues.
5. Good conceptual model.
6. Why the focus on agriculture and not also urban, commercial, residential sprawl and industry inputs? All land uses with the watershed should be considered.
7. Why only focus on migratory birds, and not fish and other wildlife?
8. The partnerships, metrics, and ecosystem services hierarchy that are advocated are wonderful, but the devil is in the details. This effort needs outside assistance and peer review.
9. Other challenges: multiple stressors in every watershed, scale, FTEs, integrating other relevant research, ecosystem services linkage (e.g., biodiversity, groundwater and stream recharge-hydrologic connectivity, fisheries, climate change)
10. **Tampa Bay:**
11. Nicely designed project.
12. Fig 3's partnerships are impressive, but difficult to imagine how this will happen in a productive manner. NOAA should be involved. Can it be that ONE FTE is coming from all of these partners (p. 6, 1.4.4)?
13. The initial valuation findings in 2008 are quite surprising and frankly difficult to believe that recreation, aesthetics and flood control are not high ranking.
14. Challenges are again $ and FTEs.
15. Excellent FigA1.
16. P. 10. It is also difficult to believe that "exact units for each measure leading to services" will be determined from literature reviews.
17. Solids should be added as a potential stressor and service for wetlands, just as nutrients are.
18. **Willamette:**
19. What is WESP?
20. The project seems to be routine monitoring efforts and little to do with linking to ecosystem services and valuation. The previous SAB comment regarding this concern still applies.

21. Appen B is not an adequate conceptual model.
22. P. 10 last line. Note EPA did not edit this line and is confused about collaborations.
23. **Coastal Carolinas:**
24. It is unclear how they will "characterize and quantify the changes in the spatial and temporal distribution of coastal ecosystem service production and determine how those changes translate into changes in human well-being."
25. Appen. B conceptual model is weak.
26. **Southwest:**
27. Conceptual model is good, but what about aquatic life, N loading. Why is N loading leaving the model and not inputing into the model?
28. Too few FTEs
29. **Cross Place Based Coordination:**
30. This section is quite weak and is critically important for the success of ERSP's goals.

Comments from Dr. Peter Chapman

General Comments

I *commend USEPA staff* involved in the Ecosystem Services Research Program for listening to what we had to say in our initial meeting and written submissions and acting on many of our suggestions or, where appropriate, explaining why alternative actions were more appropriate. I also commend them on finding innovative means in many cases to address the technical and other challenges posed by their innovative, ambitious and very necessary work. I particularly like: consideration of direct and indirect drivers; the aim to not only meet or exceed statutory requirements, but to perhaps eventually obviate regulations; involvement of appropriate outside experts; addition of the Southwestern place-based study; client-based scenarios; excellent progress on national partnerships at various levels; presentations outside the U.S.; good progress on integration (except apparently in LTG5, see General Comment 6d, below); a trans-disciplinary approach to research; additional details such as names of USEPA key personnel, not previously provided; inclusion of Bayesian analyses and weight of evidence; meta-analyses; flexibility in the program (e.g., the appropriate inclusion of ocean acidification to coral reef research); etc. However, I also noted at the meeting some serious flaws as follows. Those underlined remain to be corrected.

1. We (the SAB EPEC) repeatedly emphasized the need for *adequate funding and support* including travel budgets for this program; although improvements have been made, neither need has been fully addressed. Other Key Challenges that require funding and other support are well documented on page 8 of the Status Report and Future Directions. In my opinion, *an overall change in Agency focus appears to be required if this program is to succeed.*

2. Related to General Comment 1, above, as noted in the materials provided (p 5 of the Status Report and Future Directions), *outreach and education, valuation and human well-being have not been adequately incorporated into the Program due to lack of funding.* They need to be incorporated on a priority basis using additional funds, not existing funds assigned to this program.

3. We also repeatedly emphasized the need for this project to go beyond *the boundaries of the U.S.* Although some changes have been made to the program in this direction, I find the response to date to be inadequate to the reality of a global community facing global challenges that are not restricted to artificial political boundaries. I note that the overall Goal of the Program is "To transform the way decision makers understand and respond to environmental issues." This will not occur without a global rather than a national perspective.

4. We questioned the rationale for studies of coral reefs. A response was provided in the pre-meeting materials that was not wholly convincing (see General Comment 6 below). However, given that coral reefs are charismatic and are likely to no longer exist in about 50 years due to ocean acidification, they are an appropriate ecosystem for dealing with both annihilation due to a single cause and the "death of a thousand cuts".

5. I am <u>very</u> concerned that the Program does not have the 'administrative clout' to not only put the appropriate staff in the appropriate lead positions in the program, but to keep them there. This program needs sufficient high-level support, including appropriate changes in regulatory authority, that *staffing is appropriate and is maintained*.

6. We were specific in terms of recommendations regarding the important place-based projects (pp 21-23 of our September 30, 2008 letter to the USEPA Administrator regarding LTG 5). It was not apparent from the pre-meeting materials that our advice was followed. I believe that our advice is or will be followed, but document that advice below 'for the record'.

    a. We recommended that a transparent explanation be provided of the process for selecting demonstration sites and provided organizing principles for such selection. To my surprise, only one site (Coastal Carolinas) explicitly addressed this recommendation in the pre-meeting material provided. Such explanation is needed for each of the sites along with an assessment of their comparability to other similar sites such that information extrapolation is reasonably possible. Explanations provided at the meeting were convincing but need to be documented.

    b. We recommended that "When the choices are made, they should be shown on a map that includes all U.S. States and Territories…will provide transparency regarding key ecological areas excluded….". Again, to my surprise, I could not find such a map in the pre-meeting material provided. A map was provided in the first presentation during the meeting but did not include two US states (Alaska and Hawaii) or any U.S. Territories. And a transparent explanation still needs to be documented for all sites as noted above. In future, maps need to not only include all of the U.S. and its Territories, but its near (e.g., Mexico, Canada, Cuba) and far (e.g., EU) neighbors. It is, after all, a small world related to environmental issues.

    c. Life cycle assessment (LCA) was emphasized as "a useful means for visualizing and assessing different alternative actions relative to management alternatives"

and we recommended expansion of LCA in the plan, yet the words "life cycle" did not appear in any of the material provided to this meeting. LCA is critically important in assessing relative risk, one of the key components of effective decision support. Our previous recommendation needs to be implemented. In this regard I note that Dr. Randall Bruins (USEPA-NERL) approached me during the meeting for contacts and advice regarding LCA, which I will provide.

d. We expressed concern regarding coordination within LTG5. I understand that coordination is now in place via Dr. Hal Walker and look forward to a greater degree of inter- and intra-site coordination.

e. We strongly recommended that "*transboundary issues* be explicitly considered in the place-based projects". This has not occurred. The words "transboundary" occur exactly three times in the material provided regarding LTG5, once on page 7 and twice on page 8. They are used in the context of describing difficulties and discarding any more than peripheral consideration of transboundary issues, rather than attempting to find innovative solutions. The word "transboundary" was not used in any of the LTG5 presentations at the meeting – it appears to presently be peripheral rather than integral to the Program; the reverse needs to be the case.

Charge Question 1: Current Status and Direction

Charge Question 1.1. Program responsiveness to SAB EPEC recommendations?

A high level of creative responsiveness has occurred in many parts of the program, but not prior to the meeting in all areas and particularly in LTG5 (place-based studies), as noted above in my General Comments. I am now satisfied with the level of responsiveness.

Charge Question 1.2. Balanced focus or more adjustments needed?

See General Comments, above.

Charge Question 1.3. Sufficient progress?

See General Comments, above.

Charge Question 1.4. Partnerships adequate?

No. International partnerships are inadequate. For example (p 7 of the Status Report and Future Directions), although USEPA participated in at least one major international conference, they have not involved international partners. The statement on page 8 of the Status Report and Future Directions "we are now addressing transboundary issues in two Place-Based studies: the Future Midwestern Landscapes (FML) and the Southwest Ecosystem Services Project (SWESP)" is incorrect – for example the Midwestern project generally dismisses addressing transboundary

issues (p8 of that project description). Rather than pointing to problems in addressing transboundary issues, solutions need to be sought. Further, it is not clear what "sub-global assessments" are (p 12 of the Status Report and Future Directions), nor how they can be integrated into necessary global assessments. This issue is larger than just this program. As noted on page 6 of the Willamette Ecosystem Services Project "At the highest levels of federal government there is a need for agreement upon the kinds of collaborations that should exist to meet the common good". This statement / need is applicable to the Program as a whole, not to solely this place-based study. In this regard, I strongly encourage the Program leads and coordinators to take any and all opportunities to publicize what they are doing not only in different 'trade' publications (e.g., ecology, economics) but also to laypersons via appropriate media (e.g., the Web, newspaper, radio, TV) and internationally.

Charge Question 4: Place-Based Studies

Charge Question 4.1. Conceptual models missing any critical elements?

The conceptual models for each site should be based on the same generic template, made specific for each site. Presently the models follow different templates for different sites and it is very difficult to determine what is and is not appropriate in each model. In addition, it is not clear that the Program is aware of or incorporating all relevant other studies. Further, some major foci appear to be missing, for example: Midwest – human habitat changes other than agriculture; Southwest – aquatic life; Tampa Bay – invasive species. Finally, I urge caution in decisions to "scale down" the work, "constrain" it, or make it more "manageable" – such decisions need to be based on the overall goals of the Program, not on logistic or other considerations which, although real, can reduce the utility of this much-needed Program to the point that it is not worth doing.

Charge Question 4.2. Good demonstration projects? Additional ecosystem services?

See General Comment 6, above. In addition, I am concerned regarding the development of a new indices in this project – indices (typically based on single numerical values) can be misleading due to information compression and loss, and do not fit with the 'weight of evidence' approach that is correctly the primary focus of this Program.

Charge Question 4.3. Progress in cross-place-based theme to compare and contrast the five sites?

See General Comment 6, above. In addition, I note that Dr. Hal Walker, the Place Based Coordinator, is also part of the N writing and implementation team, which is good for integration but possibly bad in terms of him having sufficient time and energy for his primary role in this Program.

Charge Question 4.4. Omissions of key partners?

The most obvious omissions are international partners. See General Comment 6e, above. This omission needs to be rectified sooner rather than later. Further, the connection between this work

and the decision-makers needs to be strengthened or the work will be of academic, not of practical relevance.

Comments from Dr. Loveday Conquest

Charge Question 1. Current Status and Direction of the ESRP

Charge Question 1.1. Whether the Program has been responsive to the Committee's primary recommendations.

The various EPA groups have taken care to respond in some detail to SAB comments for LTGs 1, 2, 3, 4, and 5. As an example, I recall much discussion about "why coral reefs?" at the April 2008 meeting, and EPA has responded to concerns expressed about that project. That particular project would be an easier sell if reefs are viewed as sentinels regarding processes of ocean acidification. As expected, the many projects have different parts which are in various stages of development.

I am glad to see that some STAR grants are being awarded (or will be awarded). The ones mentioned pertain to valuation of ecosystem services provided by wetlands.

The links between the Outreach and Education (OE) and DSF groups appear to have been strengthened somewhat. Nonetheless, it was noted at the meeting that the Outreach component is not working as well as EPA would like it to. ORD has not been set up to do outreach and therefore is not all that comfortable doing it. Perhaps this is a place where some of the partnerships would come in handy; i.e., ORD partnering with an organization whose specialty includes outreach and education.

I like the concept of "benefits transfer" to link certain ecosystem services (e.g., urban green space, night sky darkness) to HHWB outcomes (e.g., mental-health outcomes in children, endocrine system diseases). This approach will go a long way to engaging policymakers and stakeholders.

The use of experts by EPA to fill a variety of knowledge gaps is a good way to stretch limited resources. This approach seems to be working and should be continued. There remains some concern about exactly how the experts are chosen (apparently not by open solicitation); more transparency is needed here. Occasionally specifics were missing about exactly how an expert would contribute to the ESRP.

EPA is keenly aware of the challenges facing it. Of concern is the fact that some groups appear to lack sufficient travel money for EPA personnel to travel to workshops and for face-to-face collaborations, and for international travel. I am concerned about EPA's comments regarding limitations on computer software and computing power—is it merely expense, or something else? The Tampa Bay group mentions a lack of information on available funding, insufficient funds for their ecological economist (expert hire), and dwindling administrative support. ORD seems to have a good record of leveraging small amounts of funding to get a bigger bang for the buck. For example, good use of an expert hire can be very cost effective (when compared the cost of an additional FTE). In the meeting, ORD asked the committee to make specific suggestions, but the specifics need to come from ORD (perhaps some of the details from the budget in Appendix F?). An EMAP example was noted of how a few $million was used to gain

access to data sets that would have cost many times that amount to actually collect. More budget specifics like that would help.

ORD noted that there is a workshop to identify stream ecosystem service endpoints for July 2009, involving both economists and ecologists. It will take time to build up a common vocabulary and to get both groups working "in alignment". I note that EPA will investigate to see which indicators can be used to estimate ecosystem service endpoints; no doubt information gaps will also be revealed here. Because certain final ecosystem services for water have already been codified in the Clean Water Act, one can view water as a "low hanging fruit" project and therefore a good place to start.

The committee has emphasized more than once that transboundary issues need to be considered, and that the ESRP should pay more attention to studying how ecosystem services are valued in other countries, some of which are way ahead of us in this area. The U.S. can learn from what others have done. Lack of funds for international travel was noted as a barrier, so this remains a resource issue.

Charge Question 1.2. LTG 1 vs. LTGs 2-5. More balanced focus at this stage of development?

It does now seem that LTGs 2-5 are now receiving more balanced attention and focus. By concentrating on the needs in decision-makers and stakeholders, EPA has gotten more realistic about the timeline and the focus for the Decision Support Framework (DSF, previously the Decision Support Platform). The date for the completed DSF is now 2016, more reasonable than the earlier stated timelines. The development of the database of tools (APM 2) should allow users to see which tools are used for the various types of ecosystem services and has the capacity to inform users about tools of which they might not be aware. The timeline indicates that this database will be ready for external review in October 2009. It is also good that EPA is documenting decision processes under current use (that might prove useful in the development of the Decision Support Framework). Both the development of the tools database and documentation of decision processes have the potential to reveal data gaps.

Charge Question 1.3. "Has sufficient progress been made to warrant maintaining the current elements within the program?"

It appears that EPA is making progress with the ESRP on many fronts, under rather challenging conditions involving resources (not enough) and authority to direct lines of research (again, not enough). The phased approach, having a variety of projects at different stages of development (some finished or nearly so, some in the middle, some pilot projects just being started) is a good one. It would be helpful if EPA could actually produce an atlas of ecosystem services for some ecoregion or geographic region before too long.

Charge Question 1.4 "Please comment on the partnership approach being developed in the ESRP.

Part of the stated EPA definition of "success" will be demonstrated by having the logos of several organizations on the cover page of any atlas produced under the ESRP. Since EPA

admits that it is unlikely to own and maintain all parts of the ESRP over the long term, it is vital that strong partnerships be built. I do not believe that EPA can carry the burden of ESRP forever; thus the establishment of an Ecosystem Services National Atlas Consortium seems prudent. As happened with EMAP, when the funding runs out, that would signal the end of EPA's major involvement, so it is necessary to aim for sustainability through the partnerships and the Consortium. That is where the legacy of ESRP has the highest hope of continuation. For example, the Willamette Ecosystem Services Project (WESP) specifically mentions the USDA's Natural Resources Conservation Service (NRCS), with its already existing national network of district conservation offices in each county. The purview of the NRCS could be expanded to include ecosystem services. (Also pointed out is the fact that the NRCS network is such that it could serve the suburban-rural interface, an extremely important ecotone).

The partnership with the National Geographic Society is a natural one and will help immensely in terms of distribution of maps. From the Wetlands presentation, the committee learned that EPA has a partnership with the US Fish and Wildlife Service, and that new Pacific Coast plots are being added to the 2005 Status and Trends plot locations. Overall, ESRP has developed several good partnerships within the U.S., particularly with other federal agencies around data sharing as part of the M^3 process. (It came up in the committee meeting that the M^3 process could end up being the centerpiece for data sharing and interagency cooperation.) The ESRP should also consider developing international partnerships, in collaboration with the Millennium Assessment. The public-private National Ecosystem Services Research Partnership mentioned in the ESRP presentation sounds good, but note also Dr. Ingrid Burke's comments regarding her experience of the current status (embryo? fledgling?) of this Partnership.

Charge Question 2. [Not my area of expertise, so no further comments on this one.]

Charge Question 3. Implementation of Mapping, Monitoring, and Modeling Themes.

Charge Question 3.1. Usefulness of proposed products from the Mapping theme. Potential for ecosystem service atlases to communicate status, changes, and locations or ecosystem services to EPA clients and the public. Whether ecosystem service atlases will inform decision makers about: 1) social equity/social choice issues; 2) innovative valuation methods; 3) environmental and land management issues, including public/private investments.

The ecosystem service atlases can be a very effective communication tool, as demonstrated by the Willamette Alternative Futures Project and the Tampa Bay Project. The status of an ecosystem service (or set of services) can be easily conveyed to EPA clients and various stakeholders. Similarly, "alternative futures" (in this case, different trajectories for ecosystem services based upon linked forecasting models) can be displayed via maps of land use/land cover and bar charts (e.g., of natural resource indicators), allowing one to assess the consequence of policy and management choices. Another example would be mapped projections of Lyme disease risk under alternative scenarios of forest fragmentation due to housing development (or alternative scenarios based upon climate change projections), along with economic valuation of projected disease incidence. (Note: "why Lyme disease?" was asked by some committee members; I believe Lyme disease is linked to later neurological problems, and its range might be spreading, hence its importance.)

An example pertaining to social equity might be a map of an showing current air quality status (e.g., with respect to PM2.5), and projected trends in air quality. This could be coupled with a map displaying socioeconomic status (SES), thus indicating whether generally poorer areas would be more likely to experience declining air quality in future. In general, social science data (such as SES) will need to be incorporated into models to see where ecosystem services matter to human health and well-being.

It is heartening to note that the concept of ecosystem services seems to be growing. EPA has provided some examples of where ecosystem services may be used to prioritize contaminated Superfund sites for clean-up, or to inform permit and restoration decisions. In the ESRP presentation, Oregon State Senate Bill 513 having to do with ecosystem services was outlined. Particularly encouraging is the requirement to convene an ecosystem services markets working group. I surmise that the existence of the Willamette Alternative Futures Project (which has an available atlas) had something to do with this bill being sponsored.

Decision makers can also relate to valuation measures such as reduced costs for drinking water treatment (due to improved percent forest cover in source water watersheds), recreational fisheries revenue due to decreased fish contaminant levels, and improved human life expectancy due to PM2.5 reduction from urban forest canopies.

Charge Question 3.2. Next steps in monitoring and modeling, including pitfalls/challenges.

Continue the work on the Atlas (or at least **an** atlas—for a place-based project, or coral reefs, or wetlands). Continue to strengthen the partnerships. The results from the July 2009 economics/ecology workshop will be crucial. Tapping into the NRCS's national network of district conservation offices in each county sounds like a good way to get "full areal coverage", at least in the lower 48. Could ORD capitalize on this?

The results of the Green Infrastructure Analysis (forested and wetland cover) will be important in terms of demonstrating status of habitat connectivity. This is where an "alternative futures" approach can demonstrate what can happen with different trajectories of urban/suburban development. The resulting maps should have a lot of impact in terms of a communication tool with stakeholders. Similarly, maps for pollutant attenuation by riparian buffers and wetlands, drinking water sustainability, nutrient and pesticide loading, increased flood potential associated with development, etc. can really tell a story to policymakers. The report mentions that "currently there is no good national coverage of wetlands"—if that is the case, just how much information comes out of the National Wetlands Inventory?

I encourage continued work on the Analytical Tools Interface for Landscape Assessments (AtTILA). The notion of a user being able to do an ecosystem service calculation based upon one's own local data is **very** appealing. To get stakeholders used to thinking and talking in terms of ecosystem services, it must be made relatively easy for people to calculate such valuations for their local situations. This would be a big step forward.

The development of national data sets (soils, cropland, wetlands data layers were pointed out in the Natl-ES presentation), is really exciting. The partnerships are key in order for this to work, and I imagine the national data set development is providing a lot of the impetus for the partnerships.

Challenges

Sufficient resources to fund enough FTEs to get the job done is, of course, always an issue. The fact that ESRP leads are, in general, not EPA managers (and thus have no authority over resources) is troubling. If new leadership comes in or starts shifting priorities of a Lab, this could really stall progress. While partnering with other organizations is essential, this does not mitigate the need for support (via resources) for ESRP from EPA managers and Lab heads.

EPA mentions quantifying uncertainty as a real challenge, very true. It is possible (can get complicated, but still possible) to quantify uncertainty for data sources based upon probability sampling. For data sources not based upon probability sampling, it is **much** more difficult to quantify uncertainty. For example, if a probability sample for an area already exists (or if one can be taken), then additional data from non-probability samples can be incorporated into the probability sample using what are called selection functions. (This is an area of sampling theory rich with research possibilities; much remains to be developed. Perhaps Dr. Don Stevens, formerly of Oregon State University, now residing in Wasilla, AK, could be called upon as an expert scientist to help in this area. I believe Dr. Tony Olsen, EPA Corvallis, is involved in this effort.) Quantifying uncertainty practically qualifies as its own ESRP project. It certainly needs to be "constantly worked on" as ESRP moves forward.

I remain concerned about the ability to develop a National Atlas (in an ArcGIS server environment) being hampered by present computing resources. For full and use of maps, one needs a GIS server with adequate computing power. In a best scenario, easy illustration of data gaps might prompt private and public entities (through the Consortium) to contribute data for use in the National Atlas.

Charge Question 4. Implementation of Place-based Studies.

There needs to be better integration of these projects into the overall arching framework. Each placed-based project should illustrate how the decision support framework operates. One cannot emphasize this point enough. I keep going back to the Willamette Alternative Futures Project. This one (having started in the mid-1990's), seems to be the most developed in terms of linking changes in stressors (land use in this case) to outcomes that could be viewed as ecosystem services.

There were some good points in the Tampa Bay Project presentation that would presumably fit well into the decision support framework. One was noting that attainment of standards for particulate matter (PM) would result in $14-$55 billion of nationwide health benefits. That is an example of an ecosystem service (removal of PM) translating into human health and well-being. Similarly, coming up with a model for relating wetland loss to increased waste water treatments to maintain specified levels of water quality is another example of such. This project has also

taken an "alternative futures" approach to assess the effects of land cover/land use on ecosystem services.

Charge Question 5. Ecosystem-specific studies: Wetlands.

The ecosystem services provided by wetlands (slide 9 in the presentation) appear to be a good start, and probably need further refinement. Most of the boxes under "Wetland Categories and Services" (slide 11) are filled in; is it possible to start building/filling in the DSF for wetlands from these studies? Slide 17 (and also remarks from Dr. Rick Linthurst) point out that ecosystem services (like species!) do not exist singly, but together, and therefore must be considered in "bundles". Furthermore, the same change in an ecosystem can be viewed both positively and negatively, for which the tradeoffs must be clear (the example presented was that of decreased storm surge reduction, but increased shrimp yield, as a marsh becomes more fragmented). Much work remains on models for ecological production functions (slide 30). Even after this is "done" (if such an endeavor can ever be said to be finished), there still remains the problem of working out models for economic production functions to be able to say something about ecosystem service benefits. EPA correctly notes (last point on slide 32) that it may not be possible to do direct measurement for all sites (a census). In order to estimate services for sites that are not measured directly, one would need a quantitative model that allows one to measure something indirectly (perhaps via remote sensing) and then translate that into the desired service. Along with this, a measure of uncertainly would need to be incorporated.

The committee was informed that the National Implementation Plan for Wetlands is now in revision and should be ready by autumn 2009. Undoubtedly this will answer many of the committee's questions regarding the wetlands study how it fits into the DSF.

The example provided in the NAtl-ES presentation (slide 26), with statements about the percentage reduction in nitrate load using so many ha of constructed wetlands (and with the $1.38/lb cost for nitrogen removal), provided a very specific statement about an ecosystem service and the cost for getting there.

Slide 11 from the ESRP presentation shows invasive species as a concern, but no mention of this was made in the Wetlands slide presentation.

Charge Question 6. The Decision Support Framework (DSF).

The concept of the DSF cannot be completed without a careful delineation of the ecological production functions.

The best way to achieve the goals of the DSF is to take a demonstration project (e.g., ecosystem services as specified in the Clean Water Act) and take it through to the finish by defining ecosystem services, assessing effects of stressors, relating them to changes in human health and well-being, valuation of ecosystem services (e.g., increase/decrease in years of human life if things got better/worse), etc. Having a carefully thought through overarching model should make this process more straightforward.

Comments from Dr. Terry Daniel

General issues (charge question 1)

Charge Questions 1.1 and 1.2.

The revisions to the ESRP MYP respond well to the recommendations of the previous SAB EPEC review by shifting away from the earlier emphasis on human wellbeing and economic valuation efforts toward greater focus on identifying, monitoring, mapping and modeling the ecological systems, endpoints and ecological production functions that are the basis for ecosystems services. Clearly, focusing the program on ecosystems *services* requires identifying ecological changes that have implications for human/social wellbeing. However, the principal strengths and the primary responsibilities of ORD-ERP are in discovering and articulating the complex webs of bio-ecological systems and processes that support, regulate, produce, store and deliver the goods and services needed and desired by humans.

The proposed ESRP requires close collaboration with economists, behavioral and social scientists whose primary work is to understand the consequences of environmental change for human/social wellbeing. This collaboration must be bi-directional. Ecological research should determine the bio-ecological effects of relevant stressors and management actions on ecological systems and represent those effects in terms that can be related by economists and social and medical scientists to changes in human health and wellbeing. An important responsibility of ecological research in this context is to identify and call attention to ecological systems that are important to human wellbeing, but which are not yet adequately appreciated. The ESRP recognizes this need for collaboration and has done an admirable job of recruiting and incorporating appropriate economics and social science expertise, mostly through temporary/part-time hires and through partnerships with other units inside and outside of the Agency. Still, the texts and presentations of the ESRP's plans and accomplishments are not always clear about how the program is balancing the bio-ecological and the human/social value sides of the ecosystems services framework that it has adopted.

Charge Question 1.3.

The ESRP has made admirable progress on several fronts since the last SAB-EPEC review. The overall organization of the program is better articulated and several component projects have moved along considerably. More attention has been given to the implementation of the coordination among individual projects (place studies, nitrogen study, target ecosystems), so that the likelihood of achieving the important advantages of the overall program is increased.

Charge Question 1.4.

The ESRP has continued to build and refine an impressive network of partnerships with other units within EPA, as well as with other government and private agencies. A concern here is the degree of control, and the reliability, of the many links in the elaborate network of partnerships on which the ESRP MYP depends. The revised plan acknowledges the uncertainties of the many intra-EPA partnerships on which the ESRP depends, especially the risk of program offices

changing priorities or shifting focus in the face of budget, political and other constraints. The same issue surely applies to the extra-Agency partners—perhaps even more so. The ORD-ERP should be clear about the parts of the ESRP plan that they have the capability to execute on their own, versus the parts that require (and to what extent) continuing contributions from others, over whom the ORD-ERP has little or no actual control. This is not to discourage the admirable accomplishment of wide support and promises of cooperation within and outside the Agency— without which the ESRP as conceived could hardly be started. However, this is a complex and highly interconnected 10-year plan. It is unlikely that all of the various partners are going to be able to carry out fully their planned/promised roles. A realistic assessment is needed of the relative "reliability" of each partner (with regard to performing and maintaining their role in the ESRP) and of the effects on the overall plan of the failure of a given partner to fulfill their role. This assessment can be approached diplomatically; e.g., through clear, mutually agreed upon statements of what the program is counting on partner X to perform (as in a formal MOU) and what accomplishing their role contributes to the overall success of the program (and by implication what will not be accomplished if this role is not fulfilled). It would be prudent for the directors of the ESRP to consider contingency plans now.

Specific assignments

Charge Question 3 – addressing implementation of mapping, monitoring and modeling themes

National Monitoring for Ecosystem Services (no specific charge question presented)

"We will design a monitoring system for inventorying ecosystem services."

From 1.8, appendix A--"For example the hierarchy of services in the Willamette and Southwest Place based areas may both include a focus on water quantity, but in the Willamette it may be for flood control while in the Southwest it may be for delivery of sufficient amounts of water to sustain population needs."

The example in the box above from the Decision Support Framework chapter highlights the distinction between ecological "endpoints" (e.g., X amount of water at place Y at time Z) and ecosystem "services" (e.g., water as a flood hazard, water for drinking). It should be clear (and probably is, but there appears to be some "back-sliding" in this presentation of the monitoring section of the ESRP), that monitoring and mapping "services" requires an "overlay" of ecological endpoints and human/social needs and wants. An important implication is that social and demographic data, including projections of future populations and their likely needs/wants, is required to identify, assess, project and map ecosystems *services* for any given place and time.

The approach implied by the current model (1.2, Figure X) might be to focus on "potential" ecosystem services (e.g., fresh water, as an *ecological endpoint*, is assumed to eventually be needed/wanted by someone—i.e., it has high potential to provide a service). However, this assumes that we can accurately/validly infer what human populations at relevant places and times (including future populations) will want/need. Of course the flood versus drinking example cited above reveals that such inferences are at least complicated and always require

some data, inferences or assumptions about the human/social contexts (in which case data and data-based inferences are to be preferred).

"We will develop monitoring designs and indicators that will allow current ecosystem services (ES) for aquatic ecosystems to be estimated on a national and regional basis."

Following the flood-versus-drink example discussed above, there is a real danger that this approach might assess the quantity of fresh water produced/ stored /delivered by ecosystems at a sample of places across the US and, by extrapolating across the floods in some parts of the country and severe water shortages in other parts conclude that "water services" for the nation are adequate. We can take it on faith that the EPA would never actually make such a mistake. However, the description of this section of the ESRP is so sparse and so undeveloped that it fails to adequately address or even acknowledge the essential distinctions between ecological endpoints and ecosystems services. The conceptual model and the implementation plan for monitoring activities in the ESRP needs to be much more explicit about how endpoint-service distinctions will be addressed.

The research on a selection of estuaries is certainly relevant and important to the assessment of aquatic ecosystems services. Based on the very brief descriptions provided here, however, it appears that this work will at most only address a very narrow set of ecological endpoints *potentially* related to a single service; e.g., populations of uncontaminated fish as a contribution to desired recreational fishing experiences/opportunities. This has the advantage of enabling the application of reasonably well developed economic valuation methods (travel cost estimates of w-t-p for recreational fishing opportunities), but this seems to be a case of looking under the lamp post. Are these the most important services of esturarine ecosystems? Is this the strongest public policy basis for protecting these systems? Do the measures here proposed provide adequate indictors (never mind measures) of the most important services of these ecosystems?

From 1.4.2, Current Impacts, Critical Accomplishments and Innovations: **"**Increased estuarine recreational fisheries associated with decreased fish contaminant levels may have resulted in $13.5M increase in recreational revenue nationally (linked to OW NARS)."

Note that recreational fishing may not be the "highest and best use" for esturarine ecosystems and that $13.5M/yr is not a lot of money these days. The danger is that this relatively convenient measure of ecosystems services value could be very misleading (especially to the public), and risks overlooking the longer term "values" of these systems to their respective regions, to the nation, and to the world that shares the oceans.

Similar concerns are raised by the descriptions of the studies of streams and lakes. Measures and maps of the miles of streams (and presumably acres of lakes) and various aspects of their condition are surely important inputs into assessing ecological endpoints related to *potential* services that might come from these ecosystems. But these measures are not themselves measures of ecosystems *services*, and they are very likely not sufficient even to begin to address many of the most important services provided by/through these ecosystems.

The later sections of this chapter are also brief and incomplete, but somewhat more encouraging. The reference to "indicators" (rather than "services") and the note that Jim Boyd is assisting in the design of the monitoring program give some assurance that the endpoint-versus-service problems noted above will be properly addressed. Certainly, properly constructed indicators can provide suitable "estimates" of ecosystems services, as Boyd's work has shown. But the construction of such indicators requires the "overlay" of ecological and social factors (at a place and time). The workshop to determine "final ecosystems service indicators" for stream ecosystems will hopefully help to refine this approach considerably.

"There 138 estuaries that represent over 90% of the estuarine surface water and freshwater inflow of the coastal regions of the contiguous US, and only about 92 of these are not currently being monitored by NOAA's National Estuarine Research Reserve System (NERRS) or EPA's National Estuary Program (NEP). Thus, a census approach may be possible, and even desirable, for estuarine ES."

132 – 92 = 40, or just 30% of the 90% (that is, 27%) of estuaries. How is this a basis for claiming a census sample?

Charge Question 3.1

Certainly dynamic atlases of ecosystems services like those described could be of considerable use to decision makers and stakeholders as well as to environmental scientists. The model that guides this mapping theme is more sophisticated than that presented in the monitoring section, but it also misses some aspects of the endpoint-service distinction. In the model, the structure and function of various ecosystems (e.g., streams) "determines" the various types of ecosystems services that flow to various populations of people. There is a bit of a chicken and egg problem here, as one could not know what structures and functions of ecosystems are relevant until you know what goods and services are needed/desired by associated (or at least potential) human populations. This would require coordinated assessments of what people need/want/care about (and when and where) and what proximal (and perhaps more remote) ecosystems are capable of sustainably contributing toward meeting those needs/wants/cares. An atlas of ecosystems services requires a joint mapping of ecosystems (in bio-ecological terms) in association with human/social values.

In some cases the human need component may be reasonably well known, as when the service in question is an adequate supply of clean/cleanable water to a specified water distribution system providing drinking water to a known population of people (perhaps one instance of the "source water" studies described later in this section). One might then be able to" back up" the downward-pointed arrows in the conceptual model presented to determine the relevant ecological systems and conditions (ecological production functions) required to sustainably produce (store and deliver) suitable water to meet the drinking water needs of that particular human population.

It may be that "ecosystems services" is not really what is represented in the atlases. Most of the examples provided actually map ecological endpoints, ecosystems and/or ecological conditions

that contribute to the provision of some service(s) to some human population (or potential population).

Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice--Only if they are explicit about what human populations are being "served" at what levels.

2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions)--Again, this requires identification of what populations (including future generations) are being served, at what levels, over what time periods, at what costs, etc.

3) issues related to environmental and land management, including public and private investments to conserve ecosystem services--If all of the above is accomplished, the atlases would certainly be helpful in this regard.

Charge Question 3.2.

 The pitfall that seems most imminent is that monitoring, modeling and mapping (including dynamic atlases) will focus on traditional (and often already available) bio-ecological variables represented in traditional ways without carefully and explicitly considering how those variables are related to human health and wellbeing. The texts and the presentations of progress on the ESRP include many excellent maps of "wetlands," "rivers" (classed by nitrogen capacity), and "vegetation cover types," for example. These are surely ecologically important, and it might be safe to assume that they are (or might be) of importance to human/social wellbeing (somewhere at some time). However, if the focus of this program is to be on ecosystems *services*, the locations, amounts and condition of these ecological components must be systematically related to the wants and needs of human populations that are or might be directly or indirectly served in some way by these ecosystems or their components. It is important that the monitoring, modeling and mapping activities of the ESRP begin systematically to incorporate the human/social variables that translate ecosystems into ecosystems services.

Charge Question 6 – addressing implementation of decision support activities.

Charge Question 6.1.

The challenge for the Decision Support System Framework project is to keep the focus on ecological aspects of the policy/decision making enterprise at EPA. Certainly the ecological aspects must be addressed in the context of all the other parts of the larger decision system, and the DSS must identify and build the required links from and to the ecological components. However, the ESRP (ORD-ERP) should place the greatest emphasis on identifying and understanding the relevant ecological components and systems, based on the best available understanding of their relationship to human health and wellbeing.

As a step in that direction, the Conceptual Model (Figure 1.2, Summary Description of ESRP) should insert an additional module under Analytic-Deliberation: Between Determine Services

and Identify Stressors it would be appropriate to insert something like Ecological Productions. This module would identify the ecological endpoints and systems on which the identified services depend, articulate the ecological production functions for those endpoints, and elaborate the fuller ecological systems in which those production functions are based. On this later point it will be important to identify a) remote but essential supporting/sustaining functions of other ecological components and systems/sub-systems and b) any important goods and services not initially identified and targeted under Determine Services to which the identified production functions and associated components/systems significantly contribute. This would seem to be one of the core responsibilities of ecological research. This Ecological Productions module would also be a prerequisite to identifying stressors and their relevant effects, through ecological systems, on the identified goods and services, to devising viable alternatives for controlling stressors and/or mitigating their negative effects, as well as to the evaluation of the management options under consideration.

While the presentation of the DSS at the 7/15/2009 meeting of EPEC (Ms. Ann Vega) differed in many respects from the text provided ahead of the meeting, it perhaps even more obscured the role of ecological research and expertise. It is important that the DSS clearly articulate the full decision context into which the ESRP should contribute, and perhaps an emphasis on non-ecological aspects is appropriate at this point for a research unit largely composed of biologists and ecologists. However, the DSS framework should serve the important role of showing explicitly where ecological science fits into the decision/policy context, how that science is constrained by the decision context, and especially how the focus on ecosystems services affects the content, processes and outputs of ecological science.

Though it is currently implied as part of the Take Action module, it would be useful to add a separate module for Monitor and Adapt. Allegiance to adaptive management is wide spread, but conformance with its key requirement is still rare. Any effort to emphasize this important follow-through would be worthwhile.

The shift in timing and goals for the DSS development is appropriate and properly responsive to the concerns raised in the SAB EPEC review. The explicit and aggressive inclusion of stakeholder involvement is appropriate and, while potentially painful at times, such involvement should improve the likelihood, the magnitude and the sustainability of the success of the ESRP.

Reliance on others inside and outside the agency for data and models to build the DSS is unavoidable and perhaps even an advantage, as it capitalizes on hard work already done and expertise not likely to be available to ORD-ERP. However, it would be prudent to systematically assess how critical each of the expected contributions is to the ESRP enterprise, what the effects would be if the quantity, quality and/or timing of the contribution is ultimately less than expected, what substitutes might be available and what modifications will be needed to the overall ESRP and/or to specific components of the plan. That is, "plan B" should be considered in some detail before it is needed.

The model shown in figure 2 contains all the right parts and most of the needed arrows—especially of the double-headed variety. The text within and outside the figure is correct in pointing out the importance of local decisions on the broader ecological and social systems. The

model graphically allows, but the text fails to adequately point out, that federal decisions have very important effects on local situations and on local decision options. The relation between local and federal levels in this context is often portrayed as having negative effects (in either direction, depending upon whom you ask), so it may be important to emphasize how this model offers the opportunity to achieve positive and synergistic effects that benefit both levels (this bi-directionality was better represented in the 7/15/09 presentation than in the pre-meeting text).

The concept of a "searchable database" of decision support tools is certainly in the right direction, but even at this early stage of development of the DSF it will be important to anticipate the needs of intended users. Among the key issues to consider even now are abilities to scale up or down (in time and in space) from existing data and models to fit particular decision contexts (on ecological and on social dimensions), how best to make up for missing data/models, and how to address multiple-stressor (multiple-media) problems based on single stressor (single medium) data and models. These needs have very likely already been surfaced in the initial stakeholder/user workshops, and they are likely to exist for some time even after the final DSS is achieved.

After hearing the 7/15/09 presentation of the current and planned DSS, including the data base of several hundred "tools," it seems that the search engine might better be modeled after "match making" systems than after more conventional key word or list of parameters systems. That is, a decision maker will need help with a complex, multi-dimensional problem, likely differing in many respects from the requirements and capabilities of any of the available tools. The task is to find tools that are likely "good mates" to the decision problem and context at hand.

Table 2 and Figure 3—please add an institutional acronym key!

Charge Question 6.2.

First, the DSS (whether just a framework or a fully implemented platform) should play a central role in the ESRP. This is a long-term very complex and highly integrated program of research involving multiple interdependent projects. The goal of the program is to provide the ecosystems sciences base for EPA to make wide range of decisions and policies. It is essential that traditional ecological research be transformed, as the ESRP envisions, into a multidisciplinary framework that focuses on ecosystems services—the ecological systems, processes and endpoints that promote human health and wellbeing. Moreover, this transformed research program must be fully integrated into the decision and policy making contexts of the Agency. A carefully crafted and effectively implemented DSS is the best, perhaps the only way effectively to achieve these important ends.

The patchwork of special temporary hires and partnerships with other agencies is a practical way to fill the needs for DSS development expertise, in the face of the existing limitations of the ORD-ERP and the inadequacy of funding for more substantially expanding the needed expertise. It will be difficult, but also very important to hold this patchwork together over the course of the ESRP. The DSS should provide guidance early on for the development of the various components of the overall research program—especially for assuring consistency and relevance among the various data collection and model building enterprises within the program. In the

end, the DSS will be needed to effectively integrate the many "tools" that are being selected, created and refined into a form that is accessible and useful for decision makers.

Comments from Drs. Otto Doering and William Moomaw

Charge Question 1

Charge Question 1.1.

The ESRP appears to have developed a more complete understanding of the reframing of environmental problems in terms of ecosystem services. However, it still appears that EPA is constrained by its legislative mandate and is still working within the framework of its legislated mandate of media and issue specific issues. How can these be reconciled?

Charge Question 1.2.

It is difficult for me to evaluate whether this goal to create a more balanced focus has been successful or not.

Charge Question 1.3.

 Yes, with some adjustments, the current elements are definitely worth keeping.

Charge Question 1.4.

 The partnership approach that is being developed represents a new approach to EPA operations to protect human health and environment or ecosystem services. The approach is less confrontational, and needs to engage parties early in the process. It is worth considering the Dutch model, where the goals are set by policy makers, and then the means for meeting those goals is negotiated with the party that is being regulated.

Charge Question 2.

Here are four questions that come to mind that are based upon discussions that have taken place within the Integrated Nitrogen Committee of SAB.

1. Since nitrogen cascades chemically through different media and ecosystems, does the systems modeling that EPA id conducting help to identify the "most effective" point of intervention, or is EPA locked into its legislative mandate to evaluate Nr medium by medium and problem by problem?

2. Which metrics or combination of metrics are most effective in setting priorities for managing reactive nitrogen within a framework of ecosystem services?

3. Are there effective ways to enhance denitrification without creating additional amounts of N_2O?

4. Is attention being given to reduced forms of Nr such as NH_3 and ammonium?

Comments from Dr. Wayne Landis

Introduction

These notes are the comments and questions that I have regarding the Ecological Services Research Program status report document and the charge questions.

Good expansion of the scope

The update reveals a program of greater scope than at the first review. It is clear that the program has been hard at work to implement some of the suggestions of the last EPEC review. The program is in its early stages and has made good progress and that is admirable. My comments on based upon reading the progress reports supplied by EPA and my experiences in conducting studies of multiple stressor systems with multiple endpoints at a variety of scales.

General notes on update report and charge questions

The phrase "Ever more complex" shows up in the document many times. Do you mean that we know understand that ecological structures are complex systems in the modern sense of the word? Do you mean that we were naïve in the past about the complications that we would find in the answers?

One of my deep concerns with reading the update and the reports is the lack of looking outside the Federal government. A general impression of mine over the last 6 years is that the United States has lost much of its leadership role in the environmental sciences in innovation, integrating stressors at a variety of scales, and in the use of analytical tools. Yet there seems to be little incorporation of lessons learned or research results from researchers outside of the U. S. If EPA is to establish itself as a leader in this area then it needs to clearly understand where the current state of the art is in this field. It is not clear to me from these documents that EPA knows where that edge is.

Update Report Page 2 Conceptual Models. I am not sure what is trying to be communicated in the conceptual model diagram Figure 1. I have seen a lot of diagrams such as this in EPA and other programs, but these mix up sources, stressors, endpoints, regulations and so forth. My first inclination in seeing something called a conceptual model is to think about how I would write an equation to describe the relationships. I cannot do that with this diagram. Is the green box an effects box? It shares a lot of the terminology with the ecosystem services box. Is all you are attempting to say is that human cultural systems and ecological systems are coupled? Isn't this well known?

The other item that is important but that I am not reading in this discussion is the importance of context and place. A strong conceptual model for the understanding of ecological services must include an understanding of social and ecological context and spatial relationships. The economies of many regions of the United States were set in part by historical events and by the already present ecological services. The Puget Sound's economy was set because of good harbor and the natural resources of timber and fishing. The cultures of many of the original European

immigrants were amenable to those industries as well, so that the region has a distinctive set of values compared to other areas in the West. There are numerous examples across the U.S. of that interaction between ecological setting, cultural beginnings and current perceptions of ecological services. How is this program going to accommodate those differences?

Update Report Page 17. Recommendation 7—Bayesian tools—It will be interesting to see what direction this takes in the various research groups. It is neat that EPA is beginning to apply these tools to ecosystem management problems. There are two families of Bayesian tools that are applicable. First, there are analogues to frequentist statistics for hypothesis testing, curve fitting and so forth. Second, there are the Bayesian belief networks that are designed to accommodate deterministic and stochastic processes within a modeled system. I have found Bayesian tools to be very informative in some of our recent research, and also find them complimentary to our regional risk assessment tools.

The US Forest Service and others have also used Bayesian networks to examine a number of resource management issues (see Marot et al 2006, McCann et al 2006). Reckow, one of your listed Special Government Employees) is also very knowledgeable about the application of such tools to watershed management.

Charge Questions

There are two key questions in this research program.
"*What are the effects of multiple stressors on ecosystem services, at multiple scales, over time*?

This has been the subject of a great deal of research over the last years in a variety of fields. Forest management plans attempt to examine this question. There are now more cases of ecological risk assessments dealing with this exact issue across the world. How have these results influenced the proposed studies?

"*What is (are) the impact(s) of changes in these services on human well-being and on the value of these services expressed in both monetary and non-monetary terms?*

This may be the more challenging question given the current makeup of the ESRP team. Again this has been an area of active research in the risk analysis field.
Life Cycle Analysis is a process that can give great insight into how changes in industrial or other processes affect a number of variables.   EPA ORD and the group at Cincinnati were some of the earliest developers of LCA. How is the current conceptual model going to incorporate that means of analysis?

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP).

Charge Question 1.1.

Progress has been made but is still so diverse in studies that it is not clear what the target is at times.

Charge Question 1.2.

There is some additional balance in the program.

Charge Question 1.3.

My experience in conducting or in collaborating on studies at regional scales has shown that a huge issue is data analysis and trying to model the risks from multiple stressors. I do not see a risk approach being taken and it is not clear what the data analysis effort will be. The human well being aspect is in part a social science segment I that area is still not funded-supported to the extent that it requires. I understand the history of the program and that acid rain and EMAP had very defined focuses, but if human well being is the goal then that has to be a research and analysis focus as well.

Charge Question 1.4.

I see lots of potential partnerships and that is a good thing. It is not clear to me how these partnerships will work in the ESRP. What are the responsibilities of the partners? What researchers will be a part of the program? How will the input of the partners be integrated into the research?

Charge Question 2: Implementation of Integrated Pilot for Reactive Nitrogen

Is this project consistent with the primary research question of the ESRP? There is one stressor involved here (reactive N)? What will this program specifically contribute to the goal of dealing with multiple stressors from multiple sources? Reactive N will have multiple impacts so perhaps this area would be the area of emphasis?

Charge Question 3: Implementation of Mapping, Monitoring, and Modeling Themes

Charge Question 3.1.

Whose questions are you trying to answer with the Atlas? At the local level the managers generally have mandated ecological services to manage and are aware of them. Water must meet standards, flooding is generally bad, industrial areas are important for economic development and residential areas need to be safe. These maps are useful if they had information about how stressors affected ecological services. That can of cause effect information would be useful but that does not appear to be the current goal.

Charge Question 3.2.

Monitoring without specific questions to be answered is often a waste of energy. My requirements for monitoring to be useful are:

Are there measurements that will provide information regarding cause-effect relationships in the study area? Often there is not a sufficient conceptual model that adequately addresses cause and effect to guide sampling. (See notes on conceptual models for Charge Question 4).
Is the time interval adequate to be able to gather enough signal to ensure that the observed relationships are not spurious?

Does the monitoring incorporate enough spatial information to allow reasonable extrapolation to the rest of the landscape of interest? In so many sites only a small portion of the area is sampled and often is not representative of all the kinds of ecological structures in the landscape, extrapolation to the rest become an issue.

In the report I saw hierarchical Bayesian modeling as one of the techniques discussed. I understand that in our previous comments that we encouraged Bayesian tools to be incorporated into the ESRP. However there are many other tools that are available. Bayesian networks can be very powerful in some areas, especially when coupled with other techniques. Marcot et al (2006) and McCann et al (2006) provide an excellent introduction of the use of Bayesian networks for natural resource management. Gibbs (2007) is an excellent example of the use of both Bayesian networks and agent based models to conduct a risk assessment regarding aquaculture (a source of multiple stressors) to shorebird production.

I am having difficulty find risk-based approaches in the ESRP? The Willamette Basin project is the exception. Why is that? There are now multiple examples of the use of risk-based approaches that deal with multiple stressors and ecological services over wide areas. I will discuss these further under Question 4.

Charge Question 4: Implementation of Place-based Studies.

Charge Question 4.1.

I am happy to note that in the conceptual models that contaminants are not an issue. Therefore CERCLA sites, long-range transport of a number of materials (PCBs and other organics, Hg) and NRDA sites undergoing restoration are not part of the conceptual models. Of the models presented the Tampa Bay stressors-drivers example would probably be the easiest to turn into a cause effect model. However, I note that contaminants, disease, and invasives (a huge issue in FL and in many coastal regions) are not included. The conceptual model of human well being (page 11) is unreadable and I am not sure believable. There are almost more indexes that inputs. As the authors suspect the complexity will fall away but I will still not be sure what it will mean.

Charge Questions 4.2-4.3.

I do not see a good connection between the studies and the decision makers. One of the great lessons of the development of ecological and human health risk assessment is the importance of involving stakeholders and decision makers early and often. Their requirements are often to meet TMDL requirements, ensure economic growth, provide clean water etc. Since some of the conceptual models do not include some of the parameters to be considered at the local or even state level the studies may be of limited use.

One of the best place based studies I have seen has been for the Northern Tropical Watersheds of Australia (Bartolo et al 2008a). These studies examined 51 catchments across the northern part of Australia and were supported by extensive sampling, stakeholder participation, the derivation of cause-effect relationships and so forth. In chapter 3 risks to the 51 catchments were identified and ranked across this broad area. In chapter 4 and more detailed analysis of the Daley River area was conducted using Bayesian networks and other modeling tools. The outcomes of these studies included maps of relative risks to a variety of sources in this area to multiple endpoints, many of which are important to the economy of the region. The summary chapter is also very straightforward about the strengths and limitations of the study and the need to better include the aboriginal people as stakeholders. Perhaps this study could be used as an example of what place-based studies should include.

Charge Question 4.4.

Many areas do have written goals or futures documents that were created by stakeholders. The Willamette Basin is one example. Many areas have wildlife and fisheries management plans especially for marine reserves and parks. I do not see (or perhaps just can not find) this information being incorporated into these conceptual models. Often this information is very specific (so many tons of fish per year).

Charge Question 5: Implementation of Ecosystem Specific Studies: Wetlands

Invasives are a huge issue in the wetlands and salt marsh coastal areas that I am familiar with yet I do not see (or can not read the models well enough) this being a significant issue in the wetlands studies. Invasives often completely alter the structure of the wetland or salt-water marsh altering sunlight, temperature, flows and habitat within the region.

Charge Question 6: Implementation of Decision Support Activities

Charge Question 6.1.

EPA has a very different mission compared to a group such as NSF. NSF's Long-term ecological research sites are more of a basic research model. The exceptions are the Baltimore and Phoenix LTER sites that are looking more closely at the urban-eco interface.
If EPA's ESRP does not aid the decision making process then does the research fit the mission of the agency? There is a great deal of experience in EPA at making decisions regarding environmental management. As far as using risk assessment tools there is experience in ORD and in the regions.

Charge Question 6.2.

As I tried to say in the comment to 6.1 having tools so that on the ground environmental decisions can be made is essential. The ESRP needs to consider its resource allocation and to use the experience of other researchers and agencies.

Citations

Bartolo R, Bayliss P, van Dam R 2008a. Ecological risk assessment for Australia's northern tropical rivers. Sub-project 2 of Australia's Tropical Rivers – an integrated data assessment and analysis (DET18). A report to Land & Water Australia. Environmental Research Institute of the Supervising Scientist, National Centre for Tropical Wetland Research, Darwin NT. Accessed at http://www.environment.gov.au/ssd/tropical-rivers/publications-reports.html#final July 9 2009.

Bartolo R, van Dam R, Bayliss P.2008b. Chapter 3 – van Dam R Semi-quantitative risk assessments – The Relative Risk Model. *Sub-project 2 of Australia's Tropical Rivers – an integrated data assessment and analysis (DET18)* (Bartolo R, Bayliss P & van Dam R). A report to Land & Water Australia. Environmental Research Institute of the Supervising Scientist, National Centre for Tropical Wetland Research, Darwin NT, 164-270. Accessed at http://www.environment.gov.au/ssd/tropical-rivers/publications-reports.html#final July 9 2009.

Bayliss P , Bartolo R , van Dam R 2008. Chapter 4 –Quantitative ecological risk assessments for the Daly River. Sub-project 2 of Australia's Tropical Rivers – an integrated data assessment and analysis (DET18) (Bartolo R, Bayliss P & van Dam R). A report to Land & Water Australia. Environmental Research Institute of the Supervising Scientist, National Centre for Tropical Wetland Research, Darwin NT, 273-415. Accessed at http://www.environment.gov.au/ssd/tropical-rivers/publications-reports.html#final July 9 2009.

Gibbs, Mark T. 2007. Assessing the Risk of an Aquaculture Development on Shorebirds Using a Bayesian Belief Model', Hum Ecol Risk Assess, 13:1, 156 – 179

Marcot BG, Steventon JD, Sutherland GD, McCann RK. 2006. Guidelines for developing and updating Bayesian belief networks applied to ecological modeling and conservation. Can J For Res 36:3075-3086

McCann RK, Marcot BG, Ellis R. 2006. Bayesian belief networks: applications in ecology and natural resource management. Can J For Res 36:3063-3074.

Landis additional comments 7/23/09

General Comment.

1) During the discussion and as noted in my comments, I am struck by the narrowness of the literature search that has been conducted for this program.
As was noted in the discussion there is a large literature on valuation in environmental risk assessment. Valuation and ecological services are very closely related topics and that literature should inform the ESRP.

Over more than a decade there has been a developing literature on how to assess risks at large scales. These risk assessments are also tied to stakeholder values, another area where the ESRP needs experience.

2) Data analysis, where is it? None of the presentations dealt with the huge data analysis issues that come with observations over such large scales. Spatial correlations are rampant, ruining assumptions about independent observations. A number of continua exist within the terrestrial and aquatic landscapes, producing gradients across the landscape. There a number of tools that can be used to look at the datasets that EPA and other agencies have gathered, but I can not find them in the current materials.

3) My biggest concern with this program is that it is still isolated in its thinking and even in its interactions. If part of the goal is to address management issues the program needs to evolve beyond the academic ecology approach to something else more goal oriented.

Comments from Dr. Judith Meyer

Charge question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

Charge Question 1.1. The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations?

The Ecosystem Services Research Program (ESRP) has been responsive to EPEC's primary recommendations. The documents and presentations provided for this consultation provided clearer justifications for the research directions as well as documenting research progress. As recommended, ESRP is focusing its attention on the ecological side of ecosystem services, and on determining ecological production functions. ESRP has revised its approach to decision support. The addition of the southwest study captures an important aspect of the US landscape that had been ignored in the previous design. ESRP has been able to hire relevant experts as Special Government Employees in disciplines not represented by existing staff, and these individuals have added impressive talent to the program. Consultation with EPA program offices (e.g., Water, Air, Superfund) has occurred and affected development of implementation plans. ESRP has excelled in development of partnerships. ESRP implementation plans have been or are being peer reviewed, although we have not seen any implementation plans or their reviews, so it is difficult to comment much further. ESRP has also shown how this research direction is responsive to recommendations made in previous SAB reports (e.g., CVPESS and Ecological Risk Assessment). The Coastal Carolinas project used the principles EPEC suggested to demonstrate why this is a good choice for place-based research. It would be useful if the other place-based studies would do the same. All of these actions demonstrate responsiveness to EPEC's earlier recommendations.

Several aspects of ESRP have incorporated the risk assessment paradigm into their conceptual models, and Appendix B provides a detailed listing of ways in which advice in the EPEC Ecological Risk Assessment report has been incorporated. However, I had a hard time seeing the forest for the trees. A clear one paragraph statement of how an assessment of ecosystem services will improve risk assessment and risk management at EPA would make the benefits of this program more apparent to the Agency. Showing how the conceptual models in the place-based studies relate to the risk assessment paradigm might also help convince skeptics of the relevance of this research.

None of the programs appear to have taken up the suggestion to use life-cycle analyses, although responses to our questions implied that this is being done. More clearly identifying where these analyses are being done and identifying them as life cycle analyses would benefit the program.

Charge Question 1.2. In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the

whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

The role of LTG1 in the entire program is more appropriate in the current ESRP than it was in the MYP previously reviewed. However, the balance may have shifted a bit too far. In particular, I would have liked to see more progress in the linkages between ecosystem services and human health. I see promise in development of the index of well-being and hope to learn more about that in future reviews. ESRP should consider hiring an expert in the relationship between environmental conditions and human health (e.g., an SGE as has been done for other LTGs; someone at CDC?) who could bring prestige and advice to this aspect of the program. Although it is appropriate that most of the emphasis in ESRP be on quantifying ecosystem services, the research is really incomplete until the benefits can also be incorporated. And this requires some attention to the linkages to human health and well-being. I recognize that this is a difficult nut to crack, but it is important to the ultimate success of the program.

Charge Question 1.3. Please assess the progress the Program has made in the15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?

Considerable progress has been made despite significant resource constraints. The ESRP is clearly making progress, but more needs to be done to publicize its existence and demonstrate the products of the program. The written materials had some citations for papers, and several submitted or in preparation. It is time for the program to get out there in the literature.

There are several groups working on ecosystem services both nationally and internationally. The unique niche of the ESRP in this field is that this assessment of ecosystem services is being done in an agency with regulatory authority; that is what makes it different from academic research on the subject. This gives ESRP the opportunity to demonstrate the applicability of the concept of ecosystem services. Providing a demonstration of its applicability (e.g., to Superfund, to wetlands mitigation) should be a high priority for the program. Having a demonstrated success, even in just one area, will be beneficial to the program.

Charge Question 1.4. Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

The documents provide multiple examples of innovative partnerships (e.g., National Geographic, NSF denitrification network, Global NEWA, Millennium Ecosystem Assessment, Business for Social Responsibility, Public-Private Partnership for Ecosystem Services). Inter-agency partnerships are also an important aspect of the program (e.g., USGS, USDA, USFS). The program has excelled in developing partnerships.

Charge Question 2. Implementation of Integrated Pilot for Reactive Nitrogen. Using the nitrogen pilot as an example of ESRP's approach to integration, please comment on how well

the ESRP has succeeded in conceptualizing a systems-approach for analysis of ecosystem service impacts. Does the project take appropriate advantage of all the other projects in the ESRP? Have major uncertainties been adequately clarified and addressed to meet Program goals? Are there additional primary gaps or uncertainties that you see as important?

The N program has established linkages with other aspects of the program – wetlands and place-based studies in particular. It will be important to emphasize how N can influence (both positively and negatively) the effects of other pollutants so that the program clearly demonstrates an alternative to a pollutant by pollutant approach to regulation. This program offers the opportunity to illustrate the concept of tradeoffs in decision-making. I saw no mention of N cascade in the documents provided, although the presentation demonstrated that the program is aware of it. Linkages between this program and the modeling program will be essential as there are real problems with linking models together and the compounding of uncertainties.

Charge Question 3. Implementation of Mapping, Monitoring, and Modeling Themes

Charge Question 3.1. Focusing specifically on the Mapping theme, please comment on the usefulness of the proposed products. For example, please comment on the potential for ecosystem service atlases to communicate the status, changes, and locations of ecosystem services to EPA clients and the public? Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice; 2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions); 3) issues related to environmental and land management, including public and private investments to conserve ecosystem services.

The mapping program seems closest to producing a useful product. The maps should be able to show the locations, status, and changes in ecosystem services, although it is not clear how they will be able to demonstrate the more dynamic aspects of ecosystem services, i.e. ecological production functions and tradeoffs. To be able to address issues of social equity and social choice, the maps will need to be linked with socioeconomic information, and it was not clear how this is being done. To be able to map benefits, the human dimension needs to be captured.

The focus on land use decisions in the mapping program seems somewhat unusual territory for EPA, particularly since the monitoring program seems to be focusing on water-related ecosystem services. This is a potential disconnect.

We were told that dams would be one layer in the map, which is appropriate given their profound influence on ecological services. In addition to showing dam location, the program could consider how to indicate alteration of flow regime. The Heinz Center has developed methods to indicate the degree of alteration of flow regime. Perhaps these could be used or modified so that this could also be represented in the Atlas. The flow regime obviously provides services such as channel maintenance, and an altered flow regime results in altered channels as well as a reduction in other ecological services.

Charge Question 3.2. What advice does the Committee have for the next steps in Monitoring and Modeling? In particular, are there pitfalls that the Office of Research and Development should be sensitive to as it develops this part of the ESRP?

I have significant concerns about the status of the modeling program. Other programs in ESRP are relying on models, yet we were provided with no information on how the modeling program is progressing. I cannot provide advice on next steps for modeling because I have no idea where they are now. Given the centrality of models in all other aspects of the program, the apparent lack of progress in this area is threatening the success of the ESRP. The modeling program should be one of the areas where program integration is most obvious, so the apparent lack of progress here is most troubling. The modeling program is also a place where issues of uncertainty should be addressed.

The decision of the monitoring program to focus on water-based services seems appropriate given the current monitoring programs of the agency. How will it link with the mapping program's emphasis on land? The need to better map the nation's small streams and geographically isolated wetlands is acute. I would hope that the monitoring, mapping and wetlands programs could jointly work on doing this. The attempt to link condition with services could make a significant contribution to a long-standing and basic ecological quest to link structure and function.

The conceptual model looks really scanty and doesn't incorporate most ES (focus is on provisioning services, not regulating, cultural or supporting). The main question seems to be whether current condition monitoring can be used to assess ecosystem services. They have used the CWA to define services: drinking, fishing, swimming, quantity – but does this miss the processes needed to produce these services? Some of the potential products mentioned here are listed as accomplishments above (e.g., Relationship between forest cover and reduced chemical water treatment costs; Reduction in N assimilation capacity of streams). How is aquatic habitat being mapped?

Charge Question 4. Implementation of Place-based Studies.

Charge Question 4.1. Given the goals of the Program, please comment on whether the conceptual models in the Place-based studies are missing any critical elements?

What is missing in the conceptual models is any consistency. The national program needs to exert some direction so that conceptual models have a consistent framework. The diversity of approaches in the different studies is indicative of a young science, and it may be useful at this stage to encourage this diversity, which is a reflection of local priorities and a result of listening to the needs of local decision makers. At the same time, some national direction is essential so that cross-system comparisons can be made. For example, the concept of a base year as used in the Midwest seems to be something useful to be incorporated into other place-based studies. It would also be helpful to incorporate some more uniform consideration of what is meant by the future, i.e., possible agreement on at least one year (2050? 2030?) to consider at all sites. Some national guidance on stressors and services to consider could also help; clearly all stressors and

services are not appropriate at all sites, but it would be good to know that all were considered for possible inclusion at each site.

All the place-based studies seem to be struggling with how to quantify ecosystem services and how to develop ecological production functions. It seems that there should be further national guidance/coordination to assist in these efforts so each study doesn't reinvent the wheel.

Charge Question 4.2. Please comment on whether, at the current level of development, the Place-based Studies will make good demonstration projects for a variety of decision makers at the local to regional scale? Are there additional ecosystem services that should also be considered in these studies?

With the experience from the range of place-based studies, the ESRP should be thinking about a framework for implementation of place-based analyses of ecosystem services. If a community or region were to want to do this kind of analysis, how could it be done?

Charge Question 4.3. Please comment on whether progress in the ESRP is improving the opportunity to compare and contrast methods and results across the five sites of the Place-based studies. What recommendations does the committee have for further integration and cross-comparison and testing among these five sites, either now or in the future?

See response to 4.1. There will always be a creative tension between receptivity to local concerns and the need for national synthesis/integration. That tension has been part of the LTER network from its beginning. Rather than trying to make all aspects of the place-based studies comparable, focus on a couple services to compare.

Charge Question 4.4. Please comment on whether there are omissions of key partners in any of the place-based studies?

The southwest study should be in contact with the Phoenix LTER based at ASU (They have a strong social science component, and one of the lead PIs – Nancy Grimm – is an aquatic ecologist with considerable expertise in N cycling).

Place-based studies are where innovations are likely to take place, also where collaborations/partnerships are likely to develop.

Charge Question 5. Implementation of Ecosystem Specific Studies: Wetlands. Please comment on the benefits that can be derived by EPA from the implementation of the wetlands research theme. Have these benefits been made clear? Is the "top down" strategy for designing the wetlands research theme evident and is EPA conducting research that will move the Agency to a national perspective on wetland production functions? Are the proposed analyses missing any stressors that are expected to have a broad impact on the services provided by wetlands?

This is one of the themes with the greatest potential for providing an immediate (or at least fairly rapid) example of a useful product coming from the ESRP. The need for assessment of ecosystem services and benefits from wetlands protection and mitigation has been identified in

the wetlands mitigation rulemaking. The current methods for assessing services and benefits (e.g., as proposed by the Army Corps of Engineers) are fundamentally flawed. This is an area where research to develop methods to quantify ecosystem services would have an immediate benefit to those in the agency who are having to write permits and consider the appropriateness of proposed mitigation banks. In its earlier advisory, EPEC noted that importance of ESRP producing something useful for decision-makers in the Agency. This program provides the opportunity to do just that.

I found the critical path analysis used in the wetlands study to be particularly useful in illustrating their conceptual model.

The legal issues around wetlands (e.g., which ones are covered under the Clean Water Act) strikes me as one of the critical legal stressors enabling the Agency to protect the ecological services that wetlands provide. How is this being addressed in this research program?

It was not clear from the written material whether headwater streams are included in this effort, although responses to my questions stated that they were. ORD has had a strong research effort demonstrating the role of headwater streams in river networks, and it is important that this be continued. The inclusion of headwater streams in the wetlands research theme is appropriate and essential.

Charge Question 6 Implementation of Decision Support Activities

Charge Question 6.1. Please comment on the defined and anticipated challenges to achieving the goals of the Decision Support Framework. What recommendations does the Committee have to overcome the most significant of these challenges?

See my response to charge question 1.2.

Charge Question 6.2. How does the EPA reconcile Decision Support as a significant need for the Ecosystem Services Research Program with the Program's relative inexperience and minimal resources?

Collaboration with programs (e.g. air agreement in Appendix G) are basically creating a position that is a science-policy liaison with a foot in each program. I see that as an important mechanism for ensuring that research results are relevant to program needs.

General comments

So many of EPA's regulatory actions deal with chemical stressors. Yet there is so little emphasis of this in any of the studies with the exception of reactive N. The program needs to show how ecosystem services research will contribute to regulatory decisions being made under regulations such as TSCA.

Comments from Dr. Charles Rabeni

Response to Charge Questions #5 (LTG # 4) Wetlands.

A. Benefits that can be derived by EPA from implementation of wetlands research theme.
The wetland topic is current, understandable by a wide variety of clients and stakeholders, with
known and quantifiable stressors and services. It has the possibility of serving as the best model
for the research effort and ultimately demonstrating the advantages of the ecosystem services
approach.

The wetlands issue could be an opportunity to contrast how the Ecosystem Services approach
might succeed where the current regulatory approach has – in many instances – failed   to protect
wetlands and associated headwaters.

B. Have these benefits been made clear? Not as well as could be. Especially where benefits are
well known and quantifiable – recreational fisheries, waterfowl production, pollution
remediation, hydraulic (flood) control). More could be done so services are expressed in clear
and unambiguous terms to excite end users?

C. Is the "top down" strategy for designing the wetlands research theme evident and is the
research being conducted adequate to move the agency to a national perspective?

Attacking the problem at various spatial scales is certainly appropriate, but it would be more
evident if the agency had a better rationale linking the relation of spatial scale to first, the
questions being asked, and second, to the appropriate decision makers.
Perhaps the agency could rank and prioritize possible users of this information so as to better
target research efforts.

The LTG 4 document states a challenge to providing appropriate production functions is due to
the variability in "hydrology and other functions". Would there be a benefit to separating
wetlands into "freshwater" and   "not fresh water" (coastal, estuarine, tidal) in making
production functions and ultimate services more homogeneous for each group. The agency
might consider a plan to incorporate particular results from place-based studies into a more
comprehensive national effort.
One question is whether the program is advanced enough to generate expectations of the
"national office" for coordination and support of the place-based studies. (For example – Would
broad coordination at the Washington level among agencies – NRCS, USFWS, USGS, be useful
to all place-based projects.)

D. Are proposed analyses missing any important stressors expected to have broad impact on
services provided by wetlands?

The LTG 4 document is necessarily presented in broad, very general terms. There is no mention
of specific stressors in the narrative. Only in Figure 1 are some very general stressors listed
(e.g., flow alteration).   The "examples of future products" indicates linkages between stressors
and ecosystem services are being pursued, but no details are given.

(Note: In general, the site specific demonstration projects reports have done a good job of relaying their specific objectives relating to wetlands)

General Issues:

The broad, general presentation of the LTG Wetlands is appropriate and probably necessary given the scope of the project. Nevertheless, the success of this program is set up along the weakest link concept, where specific objectives must all be met. A better articulation of the objectives and which ones are met already, which ones require research, and which ones are problematical would be helpful. Particularly interesting is the reemphasis – quite appropriate - of the ecological research steps, but deemphasizing the social science, outreach aspects (with one notable exception). The EPEC review was quite critical of the disparity between the importance of this program and the resources supplied, a disparity which stills continues. The daunting tasks inherent in this endeavor do not coincide with the fact that many (most? all?) personnel within the ERSP Wetlands programs are "part time", including the theme lead. These folks on staff clearly do not have many of the expertise required, and there is little or no resources to close these gaps, with either EPA personnel or additional consultants. The wetlands initiative could profitably address some of these issues by more aggressively seeking partnerships from other federal agencies – e.g., FWS NA Waterfowl initiative, or the adaptive management decision support group in the Biological Division of USGS. This seems an appropriate task for the national program to take the initiative to assist the regional projects.

The wetland initiatives of the place-based projects is quite impressive, and those groups should be commended for integrating ecosystem services thrusts into ongoing ecological research.

<u>**Comments from Dr. Amanda Rodewald**</u>

Specific Charge Questions

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

Charge Question 1.1. The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations.

ESRP has done a fine job in addressing most of the recommendations of the SAB. In particular, I'm pleased with the ways they have:
a) clarified the organizational structure, including inter/intra-program coordination, personnel responsibilities, and sources of additional expertise,
b) explicitly linked the Multi-year Plan's Long-term Goals to recent SAB recommendations about ecological risk assessment and the application of environmental decision-making (though these links also need to be somehow articulated in the actual plan too),
c) developed an innovative strategy to promote and facilitate partnerships needed to accomplish goals (i.e., public-private National Ecosystem Services Research Partnership)
d) strengthened collaborative ties with other EPA offices.

That said, the responsiveness of ESRP in other elements is more difficult to assess given that we did not have access to the Research Implementation Plans. For example, it was difficult to assess the extent to which program scope/goals had been focused to be more achievable within the timeframe.

Charge Question 1.2. In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

Perhaps I am reading the wrong area, but it seems that the LTG 1 articulated in the "Summary Descriptions of ESRP Themes and Projects" document, was identical to that in the February 2008 draft.   For the Decision Support Framework, the timeline was increased by 2 years, which is a relatively small change.

The central challenge of limited resources remains, though there is hope that the partnerships and experts will augment the EPA's fiscal and intellectual contributions.

 I am confused by the organization of the LTG1 and the "themes". Separating "decision support framework" and "human well-being" into (a) and (b) bullets following the overarching goal seems odd given that LTG1 is focused on developing the framework (so it is not one aspect but

THE goal) and improving human well-being is the ultimate aim (not one focus). To me, it seems that these are/should be highly integrated components. Were there the need for themes, it would seem that (1) sustainability of ecosystem services, (2) their value, and (3) human-well-being would be the three.

Charge Question 1.3. Please assess the progress the Program has made in the 15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan, in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?

As a whole, I am impressed by the progress that ESRP has made, especially in the areas noted in 1.1. The research conducted in support of the human well-being theme of LTG1 is exciting and seems to be proceeding well. The productivity of EPA staff in terms of presentations, workshops, reports, and publications is strong and in alignment with the Plan goals.

Charge Question 1.4. Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

I find the public-private partnership to be exciting, and I very much like the three-part framework (the ecology frame, the economic-ecologic frame, and the institutional frame) that has been advanced to guide the partnership efforts. That said, the specific nature of the partnerships remains rather vague. For example, do partners receive any direct funding? What was the outcome of the initial solicitation? Given that each partner will differ somewhat in goals/approaches/needs, what are the needs of partners to create & maintain viable partnerships?

Charge Question 2: Implementation of Integrated Pilot for Reactive Nitrogen. Using the nitrogen pilot as an example of ESRP's approach to integration, please comment on how well the ESRP has succeeded in conceptualizing a systems- approach for analysis of ecosystem service impacts. Does the project take appropriate advantage of all the other projects in the ESRP? Have major uncertainties been adequately clarified and addressed to meet Program goals? Are there additional primary gaps or uncertainties that you see as important?

The authors did a fine job explaining the Nitrogen-Theme project. In particular, the conceptual model was clear, and the links to mapping, monitoring, and place-based studies were strong. I also liked the hierarchical illustration in Appendix A. In terms of future directions, I felt that the amount of detail was insufficient for evaluation.

Do the measurements/indicators used in this Theme align with N-related indicators that will be used in the Report on the Environment?

Charge Question 3: Implementation of Mapping, Monitoring, and Modeling Themes
Charge Question 3.1. Focusing specifically on the Mapping theme, please comment on the usefulness of the proposed products. For example, please comment on the potential for ecosystem service atlases to communicate the status, changes, and locations of ecosystem

services to EPA clients and the public. Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice; 2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions); and 3) issues related to environmental and land management, including public and private investments to conserve ecosystem services.

Is the mapping/monitoring piece part of the Decision Support Tool? I would think that it would be, but I was unclear about this.

Related to decision support, when will decision-makers be included in the process? Some understanding of the type of data that they need to make decisions would provide important guidance about the structure of the Atlas. I am concerned that the development of the Atlas will reach a relatively advanced state of development before they receive substantial input from decision-makers.

One cautionary note about the informal responses of decision-makers to the presentations (as Anne Neale explained) is that the structure and application of the Atlas is still relatively general in concept. The enthusiasm of the audience may be inflated because each person naturally casts his/her own projections on the "to-be-determined" areas. The actual Atlas may be very different in the end.

I am unclear about the spatial scale and level of resolution that will be used in the Atlas. Are a priori units delimited (i.e., will a user be constrained to having ecosystem services estimated for particular HUCs or watersheds or by EPA Region), or will users be able to define the geographic area or ecosystem type for which they wish to estimate ecosystem services?

The mapping group might consider using the place-based studies as the context for working out the kinks, so to say. This would be especially helpful in involving decision-makers to comment on the usefulness and suggest revisions.

Charge Question 3.2. What advice does the Committee have for the next steps in Monitoring and Modeling? In particular, are there pitfalls that the Office of Research and Development should be sensitive to as it develops this part of the ESRP?

I am curious why the monitoring component does not explicitly integrate with the questions articulated in the Report on the Environment. Coordination with ROE as the monitoring program is developed would provide an excellent opportunity to not only advance ESRP, but also for ESRP to be one of the primary sources of data on indicators and endpoint measurements used in the ROE. Perhaps the links are already present, in which case the plan might better highlight them. On that note, I was struck that ESRP is collecting a variety of regional data as part of the monitoring program and the ecosystem & place-based studies. While I have no objections to this, ROE avoids the use of regional data (explained in their indicator criteria guidelines). What a missed opportunity if the regional data collected by ESRP were not used in ROE! In light of this, some further discussion between the two groups is suggested.

In section 1.4.1, ESRP explains that they are currently analyzing/synthesizing data from Humboldt Bay, Lagoon Pond, and Weeks Bay. I'm curious why these efforts are not initially focusing on the site-specific/place-based studies.

Charge Question 4: Implementation of Place-based Studies.

Charge Question 4.1. Given the goals of the Program, please comment on whether the conceptual models in the Place-based studies are missing any critical elements.

As I reviewed the demonstration projects, I wondered why they each did not use similar conceptual models, at least in basic architecture or level of detail. In particular, using the same conceptual model as proposed in Linthurst & Goodman's status report (page 2) would be useful. The use of completely different models for each element of the Multiyear Plan is confusing and, at times, laborious for the reader. Using similar conceptual models would facilitate cross-comparisons and testing.

Future Midwestern Landscapes: Aesthetics presumably would influence recreation, and recreation would also directly link to human health via mental & physical benefits of outdoor exercise and, alternatively, the risks associated with exercising in areas with polluted air. Of course, the models are representations and could be made ever-increasingly complex, but this may obscure the point and necessary foci. The FML model seems a bit too complex and difficult to interpret.

Tampa Bay: I was unclear why "landscape connectivity" was a value derived from ecosystem services, and the model component determining human well-being. Why would landscape connectivity not be a driver or an attribute of ecosystems?

Willamette: There seem to be two completely different conceptual models; the first titled, "WESP Conceptual Framework" on page 1 and the second titled "Conceptual Model" in Appendix B. This needs clarification. Regarding the Appendix B conceptual model, the center circle lists "biological greenhouse gas regulation, air quality regulation, water quality & quantity regulation, and habitat & biodiversity". The boxes of EPA Regulatory Authority, Staff Expertise & Resources, Client Needs, and Stakeholder Interests" all point to the center circle. I am unclear about the nature of the relationship. Do the links illustrate that these different groups will affect how we measure those endpoints? Or perhaps how we evaluate them? Perhaps how we define them? Clarification would be helpful.

Coastal Carolinas: As a reader, I like this simple model best among the demonstration projects.

Southwest: There is a lot of redundancy in the model with several differently-placed boxes for plant growth & composition, recreation, wildlife habitat, and carbon sequestration. Finding a way to reduce redundancy would simplify the model and make it easier to read.

A minor point – consistent terminology would be helpful. Currently the documents refer to these studies as "place-based studies" and "site-specific demonstration projects".

Charge Question 4.2. Please comment on whether, at the current level of development, the Place-based Studies will make good demonstration projects for a variety of decision makers at the local to regional scale. Are there additional ecosystem services that should also be considered in these studies?

Additional support for (1) how these particular locations are widely representative of major ecosystems upon which humans rely in the US and (2) the extent to which findings of place-based investigations can be generalized to other systems or geographic areas is needed.

One concern that cuts across all projects is that the future scenarios are still to be determined. Exactly how specific future scenarios are formulated or constructed seems to be a critical piece that will ultimately determine the usefulness of the projects. Currently, there is insufficient information upon which to evaluate the relevance/likelihood of the scenarios.

For each demonstration project, the listed cross-cuts seem more like explanations of topical areas that overlap rather than descriptions of ways in which the projects will attempt to directly link.

The decision support framework team would probably do well to work closely with the place-based studies to "try out" their approaches. Really, these place-based projects are where ESRP could bring everything together – mapping, monitoring, decision-supporting tool development.

I'm also wondering if it might be possible to communicate with the ROE team to see how the data collected might be applied to the next ROE. Although ROE avoids use of regional indicators, there might be opportunities to standardize certain measurements/data from which ROE could derive national indicators.

Specific comments & questions:

FML –
- Which drivers are considered?
- What are the 10 agricultural conservation practices considered in the MS landscapes, and how are they selected?
- Which approach will be used to "value" ecosystem services and how will this be applied to "critical habitat" and "sensitive species"? In these two cases, if the value of a particular location lies heavily within habitat/sensitive species areas, then it is not necessarily appropriate to quantify the value by summing across all services because there may be no opportunity for tradeoffs (i.e., if one location is the ONLY location where Endangered Species X lives, then the cumulative numerical value based on ALL ecosystem services will not reflect the true ecological value of that area).
- There is insufficient information for me to evaluate the extent to which the FML project aligns with and will inform Greenhouse Gas Rule and future regulatory decisions.
- Appendix A: FML Hierarchy of Values and Ecosystems Services was very confusing to read. Without lines or compartments, I was unable to discern which variables were linked (e.g., does Min Pests link with Min water-related illness or air-related illness? Is only Pests linked to Biodiversity, not the others?

- Appendix A: Is Minimizing reduced potential for industrial productivity an appropriate goal? This might directly conflict with many of the natural resource/recreational/environmental values that we want to maintain.
- Appendix B is impossible to read.

WRB – of the demonstration projects, this one seems the most narrow in geographic focus and the potential of results to be applied to other ecosystems/geographic regions. I might be mistaken in this opinion, which suggests that additional justification of how WRB serves as a "demonstration" project. Perhaps the national relevance is to demonstrate the approach and methodology, rather than transfer the socio-ecological findings.

Charge Question 4.3. Please comment on whether progress in ESRP's Cross-Place-based theme is improving the opportunity to compare and contrast methods and results across the five sites of the Place-based studies. What recommendations does the committee have for further integration and cross-comparison and testing among these five sites, either now or in the future?

Clearly, ESRP has begun to carefully think about cross-place integration. As I try to consider opportunities for integration, the use of widely different conceptual models (in terms of structure, organization, and level of detail) makes it difficult to identify points of integration.   Therefore, I suggest use of similar conceptual frameworks to be one important starting point for the cross-place-based coordination.

Both integration and the contribution of the studies to the field, as a whole, would likely be enhanced if overarching questions were identified – not descriptive questions (e.g., how does stressor X influence service Y in ecosystem Z), but more mechanistic ones. For example, perhaps the demonstration projects can be used to answer questions like:
- how does the structure (e.g., link density, compartmentalization) of the human-ecological network affect the resilience of ecosystem services to particular stressors?
- how do patterns of land ownership influence the level of dependency upon certain ecosystem services?
- are there particular combinations of stressors that are most detrimental to certain services?

One also could examine applied overarching questions related to the goals of ESRP. For example: how does socioecological context or management/regulatory attributes of particular regions constrain the type of decision-support framework that is useful?

The above questions are quick examples and not necessarily well-conceived, but they might illustrate how questions could drive collaboration/coordination across places.

Charge Question 4.4. Please comment on whether there are omissions of key partners in any of the place-based studies.

I don't notice any obvious omissions. Regarding partners, I really like the way that the Tampa Bay Project has involved potential end users of products as a way to prioritize research efforts. Other projects may be using similar approaches, but simply haven't described this.

Charge Question 6: Implementation of Decision Support Activities

Charge Question 6.1. Please comment on the defined and anticipated challenges to achieving the goals of the Decision Support Framework. What recommendations does the Committee have to overcome the most significant of these challenges?

One of the key steps to make the Decision Support Framework useful is to engage the wide range of stakeholders & decision-makers to understand exactly how they would use the framework and the type of data needed.

Another issue relates to how you can make decision-makers aware of the tool. After Ann Vega mentioned that a similar tool had been developed for brownfield revitalization, I quickly searched the web and immediately found The Brownfields and Land Revitalization Technology Support Center. Despite EPA being one of the members providing this web resource, I could find no links or reference to SMARTe. It took time and deliberate searching of various spellings of SMARTe to locate the tool. Though my searches might have missed the links, I suspect that they are reasonably similar to typical searches conducted by potential users of the tool. Long way of making the point – be sure that the tool is visible and easily accessed.

I agree that the issue of cumulative impacts is huge, but I don't have any clear insight about how this can be resolved.

Charge Question 6.2. How does the EPA reconcile Decision Support as a significant need for the Ecosystem Services Research Program with the Program's relative inexperience and minimal resources?

Engaging non-EPA experts as SGEs is a great start. It sounds like they also are trying to organize an NCEAS working group to focus on particular issues, which would be very helpful.

I am unclear why there isn't a tighter collaboration between the DSF and place-based study teams. It would seem that those place-based studies would provide excellent opportunity to work closely with the decision-maker/science/manager groups and to demonstrate how the DSR can operate.

Comments from Dr. James Sanders

Charge Question 1.1. Has the program been responsive to SAB comments and recommendations?

Overall, I believe that the ESRP has shown an understanding of the recommendations made, has adjusted their priorities and workloads to some extent, and through additional funds, appears to have made progress in obtaining some help to add to the in-house expertise. One of the SAB's comments, seen throughout the last review, dealt with the lack of detail, and at present implementation plans have been and are being developed. Without seeing those plan details, it is impossible to judge their overall value, but it does appear that progress is being made. The ESRP group either did not understand the SAB's concern with the attention on coral reefs, or chose to ignore it. I found the progress report for this section to be mostly defensive.

Charge Question 1.2. LTG 1 too ambitious?

No comment.

Charge Question 1.3. Progress over the past 15 months.

There is evidence of considerable progress toward all goals. Overall funding constraints remain a concern, and discussions of priorities within the Program should be occurring. Without seeing the detailed implementation plans, it is impossible to ascertain whether the available resources can achieve what is necessary.

Charge Question 1.4. Partnerships.

I continue to be positive about the partnerships being formed. There is better evidence in these progress reports of true collaborations. It is difficult at this point to assess whether these partnerships will lead to EPA adoption of ESRP concepts or integration across the agency, but they will lead to a better understanding of ES across the nation.

Charge Question 2. Nitrogen.

N was a good choice for pilot studies, as it can exert both positive and negative impacts, is widely studied, and is important to all media that are under EPA's purview. The overall concept for this study is well described, but the actual implementation for this study remains unknown. The use of the LTER conceptual framework appears to be appropriate, and the "roadmap" concept for integration also seems appropriate. However, concern remains that the actual staff time allocated to this effort is too small to accomplish all the tasks necessary. Progress has been made, the implementation plan has been reviewed, but the committee has not yet seen that plan. In addition, it appears that the ESRP has not utilized members of the Integrated Nitrogen Committee for this review; their comments would be of value. While some mention of the N study appeared in the place-based progress reports, there did not appear to be adequate coordination, nor was there evidence of an overarching plan to link planned studies in each

place, to ensure overall integration. Again, these concerns may be addressed by the individual implementation plans for the place-based studies, which the committee has not seen. The apparent lack of integration between the overall N program and the wetland program and the place-based program is a significant gap in planning.

Comments from Dr. Kathleen Segerson

Charge Question 1.

- The Agency has generally been responsive to the Committee's primary recommendations. In some cases it is hard to tell because we do not have a revised plan (i.e., a new, complete document to review), nor do we have the detailed implementation plans. In some cases, it is simply too early to tell. However, the Agency certainly seems to have tried to move in the directions recommended by the Committee, where feasible (given resource constraints). In particular, ORD has recognized its lack of expertise in the area of ecosystem valuation, and has sought to shift its focus appropriately (given its expertise) and supplement its expertise with outside experts.

- Based on this, the Plan has achieved a more balanced focus. It retains some of the work on the Decision Support platform but has scaled this back to a more feasible plan, with a more realistic timetable (but see comments on Charge Question 6). In addition, it has scaled back its overly ambitious goals regarding valuation and contributions to human well-being. However, the Charge document doesn't adequately reflect this rebalancing. It still states:

"The general research questions for the program are:
  - *What are the effects of multiple stressors on ecosystem services, at multiple scales over time?*
  - *What is the impact of changes in these services on human well-being and on the value of these services expressed in both monetary and non-monetary terms?"*

I don't think this is accurate. The second question is now no longer a major focus of the plan. And the first question is too narrow to describe the plan's focus. The description of the focus following these questions ("…the Program is focused on developing quantitative, operational definitions…..") is a more reasonable (and realistic) description of the plan's focus. I would add that the plan attempts to determine the tradeoffs in the provision of ecosystem services (i.e., how more of one service might imply less of another), which can be an important input into policy decisions, but it is not the same as valuing services in monetary or non-monetary terms.

- In terms of progress, the Agency has made substantial progress along some dimensions. For example, it has taken important steps to try to establish partnerships to leverage resources, and it has brought outside experts on board to supplement its limited expertise in some areas. Both of these actions are responsive to the SAB's previous comments. The Agency also appears to have made progress on the Decision Support Framework, collecting information (data, models, etc.) that might be useful to policymakers concerned about ecosystem services. It is hard to tell how useful this information is (see response to Charge Question 6). The Agency appears to be trying to assess the needs of decision makers. These efforts should help ensure that the information is provided in a useful form, but it is hard to tell based on the documents provided.

- ORD appears to be making efforts to partner with other units, primarily within the Agency. There seems to be some attempt to partner across agencies, but this does not appear to be as

extensive as the intra-agency efforts. The charge question asks specifically about adoption of ESRP concepts by the Agency. As noted, the Agency continues to be focused on chemicals and human health. One way to get other parts of the Agency to be more concerned about ecosystem services would be to show a link with human health. Yet this part of the ESRP is minimal at best ("opportunistic" was the phrase used), simply reflecting work being done for other purposes. Perhaps the interest or concern about ecosystem services would increase in other parts of the Agency if stronger links with human health could be established. If so, the part of the Plan devoted to this should be enhanced.

- At several points during our July meeting, the committee raised the need to have an over-arching framework for use in all of ORD's ecosystem services work, including the place-based and pollutant-specific studies. This is a key recommendation of the committee. There are several existing frameworks from which ORD could draw. These include the risk assessment/risk management paradigm and the framework proposed in the CVPESS report (which would link the ORD program more closely to other things the Agency has been interested in). Rather than putting such a framework at the end (as it was, for example, in the presentation on "Implementation of Place Based Studies: Coordination with ESRP Themes"), it should be at the forefront and guide each piece of the ESRP. Starting with this framework, the individual projects (whether place-based, or pollutant based) can then ask what specific data, models, etc. are needed to operationalize the framework in that particular context. This should include identification not only of the biophysical data and models, but also the socioeconomic and other related information. Even if ORD focuses on the biophysical data and modeling, it needs to do so with a general recognition and understanding of the broader picture in which the research must be embedded in order for it to be useful for decision making.

Charge Question 6.

The comments here reflect reactions to both the written materials received on LTG1 Decision Support, and the presentation made during the July 14 meeting, which contained information not included in the written materials.

- The charge question asks specifically about how to handle challenges. There are serious challenges here, which the Agency recognizes. ORD does not have the expertise to provide complete decision support. So the question is: what type of decision support can ORD reasonably provide through the ESRP? One avenue that is alluded to in the documents but not emphasized is the tradeoffs involved in providing ecosystem services. ORD's strength is in identifying and quantifying ecosystem services, and presumably in predicting how the provision of these services would change in response to stressors. A key part of this is tradeoffs. As emphasized in the Millennium Assessment, more of one ecosystem service might imply less of another. ORD should have the expertise to provide information about these tradeoffs (without the need to explicitly value any of the associated changes, for which it does not have the necessary expertise). In economics, this is equivalent to providing information about a "production possibilities frontier", which shows combinations of different goods (or services) that can be provided. Information about these tradeoffs (i.e., ways to identify and quantify them) would be an important input into policy discussions that

would be within the realm of what ORD could provide, given its expertise. Of course, in the longer run with more resources, ORD could expand its ability to assess or value these tradeoffs. But in the short run, with its limited resources, it could at least seek to identify them.

- There is a difference between providing information for decision makers and helping decision makers actually make decisions. The presentation and the emphasis on deliberative processes suggests that ORD envisions doing the latter rather than simply the former. This is a significant departure from ORD's previous focus, and, if this is the intention, it should be made explicit. ORD does not currently have any comparative advantage in doing this, and would need to "contract out" most of this. It has brought in a number of people with expertise in decision science/analysis, but it is still not clear that it is a good use of ORD resources to do this. It might be better to provide information that would be useful to decision makers when they are evaluating alternatives, but then "step back" and allow the decision makers to actually evaluate and make policy choices.

- A key component of decision support is making sure that information that is provided is relevant and useful. One way this can be done is through deliberative processes, but not all contexts call for this type of process (it may even be infeasible in some) and this is not the only way to include stakeholder input. As discussed in detail in the CVPESS report, information from stakeholders can be gleaned from a variety of sources or processes and used to guide the analysis without engaging in a full deliberative process. For example, information about what stakeholders care or are most concerned about can be determined from focus groups conducted at the beginning of a policy evaluation process or from other sources. This will make the analysis relevant and responsive to stakeholder needs and concerns without necessarily invoking a deliberative process or requiring involvement by decision scientists.

- While there is some reference to economics, the role of economics in the current DSF is unclear. There is little, if any, mention of "benefits" from the provision of ecosystem services, and there are no references to economics or studies by economists in the list of references on slide 22. In our previous review, we noted that ORD did not have the expertise to conduct ecological valuation. This requires expertise in social sciences, INCUDING economics. But the list of experts that ORD has hired for the DSF is almost exclusively decision scientists/analysts. As far as I could see, there were no economists on the list of "ESRP Experts", "ESRP Partners", or the "Expertise yet to be Tapped." The only reference to an economist is the hiring of a macro-economist for the NRMRL, but it is unlikely that someone with a macroeconomic orientation will be able to provide the economic expertise needed for ecological valuation. Also, in the previous version of the plan, there was reference to working with NCEE, but this reference has effectively disappeared from the current program (as described in the documents and overheads).

- In terms of applications, the DSF seems to be closely tied to the Coral Reef group. It is not clear why or whether this is wise. It might be better to try to develop the DSF in the context of something that is likely to get greater interest, particularly given the committee's view that the usefulness of the DSF needs to be demonstrated quickly. Other possible applications

where the DSF might be developed with greater visibility and interest would be one of the place-based studies or the wetlands or nitrogen projects.

- Slide 14 depicted an organizational scheme for the tools database that is very confusing, at best. First, from the categories here, it is unclear what is meant by "tools". Second, if these are the types of categories that will be used to sort the tools, then this is also very unclear. For example, what are the 15 "economic models" as distinct from the 15 "empirical models" or the 6 "conceptual models". Any economic model will be either empirical or conceptual. If this database is to be useful to decision makers, it needs to be very transparent and user-friendly.

- There seems to be considerable interest in using social networking tools. In fact, in the tools database, there are nearly as many social networking tools as economic tools! But it is unclear how social networks will be used to further the research agenda. Information collected from SNA represents a biased sample of stakeholders along a number of dimensions. Thus, the plan to use these networks to "bring stakeholders and decision makers to a common understanding about a topic" might miss the mark.

- While we have not been asked to comment on the Human Well-Being part of the ESRP, I will simply note that this is really the place where the justification for the plan lies. This part of the plan needs to occupy a key place in the broad conceptual framework (see comments above). In addition, it is imperative that the Agency show the impact of ES on human well-being BEYOND simply a connection through things like Lyme disease and near-roadway ambient air quality. In fact, just including these two studies weakens rather than strengthens the case for ES protection. It leaves the impression that these are the only examples of impacts on human well-being that the Agency can come up with. I personally would urge the Agency to consider refocusing the human well-being component of the ESRP around the work on the index of human well-being, rather than on the Lyme and near-roadway studies. This is the over-arching theme here, namely, that ES affect human well-being through a number of channels delineated in the index of well-being. So, that index should be the primary focus (at least conceptually) of this part of the plan. The other specific studies like Lyme can then be placed in this broader framework as illustrations of attempts to quantify individual components of the index.

Comments from Mr. Timothy Thompson

Over-Arching Comments

The overall program goals for defining and applying ecological services is supported and endorsed by the SAB EPEC. This effort can have a lasting effect on the way ecological systems are evaluated, valued, and used and/or preserved.   ESRP builds off of programs that were reviewed and endorsed enthusiastically by the SAB beginning in 2005 (see discussion below on CrEAM, GISST, and ReVA).   Support for these now-combined efforts through the ESRP should be continued, and in particular integrating those tools with values of ecosystem services. Kudos to the entire ESRP team for its hard work and continuing thoughtful and enthusiastic endeavors.

1. Focus efforts and resources on demonstration projects. ESRP as construed in the MYP and updates supplied to the SAB is an overly ambitious program that is in danger of accomplishing many incremental steps, but not producing a long-term tool that is broadly used. Like the previous EPA GIS-based ecological decision tools, ESRP has as a serious Achilles heel that it must work to overcome; lack of a specific regulatory driver and/or demonstrated customer base. There existed a prevalent "if you build it they will come" theme throughout the presentations; i.e., the existence of the tool(s) will create a use and need.   This can and should be done – but an over-arching theme of the previous SAB report, and repeated in this review, is that ESRP should focus its resources on doing well the five (with a suggested sixth) demonstration projects, and forgo for now the larger, costly efforts such as building a national resource inventory.

2. Update the MYP. ESRP needs to put its plans and objectives on firmer ground by formulation of a clear and concise Multi-Year Plan (MYP) that includes the Implementation Plans (IP) for the individual projects under the Long Term Goals (LTG) and cross-walks between products and services that will be developed to specific uses and/or regulatory applications, and outreach for technology decision-tool transfer.   The SAB previously commented on this; the material provided prior to the meeting did not dispel the feeling of "lack of specificity" in the overall program. Having said that, some of the presentations did an excellent job in assisting in the SAB's understanding. Specific comments include:

- Recommended that the MYP February 2008 Review Draft be revised to incorporate (a) the specific comments of SAB in September 2008, and to include any supplemental Implementation Plans that have been developed (e.g., ESRP Implementation Plans for Wetlands and Coral Reefs cited in the LTG4). (Applies to Charge Question 1.1)
- Articulation of research priorities for all programs (e.g., LTG4 – see comments to CQ5). There needs to be walkway between Regulatory Need →Long Term Goals →Research Questions →Work Products →Outreach →Implementation Plans.   Schedules for work products are offered for some efforts (e.g., coral reefs), but not for others (e.g., wetlands).
- Given the emphasis on services, clearer discussion of how Multi Criteria Decision Analysis tools will be developed and incorporated.

- Clear links with existing/previous intra-Agency programs. There are no links in the MYP, or in the June 28 Update Memo to specific examples of similar programs that have previously been reviewed by the SAB. These include:

    o Review of the Environmental Economics Research Strategy of the U.S. Environmental Protection Agency (2004);
    o EPA's Regional Vulnerability Assessment (ReVA) Program (2005)
    o SAB Review of the EPA Region 6 Geographic Information System Screening Tool (2006)
    o SAB Review of the EPA Region 5 Critical Ecosystem Assessment Model - CrEAM (23006)
    o ORD Sustainability Research Strategy and the Science and Technology for Sustainability Multi-year Plan (2007)

- MYP re-write to indicate what LTG each is working on, the specific research being conducted, and the specific work product each is tied to. This is also an issue of transparency; how and why were these experts selected. The Status Report (June 2009) in Appendix D provides a list of "Expert Hires to Complement In-House Expertise". As articulated, this is a recitation of individuals, some qualifications, without a specific need or product identified.
- Strengthening of the individual demonstration project discussions to include expected tools, and outcomes, with clearly-defined measures of success for the tool and outreach products
- Identification of user community for the tool(s), potential regulatory programs or efforts that the tools will aid, and a defined program for outreach to achieve tech transfer.

3. Recommend that ESRP continue seeking input from the SAB EPEC and the BOSC. The process used to formulate, focus, and review ORD's *Land Preservation and Restoration Multi-Year Research Plan: Fiscal Years 2006 to 2011* is a process that might be considered in the revision of the ESRP MYP. That plan was reviewed twice by the SAB, and formed a basis for subsequent reviews by the Board of Scientific Counselors (BOSC). SAB provided the necessary scientific input into the MYP, while the BOSC provided early and mid-cycle reviews on whether the plan was achieving its goals, making best use of resources, and input to ORD when resource changes were required based on shifting budgets and mandated research needs (e.g., reduced program budget combined with the need to assess potential human health risks from releases of nanotubes). The SAB should have an opportunity to review the IPs in the course of providing comments to EPA. The MYP and subsequent responses to not provide the level-of-detail needed to assess the actions taken to incorporate SAB recommendations. (Applies also to Charge Questions 1.1 and 1.3)

4, Building a legacy and a lasting impact. The SAB reviewed several predecessors to ESRP; observations from these programs are germane to ESRP in that it appears that these previous efforts left a legacy, but no lasting impact. The discussion below highlights the critical need to

build support through demonstration and tech transfer of the tools and methods. The previous programs appear to have to have created a legacy of tools, but without a lasting impact in any regulatory process. ESRP has the distinct promise of providing this much needed tool if it can but focus its efforts and demonstrate utility. Please note the following:

- *CrEAM* - SAB provided a review of EPA Region 5's <u>Critical Ecosystem Assessment Model (CrEAM)</u> dated June 22, 2005.   The salient elements from this review included:

    o SAB endorsed the tool and approach
    o SAB called for investment of additional resources
    o Model validation was recommended and subsequently attempted by EPA (2008) with the finding that *data collected using the protocols in field trials in 2005 and 2006 did not match well with the corresponding CrEAM scores*.
    o CrEAM as a program appears to have been dropped within Region 5 and EPA, at least in terms of no longer hosting a web site, no tangible demonstration of use in regional decision making, and simply not finding reference to CrEAM outside of the SAB review on the web and the 2008 summary document.

Reference: EPA (2008) *Quick Assessment Protocols for Measuring Relative Ecological Significance of Terrestrial Ecosystems* EPA/600/R-08/061 May 2008

- *ReVA* – the Regional Vulnerability Assessment (ReVA) Program was reviewed by SAB in a letter dated October 12, 2005. In that letter SAB acknowledged *that development of the ReVA has been an extraordinary and elegant effort by a dedicated and highly skilled team.* Similar to CrEAM the following elements are germane to ESRP and this review:

    o SAB endorsed the tool and approach
    o SAB called for investment of additional resources
    o SAB underscored *the need for EPA to provide additional resources and in-house expertise to fully develop ReVA and to better leverage outside expertise by working closely with other government agencies and academic institutions.*
    o EPA provided an excellent demonstration of the tool through the Sustainable Environment for Quality of Life (SEQL) data set for the Charlotte, North Carolina region.
    o ReVA as a tool does not appear to have progressed in terms of application to regional problems – at least based upon the lack of citing in the MYP and on EPA web sites.
    o ReVA applications ***were*** listed in Randy Bruin's presentation; as these become "successes" they need to be documented and disseminated.

- *GISST* - EPA Region 6's Geographic Information System Screening Tool (GIST) provided it's review in a letter dated September 28, 2006. The same observations

provided above for CrEAM and ReVA are germane to the GISST, including that there does not appear to be a long term application of the tool or any remnant of it as an independent tool.

Perhaps the most relevant recommendation of the SAB to the GISST is its note that *despite these initiatives, the Agency still does not have a unified single accepted approach for using spatially explicit information for environmental decision-making. The compartmentalized development of GIS-based tools and data by EPA program offices and regions is inefficient, given budgetary constraints and the high value of these tools for environmental decision-making. Using spatially explicit information for decision-making is a critical need that EPA must address. The SAB therefore strongly urges EPA to undertake an initiative to define a unified framework for the development of these types of tools across the Agency. A national effort to develop such a unified framework will require decision analytic expertise, and the resulting tool should be easy to modify to meet local and regional needs.*

As noted above, this is the promise of ESRP, to be that unified program. Without quick and confirmed demonstration of the utility, ESRP may also leave a legacy, but no lasting influence.

Specific Charge Questions

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

Charge Question 1.1.   The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations.

On the basis of the presentations made to the SAB it appears that considerable effort and progress incorporating SAB comments into the long term goals for many, but not all of the LTGs. On the basis of initial material provided, the Agency did not appear to be responsive to the SAB's recommendations.   There appears to be a lot of effort expended, but it would have been helpful to have been provided with more specific information. The specifics are possibly in the 12 Implementation Plans, but those were not made available to the EPEC. Fortunately, many of the presentations were helpful in clarifying progress – those are noted accordingly, below. Specific comments include:

1.) Great progress was demonstrated in the presentations on incorporating ecological services into the LTGs. The over-arching emphasis appears to still be on resource benefits to humans.
2.) The justification of research priorities are still not clearly articulated for all programs; LTGs 1 – 3 and 5 did provide good explanation in the presentations; LTG4 appears to be significantly lagging in effort.
3.) See Overarching Comments 1 and 2 on demonstration projects and MYP

4.) Rather than scaling back the overall ESRP program on focused efforts as suggested by the SAB, the program articulated during this review appears to have been expanded. The overall program is still too broad for the current resource level.

5.) Regarding LTG4, the Status Report of June 24, 2009 does not provide sufficient or complete information on LTG4 to understand what progress has been made. For example, under Recommendation 1, what specifically does "Wetland theme is narrowing the list of ecosystem services relevant to EPA programs" mean? It would also be helpful if progress under each recommendation ("R") was noted for all LTGs. LTG4 does not have any progress noted under R2, R3, R5, R6, R7, or R12. In the interest of being complete, even where a recommendation is not relevant or germane to LTG4, a short statement would be helpful indicating so. Having said that, as I read it, most of these recommendations have some element pertaining to LTG4.

6.) The material provided in response to the SAB September 2008 comments to the MYP does little to support the continuing need to conduct any Coral Reef-related research.

Charge Question 1.2. In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

 Given the lack of specific information it is difficult to determine to what "balanced focus" may have been achieved for LTG1. That balance may be better reflected in the IPs for the LTGs, and specifically for LTG1, but we did not have the opportunity to review those. Hints of balancing were certainly provided in the presentations for LTGs 1 – 3 and 5, but we see only the "great Oz" and are left to wonder how the levers are being pulled behind the curtain.

EPEC commented that LTG 1 was too ambitious; principally given the stated high level of program goals combined with the lack of in-house and/or external expertise, lack of clear work products within reasonable time frames, and the inherent difficulties in developing multi-criteria decision support systems that integrate values with science. A strong recommendation by the SAB in the previous review, and by several reviewers in our July 2009 meeting, that the most critical element is to focus limited resources on the demonstration projects. Dr. Greg Biddinger's comments on CQ 6.1 address this issue, and I endorse his comments here, as well.

Charge Question 1.3. Please assess the progress the Program has made in the 15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan, in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?
Comments are given with the caveat that we are limited by what was provided to review and the presentations.

LTG1 – Generally good progress appears to have been made here. This goal is to some degree dependent upon progress in the demonstration projects – and would be expected to progress with the overall program.

LTG2 – This program is perhaps the most ambitious of all the LTGs. Over the last 15 months it would appear that this group has undertaken a flurry of activities, many of which appear to be related to building intra and inter- federal agency support for the National Atlas of Ecosystem Services. Perhaps this is one area where the overall effort can be scaled back to adequately develop the necessary mapping resources solely to support the LTG5 Demonstration Projects. While simultaneously laudable and desirable, this effort should be built in phases over time. The resources focused on the national inventory might better be utilized at the regional level, including validating ecosystem model predictions from the inventory with on ground data. Please note previous Over Arching Comment 4 on the difficulties associated with CrEAM in validating model predictions in the field.

LTG3 – This LTG appears to have made the most progress in the last 15 months. This was perhaps also the most concise presentation and road map presented – which could/should serve as a model for other LTGs. There is still a need to connect to what products are going to be tested and tried here, but citing in particular the ties to the excellent resources in the Future Midwestern Landscapes Study, and the Coastal Carolinas Study, it appears this group is making substantive progress. In fairness, it appears this group also is taking advantage of the previous work done through CrEAM and ReVA in these two area; credit should be given by this group to those previous efforts.

LTG4 – This LTG is of critical importance to the overall assessment of ecosystem services, but it appears that this group is lagging far behind in terms of developing and implementing plans. Credit can be given to the group for thinking through what wetland services would be important to value, but the presentation provided seems like material that should have gone into the formulation of the MYP, and certainly should not have taken 15 months to produce. Most of what was presented is already known to many of the SAB members who work in/with wetlands, so the presentation was not specifically useful. It is somewhat disconcerting that after this time, the presentation simply noted that "ORD Staff are gaining experience …. through literature reviews, seminars, and exploring data through meta analysis." This does not seem to be the most efficient use of resources; external consultants may be needed here. In addition, there may be some leadership and organizational issues here that would benefit from management action to correct the lagging LTG. It is curious that we did not see a single presentation from the Coral Reefers.

 LTG5 - Comments below on individual plans

 • Implementations of Place Based Studies – this comment is specific to the presentation of Hal Walker.   The conceptual frameworks shown were a thoughtful attempt to balance the multiple elements that need to be considered in these studies, but the SAB commented previously that the risk assessment format should be followed. Both the Ecological Risk Assessment Problem Formulation paradigm and the Life Cycle Assessment model were offered up as unifying structures upon which to construct these demonstration projects. It is not necessary, nor should an attempt be made to construct a new paradigm – rather adapt the existing paradigm for future presentations.

- Future Midwestern Landscapes - An excellent presentation by Randy Bruins helped illuminate the direction this study was taking. It was good to see the ReVA process cited here; in fairness much of the underlying data was built under the CrEAM program and acknowledgement in future presentations of that would be useful to show continuity. Identifying the FML-EDT as the product goal was very good.   Two germane questions were discussed amongst several SAB members; (1) How to validate the model decisions predictions with on-ground data (noting the previous issues with CrEAM), and (2) Are biofuel's an appropriate target scenario given that biofuels are on the decline in the Midwest with several refineries being closed down?

- Tampa Bay – Another good example project and presentation by Marc Russell.   It provided a sense of where the project was headed, and what kind of decisions might be resolved with this set of tools. What was not clear is what tool(s) were being used (e.g., ReVA?), what will ultimately be the tool produced, the status of development, and the end users. Suspect all of that has been developed – but it would have been helpful to have had that presented. Same question on ground-truthing or validating models is germane to this project, as well.

- Willamette River – The only material available to evaluate this project is the summary description provided to the SAB.   This appears on the base of this description to be a very large and ambitious effort. One wonders what research related to hyporheic flow on temperature and native fish habitat has to do with defining ecosystem services. The project states that as a goal the product will be used to plan river restoration efforts between Eugene and Albany OR. Restoration has historically not been an EPA function; again is this appropriate use of EPA ESRP resources? On face value that would not appear to be the case. A suggestion would be to extend the study area to include the Lower Willamette River through Portland. As part of the Superfund and NRDA activities there is a more critical need to identify what are the potential habitat sites and the limits/constraints to develop those.

- Coastal Carolina project – again based on the project summary there is insufficient information to determine how much work has been accomplished, vs. what was done by other programs and being accessed by ESRP now.

- Southwestern US – no comments here. The program is too early in development to be commented upon

One last thought is directed toward a sixth demonstration site. Loss of coastal wetlands in Louisiana is a problem that would seem to be directly suited for the types of tools ESRP is attempting to develop. In addition to subsidence and erosion issues, coastal Louisiana also faces

potential serious impacts from sea level rise. Dr. Annie Neale indicated that sufficient data may be available to ESRP to begin looking at this as a possibility.

Charge Question 1.4. Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

No. Partnerships, while necessary, will not result in the adaptation of ESRP broadly. The overall program lacks definition of an Outreach Program, and as Rick Lindquist stated at our meeting, no one at EPA appears to want to address that. A recommendation is that ESRP contact Steve Ells in the Contaminated Sediment Program to discuss some of the innovative elements they have been coordinating with the Regions to bring tools developed ORD at least to the Superfund sites.

Charge Question 2: Implementation of Integrated Pilot for Reactive Nitrogen.
Using the nitrogen pilot as an example of ESRP's approach to integration, please comment on how well the ESRP has succeeded in conceptualizing a systems- approach for analysis of ecosystem service impacts. Does the project take appropriate advantage of all the other projects in the ESRP? Have major uncertainties been adequately clarified and addressed to meet Program goals? Are there additional primary gaps or uncertainties that you see as important?

Based upon the presented materials – the reactive nitrogen program is a model for incorporating cross-cutting LTGs. See previous response to LT3, above.

*Charge Question 3: Implementation of Mapping, Monitoring, and Modeling Themes *

Charge Question 3.1. Focusing specifically on the Mapping theme, please comment on the usefulness of the proposed products. For example, please comment on the potential for ecosystem service atlases to communicate the status, changes, and locations of ecosystem services to EPA clients and the public. Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice; 2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions); and 3) issues related to environmental and land management, including public and private investments to conserve ecosystem services.

There is utility to having a National Atlas of Ecosystem Services. Without seeing the specifics of development, the difficulties reside in (a) identifying sources of GIS-based information for those services, (b) ensuring the data are current, (d) ground-truthing those data, and the (e) long-term maintenance of the Atlas given the inevitable changes that will occur. It is too large an effort to create a National Atlas at this point and it diverts resources away from the important ESRP function of developing and demonstrating place-based tools and uses of those tools. As stated previously, LTG2 should constrained to supporting the Site-Specific Demonstration Projects. A National Atlas can be built in phases over time after the overall ESRP agrees on the procedures to acquire and validate data, the tools necessary to query the data, field-validating the underlying data and model predictions, and a plan for long term support of the Atlas.

Charge Question 3.2. What advice does the Committee have for the next steps in Monitoring and Modeling? In particular, are there pitfalls that the Office of Research and Development should be sensitive to as it develops this part of the ESRP?

The principal comment here is methods to validate the underlying data and field-verification of decision model predictions. This has been a fundamental comment of the SAB to the previous GIS-based decision support tools developed by EPA, and it remains a concern here.

Charge Question 4: Implementation of Place-based Studies.

Charge Question 4.1. Given the goals of the Program, please comment on whether the conceptual models in the Place-based studies are missing any critical elements.

See previous comment on using the Ecorisk Assessment problem formulation process as a unifying approach for all place-based demonstration projects.

Charge Question 4.2. Please comment on whether, at the current level of development, the Place-based Studies will make good demonstration projects for a variety of decision makers at the local to regional scale. Are there additional ecosystem services that should also be considered in these studies?

A listing of the ecosystem services to be demonstrated for each of the Place-based Studies was not provided to the EPEC. These are likely in the IPs, but we cannot comment on what we have not seen.

Charge Question 4.3. Please comment on whether progress in ESRP's Cross-Place-based theme is improving the opportunity to compare and contrast methods and results across the five sites of the Place-based studies. What recommendations does the committee have for further integration and cross-comparison and testing among these five sites, either now or in the future?

Several SAB members noted that the Place-Based projects require some type of unifying conceptual model, and both the Ecological Risk Assessment problem formulation step and Life Cycle Analysis were proposed as unifying models. Please refer to the SAB's Independent Report *Advice to EPA on Advancing the Science and Application of Ecological Risk Assessment in Environmental Decision Making: A Report of the U.S. EPA Science Advisory Board* for specific recommendations on Problem Formulation.

Charge Question 4.4. Please comment on whether there are omissions of key partners in any of the place-based studies.

Insufficient information to fully comment on the individual projects.

Charge Question 5: Implementation of Ecosystem Specific Studies: Wetlands.. Please comment on the benefits that can be derived by EPA from the implementation of the wetlands research theme. Have these benefits been made clear? Is the "top down" strategy for designing the

wetlands research theme evident and is EPA conducting research that will move the Agency to a national perspective on wetland production functions? Are the proposed analyses missing any stressors that are expected to have a broad impact on the services provided by wetlands?

As noted previously in response to CQ1.3, LTG4 offered the least amount of information to evaluate the direction of the program and the benefits they seek to address. Not clear what is meant here by a "top down" strategy – a strategy was clearly absent from these materials.
Charge Question 6: Implementation of Decision Support Activities
Note: Defer to Drs. Biddinger, Daniel, and Segerson whose initial comments at the meeting I agree with and endorse.

Charge Question 6.1. Please comment on the defined and anticipated challenges to achieving the goals of the Decision Support Framework. What recommendations does the Committee have to overcome the most significant of these challenges?

Charge Question 6.2. How does the EPA reconcile Decision Support as a significant need for the Ecosystem Services Research Program with the Program's relative inexperience and minimal resources?

Enclosure 4: EPA Charge Questions to the Committee

Charge to the SAB Ecological Processes and Effects Committee for the Consultation on EPA's Ecosystems Services Research Program and Projects

June 29, 2009

Background

In 2008, the Environmental Protection Agency's Office of Research and Development (ORD) prepared a multi-year plan for research on ecosystem services. The resulting program, the Ecosystem Services Research Program (ESRP), is a focused revision of research related to ecosystem services already underway in ORD. The new vision, mission and goal of this plan are defined below:

Vision: Contribute to a comprehensive theory and practice for characterizing, quantifying, and valuing ecosystem services, to ensure that their relationship to human well-being is consistently incorporated into environmental decision making.

Mission: Provide the information and methods needed by decision makers to assess the benefits of ecosystem goods and services to human well-being for inclusion in management alternatives.

Goal: To transform 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.

The general research questions for the Program are:

- *What are the effects of multiple stressors on ecosystem services, at multiple scales, over time*?
- *What is the impact of changes in these services on human well-being and on the value of these services expressed in both monetary and non-monetary terms?*

To answer these questions the Program is focused on developing quantitative, operational definitions for ecosystem services; knowing how these services are distributed throughout the landscape, and in what quantity and quality; projecting how these services respond to combinations of large and small scale stressors; and determining alternative management options that would optimize their sustainability.

The intent is to inform a wide range of issues related to questions of social choice, with a special focus on informing trade-offs among ecosystem services provided under alternative management and policy decisions. To achieve this objective, the Program has undertaken a multi-dimensional research plan that includes a range of focused investigations as well as integrating, thematic elements. The focused investigations look at the provision of ecosystem services from three

different angles: (1) the effect of a single, ubiquitous pollutant (reactive nitrogen) on service quality and quantity; (2) the dynamics of service flows in two priority ecosystems (wetlands and coral reefs); and (3) the dynamics of service flows in five geographic regions (Midwestern US; Willamette Basin, Oregon; Tampa Bay, Florida; the Coastal Carolinas, and the Southwestern U.S.), that represent a spectrum of ecological and socioeconomic characteristics. The cross-cutting themes include the relationship between ecosystem services and human health; landscape characterization; ecosystem service inventories; alternative management option modeling techniques; and ecosystem service valuation. The ESRP plans to integrate the research outputs from the focused investigations and the thematic work into a decision support platform for use by clients, and to convey research findings through an organized education and outreach effort.

The research will have four general types of outputs:

- *Measures and dynamic maps of ecosystem services* – Colloquially known as "maps," these products reflect the most recent advances in ecological monitoring, spatial analysis, ecological mapping, and cartographic techniques in order to create spatial representations of ecosystem services over multiple scales and time-periods. They will be used for communication, outreach, planning, assessment, and resource management.

- *Predictive models relating to the response of stressors* – Models are the foundation of our ability to forecast change and proactively assess how ecosystem functions and services are likely to respond to natural and human stressors. These models reflect a variety of techniques, including statistical, landscape, and process models. Modeling techniques are matched to needs for temporal and spatial scales, the scope of stressors and endpoints to be considered and intended use of model output.

- *Management Options and Alternative futures* – The Program develops and evaluates alternative future scenarios relevant to enhancing, conserving and/or restoring ecosystem services.   These scenarios are implemented using a suite of modeling tools; results will be presented as maps and other visualization tools.

- *Decision Support Platform* – A decision support platform is being developed to enable managers and decision-makers to explore how various policies affect the likely distribution of ecosystem services, and human health and well-being outcomes, both now and in the future. Ideally, the platform will capture user needs for decisions and effectively translate our analytical results in ways that are useful to policies, rules, market incentives, and environmental stewardship.

These outputs provide the ecological information and methods needed by decision makers to assess the benefits of ecosystem services and to identify strategic management options needed to meet the desired outcome for the Ecosystem Services Research Program, which is to secure the integrity and productivity of our ecological systems over space and time.

Overarching Charge to the SAB

In 2008, the ESRP's draft Strategic Multi-Year Plan was reviewed by the SAB Ecological Processes and Effects Committee (EPEC). In turn, the ESRP began revising the Strategy and also began developing detailed Research Implementation Plans. The purpose of the 2009 EPEC consultation is to:

- Assess whether the Committee's recommendations and concerns were appropriately acted upon.

- Review the ongoing work of ESRP for its scientific merit, including its demonstration of disciplinary strength in ecology and its transdisciplinary approach to implementing and integrating the Program.

- Assess the progress the Program has made in 15 months, in light of budget and staffing constraints.

- Offer additional recommendations for meeting the challenges facing the Program as the projects move forward, including identifying measures of success.

Specifically, ORD asks the SAB to respond to the following charge questions.

Specific Charge Questions

Charge Question 1. Current Status and Direction of the Ecosystem Services Research program (ESRP)

1.1   The SAB previously reviewed the ESRP's draft Strategic Multi-Year Plan and recommended improvements in the strategic direction and focus of the Program, the research goals and questions, and the program implementation strategy. Given the current status and direction of the ESRP, please comment on whether the Program has been responsive to the intent of the Committee's primary recommendations.

1.2   In the SAB advisory report on the EPA Ecological Research Program Multi-Year Plan there was considerable discussion about ESRP's focus on Long-term Goal 1: valuation, human well-being, and decision support. The SAB commented that predicating the whole program on this goal had set the bar too high for success. Has the Program achieved a more balanced focus at this stage of development, or are more adjustments recommended?

1.3   Please assess the progress the Program has made in the 15 months since the SAB review of the ESRP's draft Strategic Multi-Year Plan, in light of budget and staffing constraints. Has sufficient progress been made to warrant maintaining the current elements within the program?

1.4   Please comment on the partnership approach being developed in the ESRP. Would the proposed future investments be likely to advance: integration across EPA; adoption

of ESRP concepts by the Agency; and the science of ecosystem services, including improved management of ecological risks?

Charge Question 2: Implementation of Integrated Pilot for Reactive Nitrogen

2.   Using the nitrogen pilot as an example of ESRP's approach to integration, please comment on how well the ESRP has succeeded in conceptualizing a systems-approach for analysis of ecosystem service impacts. Does the project take appropriate advantage of all the other projects in the ESRP? Have major uncertainties been adequately clarified and addressed to meet Program goals? Are there additional primary gaps or uncertainties that you see as important?

Charge Question 3: Implementation of Mapping, Monitoring, and Modeling Themes

3.1   Focusing specifically on the Mapping theme, please comment on the usefulness of the proposed products. For example, please comment on the potential for ecosystem service atlases to communicate the status, changes, and locations of ecosystem services to EPA clients and the public. Similarly, please comment on whether ecosystem service atlases will inform decision makers about: 1) issues related to social equity and social choice; 2) innovative valuation methods (e.g., by providing information on location, availability of substitutes, and changes over baseline conditions); and 3) issues related to environmental and land management, including public and private investments to conserve ecosystem services.

3.2   What advice does the Committee have for the next steps in Monitoring and Modeling? In particular, are there pitfalls that the Office of Research and Development should be sensitive to as it develops this part of the ESRP?

Charge Question 4: Implementation of Place-based Studies.

4.1   Given the goals of the Program, please comment on whether the conceptual models in the Place-based studies are missing any critical elements.

4.2   Please comment on whether, at the current level of development, the Place-based Studies will make good demonstration projects for a variety of decision makers at the local to regional scale. Are there additional ecosystem services that should also be considered in these studies?

4.3   Please comment on whether progress in ESRP's Cross-Place-based theme is improving the opportunity to compare and contrast methods and results across the five sites of the Place-based studies. What recommendations does the committee have for further integration and cross-comparison and testing among these five sites, either now or in the future?

4.4   Please comment on whether there are omissions of key partners in any of the place-based studies.

Charge Question 5: Implementation of Ecosystem Specific Studies: Wetlands

5.   Please comment on the benefits that can be derived by EPA from the implementation of the wetlands research theme. Have these benefits been made clear? Is the "top down" strategy for designing the wetlands research theme evident and is   EPA conducting research that will move the Agency to a national perspective on wetland production functions? Are the proposed analyses missing any stressors that are expected to have a broad impact on the services provided by wetlands?

Charge Question 6: Implementation of Decision Support Activities

6.1   Please comment on the defined and anticipated challenges to achieving the goals of the Decision Support Framework. What recommendations does the Committee have to overcome the most significant of these challenges?

6.2   How does the EPA reconcile Decision Support as a significant need for the Ecosystem Services Research Program with the Program's relative inexperience and minimal resources?