Summary Minutes of the
U.S. Environmental Protection Agency (EPA)
Science Advisory Board (SAB) Ecological Processes and Effects Committee
Augmented for the Consultation on EPA's Ecosystem Services Research Program

Meeting, July 14 – July 15, 2009

Committee Members: See Committee Roster – Appendix A

Date and Time: Tuesday, July 14, 9:00 a.m. - 5:15 p.m.; Wednesday, July 15, 8:30 a.m. - 12:00 noon Eastern Daylight Time

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

Purpose: The purpose of this meeting was to provide consultative advice on implementation of EPA's Ecosystem Services Research Program (ESRP).

Attendees: Committee Chair: Dr. Judith Meyer

Committee Members: Dr. Fred Benfield
Dr. Gregory Biddinger
Dr. Ingrid Burke
Dr. Allen Burton
Dr. Peter Chapman
Dr. Loveday Conquest
Dr. Terry Daniel
Dr. Otto Doering
Dr. Wayne Landis
Dr. William Moomaw
Dr. Charles Rabeni
Dr. Amanda Rodewald
Dr. Mark Schwartz
Dr. James Sanders
Dr. Kathleen Segerson
Mr. Timothy Thompson

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

EPA Staff: Thomas Barnwell
Randall Bruins

Jana Compton
Michelle Cutrofello
Gordon Evans
Chris Faulkner
Iris Goodman
Janet Keough
Rick Linthurst
Ric Lopez
John Macauley
Marisa Mazzota
Anne Neale
Janet Nestlerode
Marc Russell
Kathryn Saterson
Anne Sergeant
Greg Susanke
Nita Tallent-Halsell
Ann Vega
Hal Walker

Others Present: Maria Hegstat, Inside EPA

Meeting Summary

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

Convene Meeting

Dr. Thomas Armitage, Designated Federal Officer (DFO) for the SAB Ecological Processes and Effects Committee convened the meeting at 9:00 a.m. on July 14th. He stated that the EPA Science Advisory Board (SAB) is a chartered federal advisory committee. He reviewed Federal advisory Committee Act (FACA) requirements. He noted the Committee's compliance with ethics requirements. Dr. Armitage stated that as DFO, he would be present during Committee business and deliberations. He stated that summary minutes of the meeting would be prepared and certified by the Chair.

Welcoming Remarks

Dr. Vanessa Vu, Director of the EPA SAB Office, welcomed the Committee members and thanked them for providing advice to EPA on the Ecosystem Services Research Program.

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

Dr. Judith Meyer, Chair of the SAB Ecological Processes and Effects Committee (EPEC) provided introductory remarks. She asked members of the Committee and other meeting attendees to introduce themselves. After the introductions, she thanked the members for participating in the meeting, outlined the purpose of the meeting and reviewed the agenda (Appendix B). She stated that the Committee had previously reviewed the EPA Ecological Research Program Multi-Year Plan. She stated that the Committee would be meeting during the next two days to provide consultative advice on EPA's implementation of the program. She stated that EPA had asked the Committee to assess: 1) whether the Agency had responded appropriately to the Committee's previous recommendations and concerns; 2) the scientific merit of the ongoing work of the Ecosystem Services Research Program; and 3) the progress of the research program. She noted that the Committee had also been asked to offer additional recommendations for meeting challenges facing the program as projects move forward. Dr. Meyer reviewed the six specific charge questions provided to the Committee (Appendix C)

Dr. Meyer also stated that the meeting of the Committee was a consultation (not a review) and therefore a consensus advisory report would not be prepared. She stated that the comments of individual Committee members would be appended to a letter that she would send to the EPA administrator summarizing key points discussed at the meeting. Dr. Meyer then asked EPA staff to present their opening remarks and background information to the Committee.

Introductory Remarks from EPA

Remarks from Dr. Rick Linthurt and Ms. Iris Goodman (EPA Office of Research and Development)

Dr. Rick Linthurst and Ms. Iris Goodman of EPA's Office of Research and Development (ORD) presented an overview of the current direction of the Ecosystem Services Research Program. Their presentation slides are provided in Appendix D.

Committee Discussion of the Current Direction of the Research Program

The Committee discussed the current status and direction of the Ecosystem Services Research Program. Members asked clarifying questions to EPA and discussed responses to charge questions 1.1-1.4 (Appendix C)

Several members commented that EPA had been responsive to the Committee's previous recommendations. A member stated that the ESRP had worked to form partnerships. She stated that partnerships were very important to the success of the program but noted that the "partnership model" should be clarified (i.e., it was not completely clear how decisions were made to develop various partnerships). Another member stated it was important to more clearly the describe work partners would undertake.

A member noted that in its previous advisory report to EPA, the SAB EPEC had expressed concern about imbalance between research to develop decision support tools and other ESRP research. She commented that more balance had been achieved by increasing the ESRP focus on ecological production functions (rather than valuation of services) and enlisting the help of outside experts to support research in different areas.

The Committee discussed how the ESRP could help EPA build capacity (i.e., tools and information) to make decisions. A member stated that, although the ESRP had achieved greater balance by focusing less on the decision support infrastructure, it was important that the EPA not delay development and implementation of the decision support framework too long.

Other members commented on the themes of partnerships and program balance. Members stated that the program was doing a good job of raising awareness of the importance of linking decisions to ecosystem service flows. However, they expressed concern about possible lack of regulatory authority for this decision making context. Members stated that early demonstration of such decision making was important. A member stated that it was important to provide information to demonstrate how ecological production functions would be applied to evaluate trade-offs in decision making. A member stressed the importance of forming partnerships with other federal agencies. He noted that work completed by the U.S. Army Corps of Engineers could be particularly useful. EPA staff indicated that partnerships with other federal agencies were important and noted that the land program (of the ESRP) had been successful in forming such partnerships.

The Committee discussed how the ESRP could provide a unified approach to the use of spatially explicit data in decision making. A member described various geospatial analysis approaches and methods that had been reviewed by the SAB EPEC. These included the Regional Vulnerability Assessment Program (ReVA), the Geographic Information System Screening Tool (GISST), the Critical Ecosystem Assessment Model (CrEAM), the Sustainability Research Strategy, and tools for multi-criteria decision making. The member asked how work that EPA had completed to develop these approaches and methods was being integrated into the ESRP. Dr. Linthurst described how ReVA tools were being used in the ESRP. Ms. Goodman indicated that the ESRP was multidimensional and, as such, it was bringing together much of the work previously completed in these other programs.

The Committee discussed the importance of making the ESRP relevant to EPA regulatory programs. A member noted that various EPA programs had authority to regulate specific kinds of stressors. Members stated that it was particularly important to develop ecosystem services production functions to move the ESRP forward. EPA staff noted that it was important to provide information and tools that would facilitate regulation by setting up markets and trading.

The Committee further discussed the importance of partnerships. A member stated that the ESRP was bold, innovative, and necessary, and could be transformative. However, as stated in the previous review of the Multi-Year Plan, additional resources were needed to support the research. In this regard, he stressed the importance of forming partnerships. He noted that in the long term, it could be difficult to sustain work with some partners because they could be pulled away from the program. He stressed that EPA should think about how it could accomplish its critical work if partners left the program. Several Committee members noted that the program had "come a long way" since the first draft of the Multi-Year Plan was reviewed. One member noted, however, that EPA still seemed to be working to define ecosystem services. He noted that ecosystem services could be defined in terms of benefits, but he stressed that it was important to focus on ecological stressors and effects that were the most relevant to EPA. He stated that some stressors were less relevant than others to various EPA regulatory programs. In this regard, the Chair noted that parts of the ESRP focused on land use. She stated that land use decisions were usually made by local authorities. EPA staff responded that they wanted to provide tools that could be used to help managers and decision makers to make choices.

A member stated that it was important for EPA to work with international partners. Another member stated that it was important to relate ecosystem services to human health. A member stated that the human health aspects of the ESRP seemed to be narrowly focused on Lyme disease. She stated that it was important to broadly relate ecosystem services to human well-being. A member stated that it would be useful to commit additional resources to developing an index of well being. She stated that this appeared to be a critical issue for EPA programs. A member suggested that it would be useful for EPA to clearly indicate how the ESRP was linked to the Agency's strategic plan.

The Committee discussed the importance of focusing on life cycle assessment in the ESRP. EPA staff noted that a life cycle approach was being used to assess the ecological affects associated with alternative fuels. A member stated that the European Community was developing a life cycle sustainability initiative and noted that it might be useful for EPA to consider what had been accomplished in that effort. Several Committee members discussed how land use decisions might be considered in the context of life cycle assessment. A member stressed that it was important to develop tools that would allow stakeholders to quantify ecosystem services using local data and to link development of research program products to the immediate needs of EPA programs.

Discussion of Pollutant Specific Studies – Nitrogen

EPA ORD staff provided an overview of ESRP research to understand the effects of reactive nitrogen on ecosystem services. Slides of this presentation are provided in Appendix E. The Committee then discussed the response to Charge Question 2 (Appendix C).

The Committee discussed the challenge of developing an integrated approach to managing reactive nitrogen. A member stated that the SAB Integrated Nitrogen Committee had considered the concept of the nitrogen cascade (i.e., the transformation and effects of nitrogen as it circulates through the atmosphere, hydrosphere, and biosphere). The member stated that it was important to identify critical intervention points in the cascade. He noted that 'tipping points" could be identified to see where critical loads of nitrogen were exceeded. Another member noted that the nitrogen cascade underscored the difficulty of regulating reactive nitrogen because it showed that the effects of a given amount of nitrogen varied considerably in different ecosystem compartments. A member stated that EPA had authority under different statues to regulate nitrogen but an integrated approach was needed to regulate different forms of reactive nitrogen.

The Committee discussed whether reactive nitrogen was an appropriate pollutant to study in the ESRP. Several members stated that nitrogen was an excellent choice. They indicated however that, although resources had increased to support this work, the available resources were not adequate. A member stated that it was particularly important for EPA to work with international partners to address transboundary pollution. He noted that atmospheric sources of nitrogen were a transboundary concern.

A member asked EPA staff to define reactive nitrogen. EPA staff responded that reactive nitrogen could be defined as nitrogen that was not in the form of N_2 . Another member stated that nitrogen would be a perfect ecosystem services case study to include in the Agency's Report on the Environment.

The Committee further discussed the need to form partnerships with the National Oceanic and Atmospheric Administration (NOAA) and the National Science Foundation (NSF). Members noted that these agencies had ongoing projects that addressed nitrogen enrichment. EPA staff stated that the ESRP would build upon U.S. Geological Survey (USGS) work on the SPARROW (Spatially Referenced Regression on Watershed Attributes) model.

The Committee further discussed the nitrogen cascade and how nitrogen research could support EPA regulatory programs. A member commented that EPA was using a system model concept, but it was not clear whether EPA had incorporated the latest thinking about the nitrogen cascade into the ESRP. He stated that EPA should use the latest science. Committee members further questioned EPA about the partnerships that had been formed. EPA staff indicated that they were working to form additional partnerships.

A member suggested that, as part of its nitrogen research, EPA could consider looking at fertilizer services. Another member stated that it would be useful to consider the concept of regulatory incentives, and suggested that a nitrogen cap and trade system could be considered. A member stated that, in a regulatory sense (i.e., with regard to regulating reactive nitrogen), Europe may be ahead of the U.S., and he suggested forming research partnerships with European organizations. Another member reiterated the importance of considering transboundary pollution in the ESRP. He noted that although reactive

nitrogen was an important pollutant to study, there were other pollutants that could also be part of the program. He mentioned, for example, the importance of mercury. A member also stated that in the background material provided to the Committee he had not seen a good discussion of how the ESRP was addressing uncertainty. EPA staff stated that they were planning additional modeling work that would address uncertainty.

A member asked EPA staff whether the ESRP nitrogen program was working with the EPA Council on Regulatory Environmental Modeling and leveraging ongoing modeling work within the Agency. Staff responded that EPA modelers were involved in the ESRP. A member stated that models could be used to assist ESRP researchers with conceptual thinking.

Following the discussion of nitrogen research the Committee recessed for lunch.

Public Comments

Following lunch the Chair reconvened the meeting and noted that time had been reserved on the agenda for public comments but no requests to provide comments had been received.

Discussion of Modeling, Mapping, and Monitoring

EPA ORD staff presented an overview of ESRP research to develop a National Atlas of Ecosystem Services. Slides of this presentation are provided in Appendix F. The Committee asked clarifying questions and discussed the response to Charge Questions 3.1-3.2 (Appendix C).

Several members commented on the importance of mapping ecosystem services. A member stated that this part of the ESRP could be viewed as an umbrella for accessing information about other initiatives at EPA. Committee members discussed the tools being developed in the ESRP modeling mapping, and monitoring program. A member stated that it was important to make the tools available to community planners and interested stakeholders. EPA staff stated that the tools developed by the program would be downloadable.

The committee discussed the use of models to develop the ecosystem services maps. A member stated that it might be appropriate to call the output on the maps scalars in order to indicate that most of this information was output from models. A member noted that activities to develop ecosystem maps were proceeding “ahead” of efforts to develop a decision support framework. He questioned whether this was a problem, and asked how the mapping information would be “ported” into the framework. EPA staff responded that it would be very important for the mapping staff to work with the decision support staff. A member noted that there was some risk involved in developing the maps ahead of the production functions and the decision support framework because the most appropriate information might not be provided.

The Committee discussed the need to check the validity of models (which were the basis for ecosystem services maps). Members suggested that the validity of the models could be checked in the ESRP place-based studies.

The Committee discussed the importance of providing tools that could be used by local entities to conduct analyses of ecosystem services. Members noted that EPA could not do all of the analysis for local entities and therefore tools should be provided to allow them to conduct analyses using their own data.

The Committee discussed software and computing resources needed to develop a national atlas of ecosystem services. Members noted that the limited availability of such resources could hamper efforts to develop the atlas. EPA staff agreed that good computing resources were needed.

The Committee discussed the need to quantify uncertainty in the ecosystem services maps. A member stated that in developing the maps it was important to consider statistical and model uncertainty.

The Committee discussed the need to involve decision makers in the process of developing ecosystem services maps. Members stated that it would be appropriate to first identify and interact with decision makers who needed the information, and then focus development of the atlas on the kinds of information needed.

The Committee discussed ground truthing the ecosystem services maps and including socioeconomic and other data. A member stated that, in particular, it would be useful to identify dams on the maps. A member pointed out inaccuracies on the maps with regard to forest resources. He stated that the U.S. Forest Service could provide detailed information to ground truth the maps.

Discussion of Place-based Studies

EPA ORD staff presented an overview of ESRP place-based studies research. Slides of this presentation are provided in Appendix G. The Committee asked clarifying questions and discussed the response to Charge Questions 4.1- 4.4 (Appendix C).

The Committee discussed the conceptual models underlying the place-based studies. Members stated that it might be useful to develop a generic conceptual model for all of the place-based study sites and adjust this model as needed to address specific issues at individual sites. A member stated that an example of a more generic approach would be developing common scenarios for contaminated sediment sites. A member stated that a more detailed implementation plan was needed to fully evaluate the place-based studies research.

The Committee discussed resources needed for the ESRP place-based project research. Members noted that EPA needed more full time equivalent staff to conduct this research. A member noted that EPA should continue to seek outside input on the place-based

research. Members noted that other federal agencies (e.g., NOAA) were involved in similar work.

Members discussed whether EPA had responded to the Committee's previous recommendations concerning place-based research. Members stated that progress was still needed in several areas including: need for a transparent explanation of the process used to select sites; need for generalized transfer of the place-based research study findings (i.e., the need to apply the findings in other areas); need to include research that addressed transboundary issues; and need to include life cycle analysis in the program.

Committee members asked a number of questions. A member questioned why the Southwest place-based research project had been selected. EPA staff responded that the Southwest project was selected in part because it represented a very diverse landscape where EPA could look at the effects of hydrologic changes on a watershed scale.

The committee discussed how the place-based projects research had been funded and how the sites were chosen. Members stated that it was important to clearly describe the comparability of the selected place-based research sites to other areas.

The Committee further discussed the importance of comparability across place-based sites. Members stated that scale issues should be looked at consistently across sites. Members commented that the individual place-based projects appeared to have been developed somewhat independently. A member stated that the balance was too heavily weighted toward "place" and that more emphasis was needed on "national" aspects. A member stated that EPA should focus on building a framework and models that others could use. Another member stated that several such models should be considered, and specifically mentioned a relative risk model. A member stated that it was also important to acknowledge uncertainty in a straightforward manner. Another member stated that EPA might want to develop a standardized process for selecting place-based sites. EPA staff responded that some standardization of this process was important but flexibility was also needed.

The Committee discussed how a framework could be further developed for the place-based studies program. A member suggested that a problem formulation step would be useful to understand and articulate why the tools in the program were developed. Another member stated that EPA could consider using the placed-based projects to collect data for national indicators. A member stated that the program could benefit from showing how its research would contribute to EPA's risk assessment work. A member stated that ESRP should start with a conceptual framework and then show how the place-based studies fit together. EPA staff indicated that the Agency was trying to retrofit the projects into the decision support framework. Several members noted that the SAB Committee on Valuing the Protection of Ecological Systems and Services (CVPESS) report and National Research Council (NRC) reports had provided additional information on a framework for thinking about ecosystem services. A member noted that this framework involved more than risk assessment, it addressed risk management and performance assessment.

General Committee Discussion of the Program

Following discussion of the place-based studies, Committee members provided additional general comments on the ESRP.

Committee members offered a number of overarching comments on the program. They found that: it was bold, innovative, and necessary; it was transdisciplinary, it addressed multiple stressors, and it could result in fundamental changes inside and outside of EPA. They noted, however, that the program could not achieve its full potential with the level resources that had been provided.

Committee members noted that, in its budget presentation to the Science Advisory Board, ORD had indicated that it would be pursuing an integrated multidisciplinary approach to research. Members stated that the ESRP was a good example of this kind of approach.

Members discussed a number of other points. These included the following:

- The ESRP presents an opportunity to advance risk assessment to the level of performance (outcomes)
- The ESRP will enable EPA to present the value of its work to the public.
- The ESRP will enable EPA to do a better job of preparing the Report on the Environment
- The ESRP can influence smart growth and sustainability programs
- EPA has fallen behind in ecological research because of lack of resources
- It is important to stress benefits as well as risk

Committee members discussed whether it would be useful to review more detailed ESRP research implementation plans. EPA staff stated that they would like the SAB to continue reviewing the work undertaken by the ESRP. Several members noted that it would be useful to review more detailed information. The Chair stated that it would be important to review a modeling and monitoring implementation plan and expressed concern that these aspects of the program were not more fully developed. A member stated that he would have liked more information providing an understanding of when the ESRP goals would be achieved and how they would be achieved. Several members stated that it would be useful to look at the implementation plans to understand the linkages between various parts of the program.

Following the General Discussion the Chair thanked the members for their comments and stated that the Committee would recess for the day. She stated that the meeting would begin the next day (Wednesday, July 15) at 8:30 a.m. She noted that the next day the Committee would discuss the ESRP ecosystem specific studies (wetlands) and decision support activities before discussing key points that should be included in the consultation letter to EPA.

Wednesday, July 15, 2009

Discussion of Ecosystem-Specific Studies - Wetlands

The meeting was called to order at 8:30 a.m. EPA ORD staff presented an overview of ESRP ecosystem-specific studies on wetlands. Slides of this presentation are provided in Appendix H. The presentation addressed work to accomplish EPA's goals of demonstrating: the ability to use wetland condition indices to estimate ecosystem service production functions; the roles of location, pattern, and connectivity of wetlands in delivery of multiple services; creation of wetland landscape profiles of services for most major classes of wetlands over most of the coterminous U.S.; and testing wetland landscape profiles for usefulness in predicting suites of wetland services at scales appropriate for decision making. The Committee asked clarifying questions and discussed the response to Charge Question 5 (Appendix C).

Before discussing the ESRP wetlands research, a Committee member again stated that it would be useful for the Committee to review ORD's implementation plans for the ESRP. He noted that the information provided to the Committee did not fully describe all of the work products.

Members commented on implementation of the ESRP wetlands research program. A member stated that the U.S. Army Corps of Engineers, Department of Defense, and U.S. Fish and Wildlife Service had been working on wetlands issues for a number of years. He stated that, given this other work, the utility of what the ESRP was doing was not clear. Another member strongly disagreed with the statement that that the utility of the ERSP wetlands research program was not clear. She stated that the ESRP wetlands research program could provide immediate benefits, and specifically noted that it offered the potential for immediate payoff in mitigation decisions.

Another member stated that EPA should reach out to end users and find out what tools were important. A member stated that it would be helpful to see the implementation plan for wetlands research. He also noted that it was important to partner with the EPA Office of Water on the ESRP wetlands research.

The Committee discussed the scope of the program and the need for collaboration with other federal agencies. A member asked whether riparian wetlands (particularly those associated with small streams) were included in the program. EPA staff responded that some of the place-based Coastal Carolina work was in small streams. A member noted that the U.S. Department of Agriculture (USDA) Conservation Effects Assessment Program (CEAP) was quantifying the environmental benefits of conservation practices used by private landowners participating in selected U.S. Department of Agriculture conservation programs. He noted that it would be particularly useful for EPA to take advantage of the USDA wetlands work. A member commented that there seemed to be some lack of coordination among cross-cutting ESRP themes. The committee discussed the importance of: including isolated wetlands in the ESRP, considering both biological and physical attributes in production functions, and considering regional differences. A

member commented that indices should be used with caution because they did not take weight of evidence into consideration.

The Committee discussed the development of ecological services production functions. A member stated that it was important to "look out" from steps along a production function to see how it related to other services or possibly disservices. EPA staff stated that it was important to look at a bundle of services. A member stated that it was important to clearly identify benefits of services. For example, the services of clean water and flood control could be of varying importance in different areas of the country. He noted that particular services may be considered to be more important when they result in greater benefit to people.

Discussion of Decision Support Activities

EPA ORD staff presented an overview of ESRP decision support activities. Slides of this presentation are provided in Appendix I. The Committee asked clarifying questions and discussed a number of issues in response to Charge Questions 6.1 – 6.2 (Appendix C).

Members discussed the importance of developing a decision support framework for the use of ecosystem services production functions, data, and information for decision making. A member commented that it was very important to work closely with stakeholders on decision support activities. He noted that lack of regulatory authority for decisions that were based on ecosystem services considerations could pose a problem. He stated that it was important to demonstrate such decisions and recommended that EPA begin to look for a programmatic application (e.g., Superfund or Brownfields) for a demonstration. He stated that this would build management support.

The Committee discussed the changes that EPA had incorporated into the decision support research. A member noted that in its previous advisory report the SAB had indicated that ORD's work to develop a decision support platform was overly ambitious and focused too much on software. He commented that in this regard, EPA's movement toward developing a decision support framework was appropriate. He noted, however, that different conceptual models had been developed for each of the place-based projects, and that a framework was needed to show how the projects meshed. He also noted that various decisions required consideration of information on different scales, and it was not clear how EPA could provide this information across all of these scales.

A member commented that although EPA had scaled back the decision support platform to a decision support framework (scaling back from helping to make decisions to providing information that would help others make decisions), ORD's role in the decision making process was still not clear. She noted that it was not clear why the decision support framework was so closely tied to development of the coral reef research program. A member commented that it was important to get information about what people care about and focus the program on those things.

Members discussed other aspects of ESRP decision support activities including the following:

- It was not clear how the database would be used and what tools were to be included. Members stated that a database of 235 tools was not particularly useful. Members stated that EPA needed to think about what people would do with the tools and how the database could be made more useful.
- A member stated that was hard to see how the proposed use of social networking tools would work.
- Members stated that early demonstration of how the ESRP supported decisions was important and that EPA should consider focusing on wetlands mitigation as an early demonstration. Members noted that regional planning examples could be considered.
- The importance of outreach was further discussed. A member suggested that ORD look at the EPA Superfund Program's contaminated sediment outreach activities as an example.

Discussion of Ecosystem Services Research Program Progress to Date

Following the discussion of decision support activities, the Chair thanked the members for their comments and asked that they provide written comments in response to the charge questions to the DFO by July 24th. She stated that the comments would be attached to a letter to the EPA Administrator along with a summary of the key points discussed at the consultation. The Chair stated that the letter and attachments would be sent to Committee members for review before it was transmitted to the Administrator.

The Chair then called for discussion of key points that members wanted to convey to EPA. The key points discussed by the Committee are summarized in Appendix J.

The Chair thanked the members for their comments and thanked EPA staff for presenting information and responding to the Committee's questions. She then adjourned the meeting.

Respectfully Submitted:

/signed/

Dr. Thomas Armitage
Designated Federal Officer

Certified as True:

/signed/

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

APPENDICES

Appendix A: Committee Roster

Appendix B: Meeting Agenda

Appendix C: Charge to the Committee

Appendix D: Presentation: Ecosystem Services Research Program, (Rick A Linthurst and Iris Goodman)

Appendix E: Implementation of Pollutant Specific Studies – Nitrogen (Jana Compton)

Appendix F: Presentation: Mapping and the National Atlas of Ecosystem Services (NAtl-ES) (Annie Neale)

Appendix G: Presentations: Implementation of Place-based Studies: Coordination with ESRP Themes (Hal Walker); Ecosystem Services Demonstration Project – Tampa Bay (Marc Russell); Future Midwestern Landscapes Study (Betsy Smith and (Randy Bruins)

Appendix H: Wetland Ecosystem Services Program – ESRP – Wetlands (Janet Keough)

Appendix I: Decision Support Framework – DSF (Ann Vega)

Appendix J: Summary of Key Points Discussed

Appendix A – Committee Roster

U.S. Environmental Protection Agency
Science Advisory Board
Ecological Processes and Effects Committee Augmented for the Consultation on EPA's Ecosystem Services Research Program

CHAIR

Dr. Judith L. Meyer, Distinguished Research Professor Emeritus, University of Georgia, Lopez Island, WA

MEMBERS

Dr. Richelle Allen-King, Professor and Chair, Department of Geology, University at Buffalo, Buffalo, NY

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

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

Dr. Ingrid Burke, Director, Haub School and Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, Laramie, WY

Dr. G. Allen Burton, Professor and Director, Cooperative Institute for Limnology and Ecosystems Research, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI

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

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

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

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

Dr. Wayne Landis, Professor and Director, Department of Environmental Toxicology, Institute of Environmental Toxicology, Huxley College of the Environment, Western Washington University, Bellingham, WA

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

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

Dr. Charles Rabeni, Research Professor, Department of Fisheries & Wildlife, University of Missouri, Columbia, MO

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

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

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

Mr. Timothy Thompson, Senior Environmental Scientist, Science, Engineering, and the Environment, LLC, Seattle, WA

Dr. Ivor van Heerden, Director, Center for the Study of Public Health Impacts of Hurricanes, Louisiana State University, Baton Rouge, LA

SCIENCE ADVISORY BOARD STAFF
Dr. Thomas Armitage, U.S. Environmental Protection Agency, Washington, DC

Appendix B – Meeting Agenda

U.S. ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD
Ecological Processes and Effects Committee Augmented for the Consultation on EPA's Ecosystem Services Research Program
Public Meeting, July 14 – 15, 2009
SAB Conference Center
1025 F Street, N.W., Room 3705, Washington, D.C. 20004

AGENDA

Tuesday, July 14, 2009

9:00 - 9:10 a.m.	**Meeting Convened by the Designated Federal Officer** Dr. Thomas Armitage
	Welcoming Remarks Dr. Anthony Maciorowski, Deputy Director EPA Science Advisory Board Staff Office
9:10 - 9:20 a.m.	**Purpose of the Meeting and Review of Agenda** Dr. Judith Meyer, Chair
9:20 - 9:50 a.m.	**Current Direction of EPA Ecosystem Services Research Program** Dr. Rick Linthurst, National Program Director for Ecology U.S. EPA Office of Research and Development
	Ms. Iris Goodman, Deputy National Program Director for Ecology U.S. EPA Office of Research and Development
9:50 – 10:45 a.m.	**Committee Discussion of Current Research Program Direction (response to charge questions 1.1 – 1.4)** Lead Discussants and Committee
10:45 – 11:00 a.m.	**BREAK**
11:00 – 11:20 a.m.	**Implementation of Pollutant Specific Studies – Nitrogen** Dr. Jana Compton EPA Office of Research and Development

11:20 a.m. – 12:00 p.m.	**Committee Discussion of Pollutant Specific Studies (response to charge question 2)** Lead Discussants and Committee
12:00 – 1:00 p.m.	**LUNCH**
1:00 – 1:15 p.m.	**Public Comments**
1:15 – 1:45 p.m.	**Implementation of Modeling, Mapping, and Monitoring** Dr. Rick Linthurst, National Program Director for Ecology U.S. EPA Office of Research and Development Ms. Anne Neale U.S. EPA Office of Research and Development
1:45 – 2:15 p.m.	**Committee Discussion of Modeling, Mapping, and Monitoring (response to charge questions 3.1 – 3.2)** Lead Discussants and Committee
2:15 – 2:30 p.m.	**BREAK**
2:30 – 3:15 p.m.	**Implementation of Place-based Studies (Cross-Place Coordination, Future Midwestern Landscapes and Tampa Bay)** Dr. Hal Walker EPA Office of Research and Development Dr. Randy Bruins EPA Office of Research and Development Dr. Marc Russell EPA Office of Research and Development
3:15 – 4:15 p.m.	**Committee Discussion of Place-based Studies (response to charge questions 4.1 – 4.4)** Lead Discussants and Committee
4:15 – 5:00 p.m.	**General Committee Discussion of Program** Dr. Meyer and Committee
5:00 – 5:15 p.m.	**Summary of the Discussion for the Day** Dr. Judith Meyer, Chair
5:15 p.m.	**Recess for Day**

Wednesday, July 15, 2009

8:30 – 9:00 a.m.	**Implementation of Ecosystem Specific Studies – Wetlands** Dr. Janet Keough EPA Office of Research and Development
9:00 – 10:00 a.m.	**Committee Discussion of Ecosystem Specific Studies (response to charge question 5)** Lead Discussants and Committee
10:00 – 10:15 a.m.	**BREAK**
10:15 – 10:30 a.m.	**Implementation of Decision Support Activities** Ms. Ann Vega EPA Office of Research and Development
10:30 – 11:15 a.m.	**Committee Discussion of Decision Support Activities (response to charge questions 6.1-6.2)** Lead Discussants and Committee
11:15a.m. - 12:00 noon	**General Discussion of the Ecosystem Services Research Program Progress to Date** Dr. Judith Meyer, Chair
12:00 noon	**ADJOURN**

Appendix C – Committee Charge

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?

Appendix D – Presentation: Ecosystem Services Research Program (Rick A. Linthurst and Iris Goodman)

The Ecosystem Services Research Program

Rick A. Linthurst, Ph.D., Director
Iris Goodman, Deputy
Office of Research and Development
USEPA

Science Advisory Board Presentation
Environmental Processes and Effects Committee

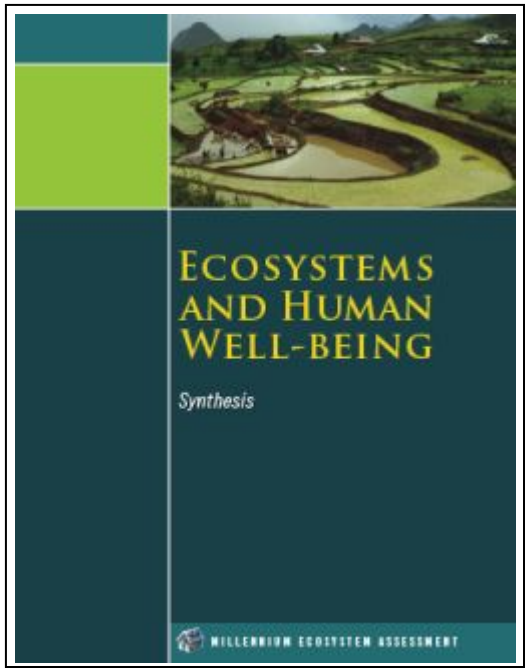
July 14, 2009

Presentation

- How did get here?
- Where are we going?
- Evidence of acceptance
- Elements of the ESRP Strategy
- Nitrogen as an integrating theme
- Highlights of changes in response to EPEC.
- Other influential SAB reports
- Our Next Steps

Millennium Ecosystem Assessment

- All aspects of human well-being are dependent upon nature and the world's ecosystems
- Unless we account for the full value of ecosystem services, humans will continue to degrade and deplete natural systems.



ESRP's role is to provide the science to

- Clarify this dependence,
- Describe the full range of values, and
- Quantify what we know about different services – their status, trends, thresholds, trade-offs.

Vision

A comprehensive theory and practice for quantifying ecosystem services so that their value and their relationship to human well-being, can be consistently incorporated into environmental decision making.

Goal

Transform the way decision makers understand and respond to environmental issues by making clear the ways in which our management choices affect the type, quality and sustainability of the services we receive from ecosystems.

Oregon State Senate Bill 513

Sponsored by Senator DEVLIN; Senator ATKINSON, Representatives GARRETT, GILLIAM

SUMMARY

Establishes policy regarding ecosystem services. Makes legislative findings regarding ecosystem services.

Encourages state agencies to take certain actions related to ecosystem services and ecosystem services markets.

Requires Sustainability Board to convene ecosystem services markets working group.

[*Appropriates moneys from General Fund to Sustainability Board for purpose of ecosystem services markets working group.*]

A BILL FOR AN ACT

(1) "Adaptive management mechanisms" means the processes of implementing programs in a scientifically based, systematically structured approach that tests and monitors assumptions and predictions in management activities and then uses the resulting information to improve programs and management activities.

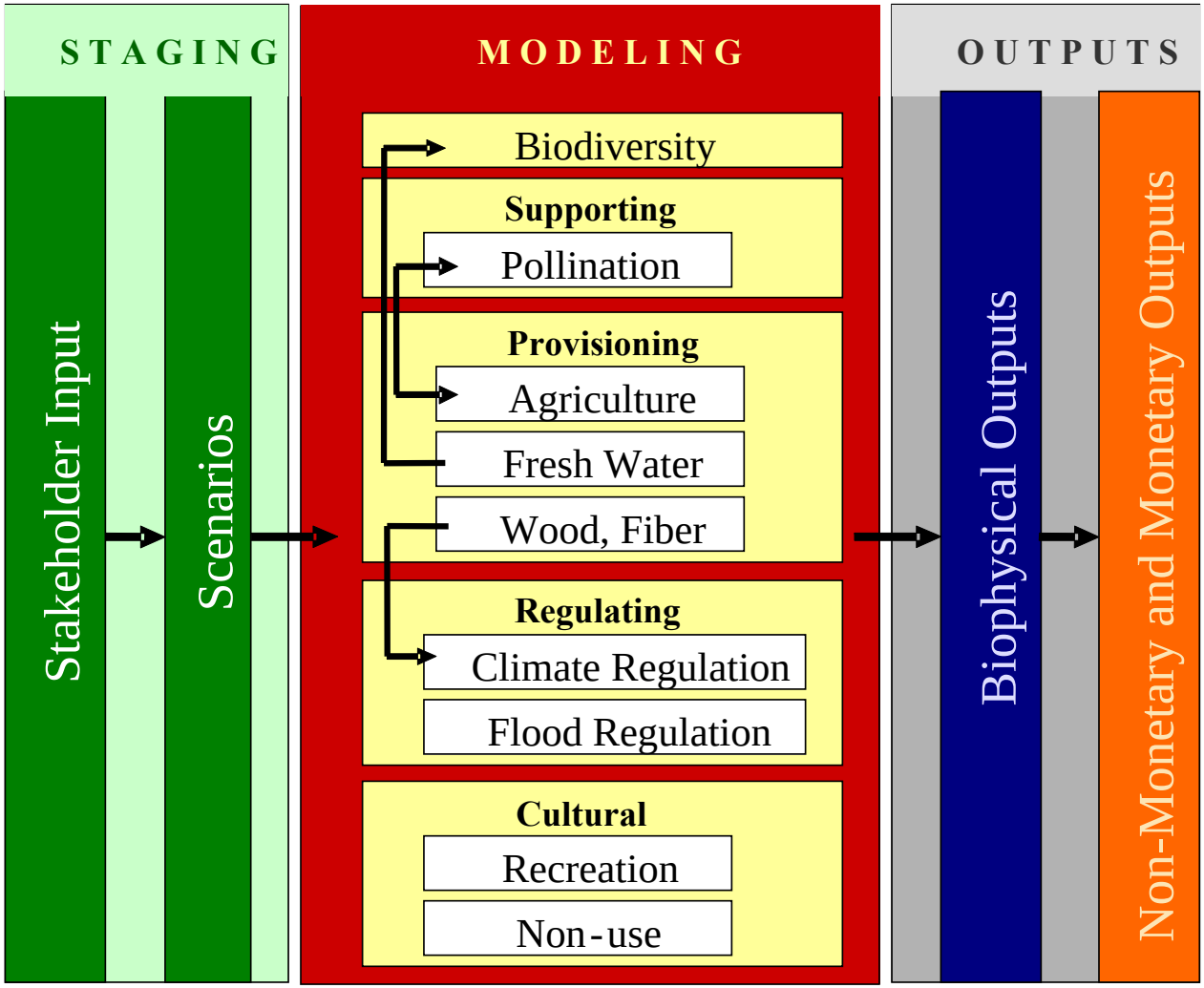
(2) "Ecological values" means clean air, clean and abundant water, fish and wildlife habitat and other values that are generally considered public goods.

(3) "Ecosystem services" means the benefits that human communities enjoy as a result of natural processes and biological diversity.

(4) "Ecosystem services market" means a system in which providers of ecosystem services can access financing to protect, restore and maintain ecological values, including the full spectrum of regulatory, quasi-regulatory and voluntary markets.

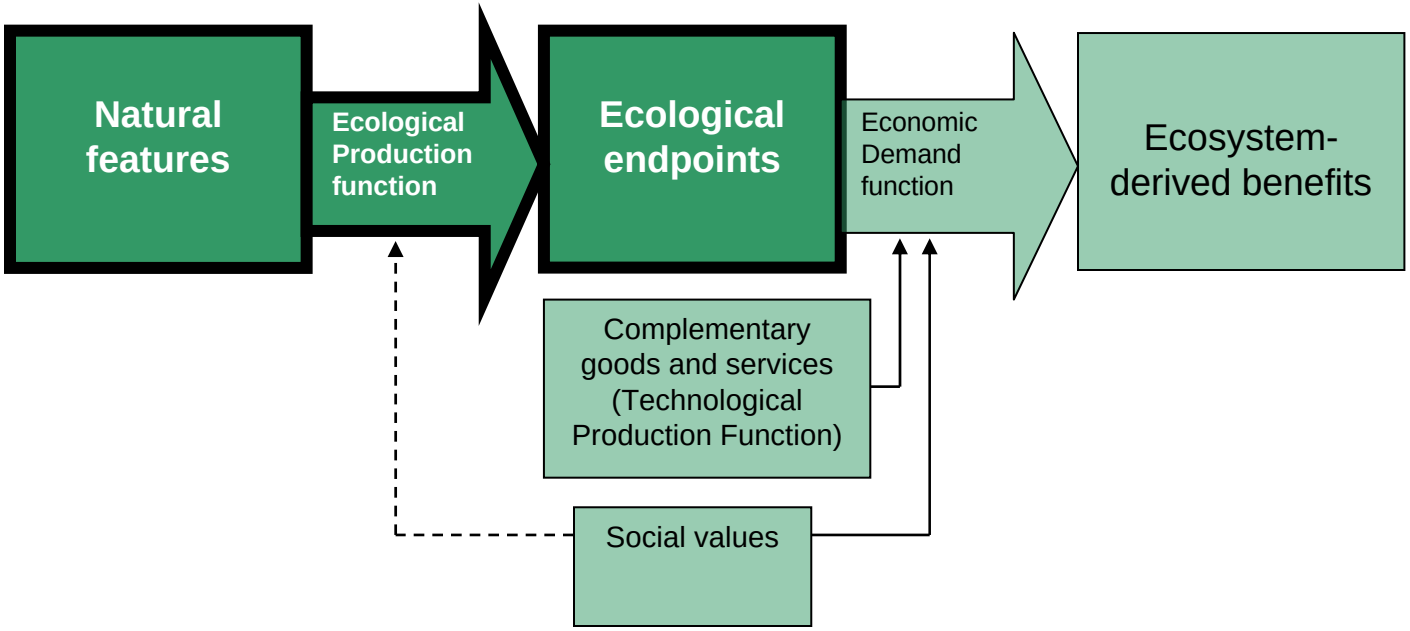
(5) "Payment for ecosystem services" means arrangements through which the beneficiaries of ecosystem services pay back the providers of ecosystem services.

SECTION 2. It is the policy of this state to support the maintenance, enhancement and restoration of ecosystem services throughout Oregon, focusing on the protection of land, water, air, soil and native flora and fauna.



Modified from MEA by Taylor Ricketts, Natural Capitol Project

Ecosystem Services Framework
Lisa Wainger and Jim Boyd



High Level Research Questions

Pollutant-Based Ecosystem Services Research

How does a regulated pollutant—nitrogen—affect, positively and negatively, the bundle of ecosystem services at multiple scales?

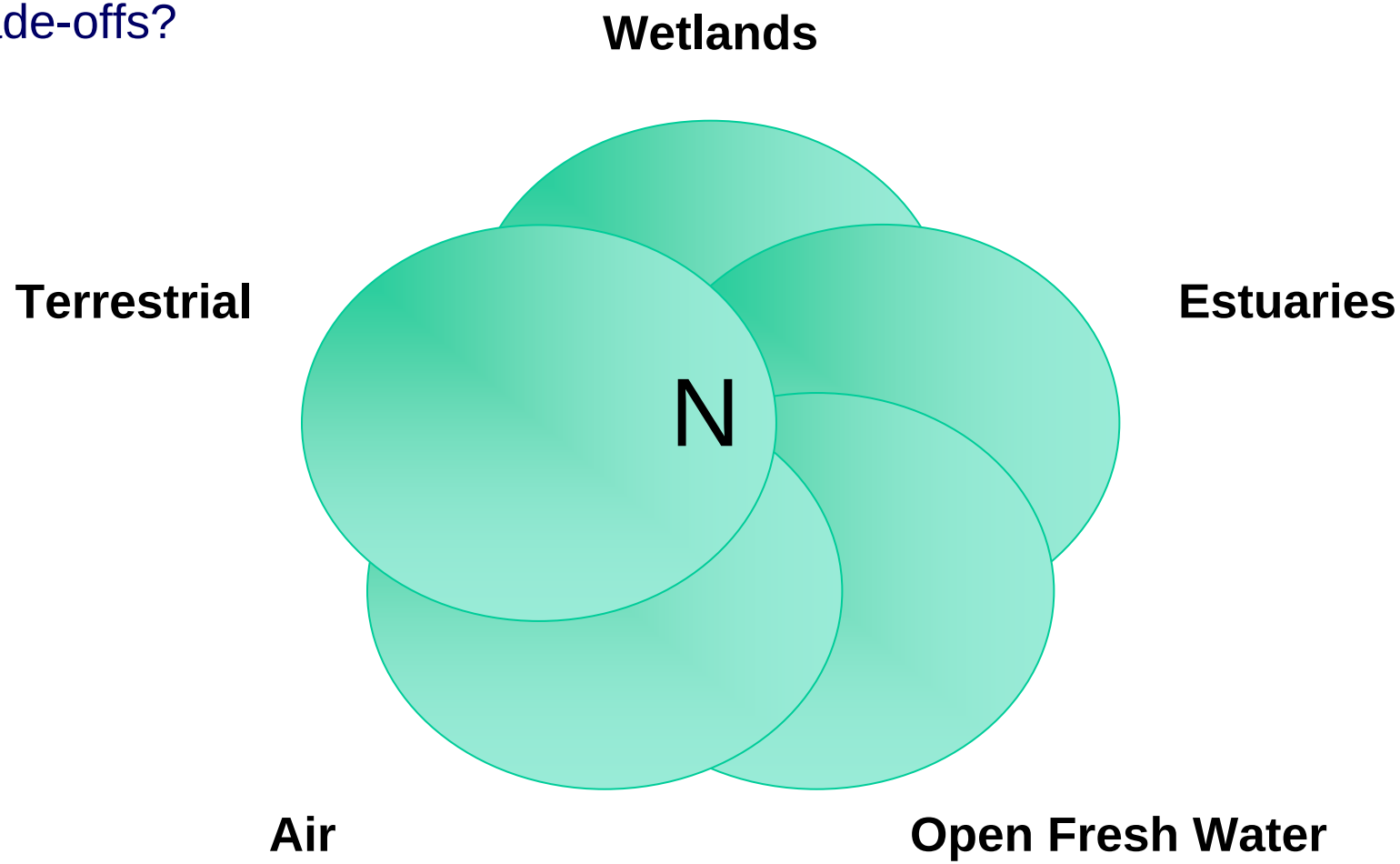
Ecosystem-Based Ecosystem Services Research

How does the bundle of ecosystem services provided by selected ecosystem types—wetlands and coral reefs—change under alternative management options at multiple scales?

Place-Based Ecosystem Services Research

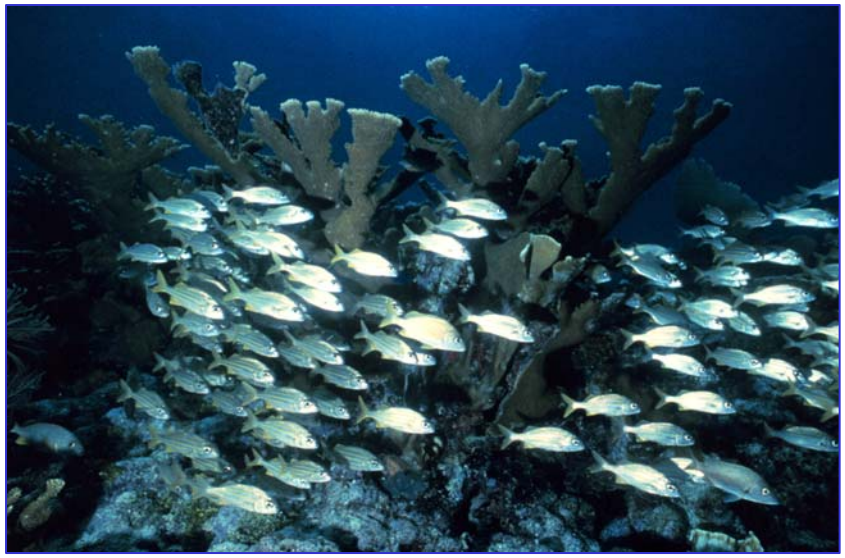
How does the bundle of ecosystem services for all ecosystems within an ecosystem district change under alternative management options?

What are the levels of N, above or below which ecosystem services are enhanced, maintained, and/or degraded and how do we manage to balance these trade-offs?



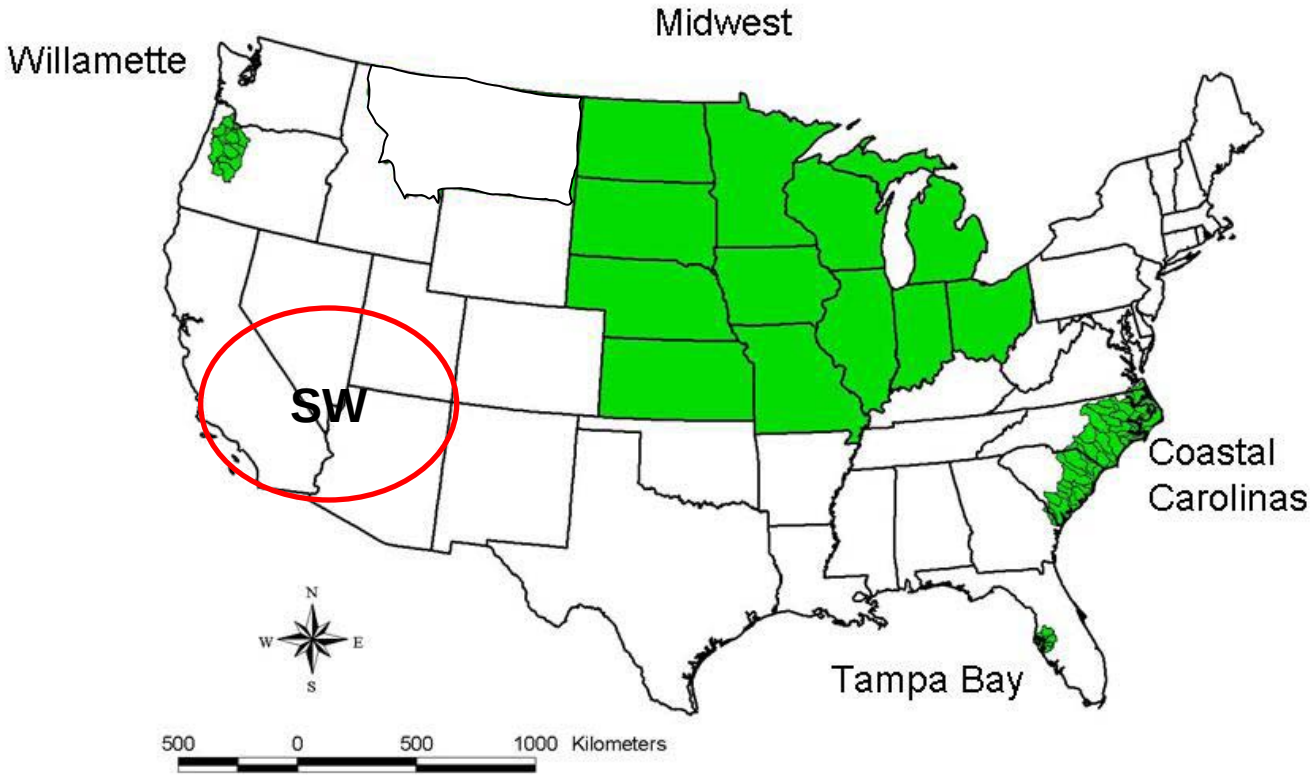
Stressors / Pressures on Wetlands

Coral Reefs



- Under current policies and management, coral reef ecosystem services are perceived as free and limitless
- Despite high visibility, dedicated research, and focused management, coral reefs are declining
- Our goal is to provide the tools and information to ensure that the ***full value*** of coral reef services is incorporated ***routinely*** into all levels of management and decisions made in the reef watershed and coastal zone.

Place Based Studies



Opportunity for coordinated site work: Standardization, Scaling, Applicability Testing, Collective Strength,….

Cross-Cutting Themes

- Landscape characterization and mapping
- Modeling
- Inventory and Monitoring
- Wetlands and nitrogen

Across all elements and place-based projects

- Education and outreach
- Human health and well-being
- Valuation
- Decision Support

ESRP Organizational Matrix

Projects and Long term Goals →		LTG 3 Pollutant-Specific Studies: 6%	LTG 4 Ecosystem Specific Studies: 23%		LTG 5: Community Based Demonstration Projects: For National, Regional, State and Local Decisions 28%					Theme Leads
	Cross Program Themes and Research Objectives	Nitrogen (6%)	Wetlands (22%)	Coral Reefs (5%)	Willamette (11%)	Tampa Bay (4%)	Mid-West (4%)	Coastal Carolinas (8%)	Southwest (1%)	
Integration, Well-Being, Valuation, Decision Support, Outreach and Education LTG 1 9%	Ecosystem Services and Human Well-Being (3%)									Laura Jackson
	Valuation of Ecosystem Services									Wayne Munns--Consultation Committee
	Decision Support (6%)									Ann Vega
	Outreach & Education to				**Budgetary Information** **~$71M** **~272 In-house scientists and support staff**					Open
Inventory, Map, and Forecast Ecosystem Services at multiple scales LTG 2 31%	Landscape Characterization and Mapping (12%)									Anne Neale
	Inventory and Monitoring of Services (14%)									Mike McDonald
	Modeling (5%)									Tom Fontaine--Consultation Committee
Pollutant Specific Studies LTG 3	Nitrogen (6%)									Jana Compton
Eco-system Specific Studies LTG 4	Wetlands (22%)									Janet Keough
Project Area Leads	Rick Linthurst and Iris Goodman	Jana Compton	Janet Keough	Bill Fisher	David Hammer	Marc Russell	Randy Bruins/ Betsy Smith	Deborah Mangis	Nita Tallent-Halsell	Rick Linthurst and Iris Goodman
				40	Hal Walker: Place Based Coordinator					

Overview of ESRP response to EPEC recommendations

Summarizing our responses using these categories:

1. Responses related to ESRP in-house research
2. Collaborations with clients for ESRP results
3. ESRP research as relates to other SAB Committees
4. Partnerships and proposals to build capacity for transdisciplinary research.

1. Responses related to ESRP in-house research

- Refined our unique systems approach to ecosystem service assessments
- Implemented and refined our cross-program organizational structure — thus, improving coordination and integration
- Increased in-house talent, learning, and capacity via seminars, developing implementation plans, and expert hires
- Created an economics committee
- In process to create a modeling committee
- Re-cast decision support
- Conducted promising exploratory work in human well-being; will expand as new opportunities arise
- Added U.S. Southwest to round out Place-based studies

2. Collaborations with EPA clients for ESRP results

- Increased recognition of ecosystem services within EPA Program Offices
- Developed closer ties to EPA Office of Water and Office of Air and Radiation
- Developed new collaboration with Office of Science Policy on reactive Nitrogen
- Created new opportunities for Regional participation: Regional Environmental Monitoring and Assessment Program redirection

3. ESRP research as it relates to other SAB Committees

a. Committee on Valuing Ecological Systems and Services (CVPESS), 2009.

b. SAB Report: *Advice to EPA on Advancing the Science and Application of Risk Assessment in Environmental Decision-making*, 2007.

c. SAB Integrated Nitrogen Committee, ongoing.

. . . . Summary highlights follow for each of these.

EPA
United States
Environmental Protection
Agency

SAB

Valuing the Protection of Ecological Systems and Services

A REPORT OF THE EPA SCIENCE ADVISORY BOARD

Technical briefing, June 10, 2009 from the SAB Committee Chair, Dr. Barton H. (Buzz) Thompson, Jr., and Vice Chair, Dr. Kathleen Segerson

Longer-term research and data-sharing recommendations to improve ecological valuation

To determine, predict, and quantify ecological changes related to EPA actions or decisions

- Continue and strengthen EPA/ORD's research program focusing on ecosystem services
- Support development of quantitative ecosystem models and baseline data on ecosystem service flows
- Collect data to parameterize ecological models and valuations for site-specific analysis or transfer to other contexts
- Continue and accelerate research to develop key indicators for use in ecological valuation

Valuations to support regional partnership activities

A major, untapped opportunity exists to use valuation at the regional level

Additional resources will be needed to take advantage of this opportunity

- EPA should avoid “short cuts” in using “off the shelf” values or transferring value information from one site to another

EPA can use and evaluate methods not used traditionally, where formal benefit assessment is not required or appropriate

EPA should develop a system for regional offices to document valuation efforts and share then with other regions, NCEE and ORD

Many aspects of ESRP enable unique contributions to improved methods for ecological risk assessment. These include its:

Transdisciplinary design

➔ mitigates against "fragmentary risk analyses"

Strength in quantitative landscape ecology

➔ analyses that cross multiple space- and time-scales

Systematic examination of effects of non-chemical stressors on ecosystem services

➔ both chemical and non-chemical stressors can be better evaluated together.

Many aspects of ESRP enable unique contributions to improved methods for ecological risk assessment (continued)

•Ecosystem service assessments that lend themselves to meta-analyses

➔ ESRP's Place-Based studies and Wetlands studies.

• Studies that include Bayesian analyses and "weight of evidence"

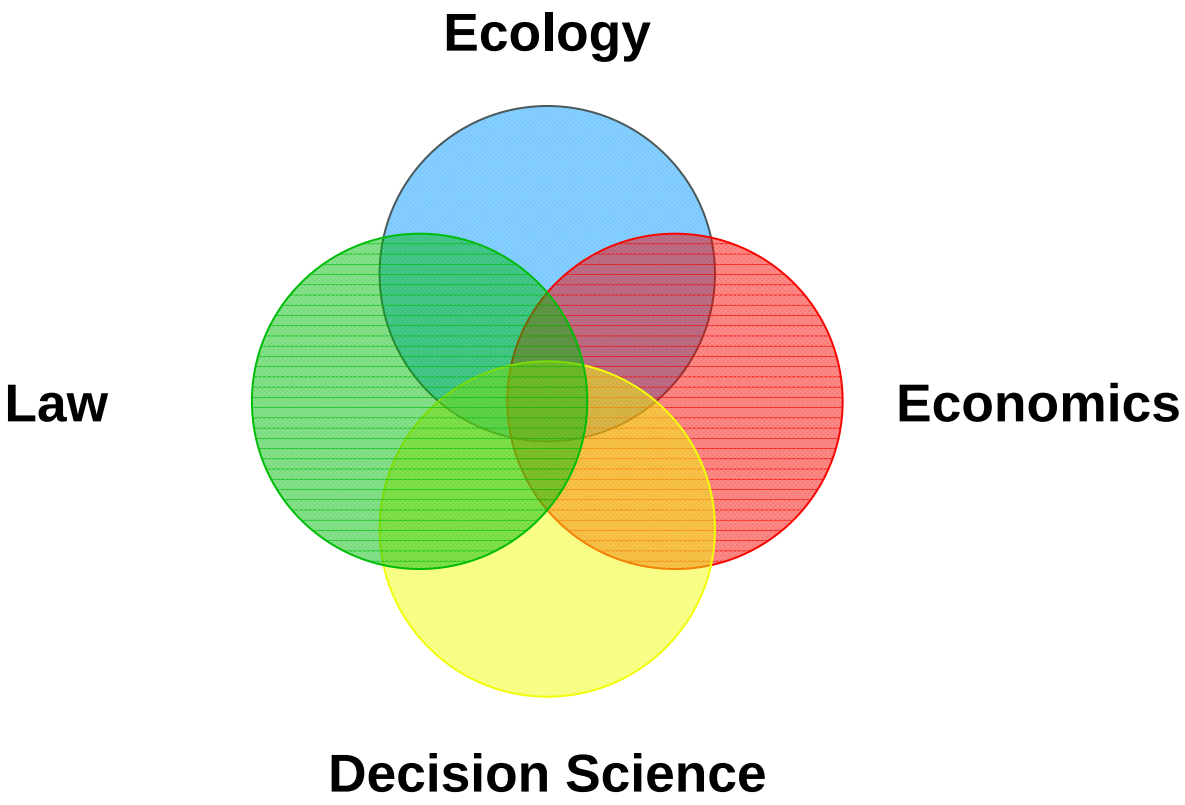
➔ preliminarily begun in Decision Support and in Modeling themes pioneering efforts to identify how social attributes of ecosystem services translate to assessment endpoints that meet decision maker needs

➔ as being investigated in ESRP's Monitoring and in Place-Based studies.

3. C. SAB Integrated Nitrogen Committee (INC)

- This Committee is ongoing – no final recommendations yet available.
- Deliberations note that using ecosystem services to assess nitrogen effects provide a rich context for understanding complex interconnections, can contribute to setting priorities for action, and can be used to identify indicators / endpoints, costs, benefits, and risks.
- INC notes ESRP's research in reactive nitrogen and ecosystem services.

Transdisciplinary Approach to Conserving Ecosystem Services



4. Partnerships and proposals to build capacity for transdisciplinary research.

A. Announced establishment of public-private National Ecosystem Services Research Partnership.

- Received more than 160 expressions of interest from:
  - State resource agencies
  - Regional planning councils
  - Interdisciplinary research institutions
  - Professional ecological organizations
  - NGOs
  - Businesses
  - Federal agencies
  - Legal practitioners

4. A. Public-private National Ecosystem Services Research Partnership, cont.

- This partnership can help “scale-up” capacity needed to refine and test ecosystem service concepts at the requisite ecological, social, and institutional scales – which is beyond what any single organization or agency can accomplish.

- ESRP’s role is to facilitate establishment of partnership.

- Partnership efforts to begin Fall, 2009.

4. B. Proposal: *Supplying ecosystem science in support of ecologic and economic sustainability*

- Goal is to expand the Agency's effective budget for environmental protection
- Methods include developing and testing new institutions, policies, and investment structures via:
  - Regional Centers of Excellence for Ecosystem Services
  - Expanding Community of Practice for Ecosystem Services
  - Providing incentives for collaborative partnerships
  - Applying ecosystem service concepts to inform investments in alternative energy and green infrastructure
  - Educating the next generation of transdisciplinary environmental professionals.

With Your Input: Proposed Next Steps

- Maintain current components, approach and activities
- Increase publication presence in the literature
- Make National Ecosystem Services Partnership a reality
- Translate applicability to the Agency

Appendix E – Implementation of Pollutant Specific Studies – Nitrogen (Jana Compton)

Ecosystem Services Research Program Pollutant-based studies: Nitrogen

July 14-15, 2009 SAB presentation

Our goal: connect the effects of increasing reactive nitrogen to ecosystem services, in order to improve policy and management related to nutrients.

ESRP Organizational Matrix

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					Hal Walker: Place Based Coordinator					

ESRP-N began as a row and has expanded to integrate across columns, particularly in LTG2.

Nitrogen Writing & Implementation Team

Jana Compton NHEERL-WED

Robin Dennis NERL-RTP

Hal Walker NHEERL-AED

Steve Jordan NHEERL-GED

Brian Hill NHEERL-MED

Ken Fritz NERL-Cinci

Richard Devereux NHEERL-GED

Bryan Milstead NHEERL-AED

Jake Beaulieu NRMRL-Cinci

Jim Latimer NHEERL-AED

Jason Lynch OAR-CAMD

Anne Rea OAR-OAQPS

Randy Waite OAR-OAQPS

Christine Davis OAR-OAQPS

Edward Dettmann NHEERL-AED

Tara Greaver NCEA

Annie Neale NERL RTP

Holly Campbell NHEERL-WED

NRC post-doc NHEERL-WED

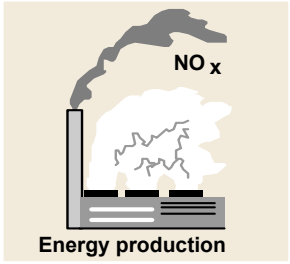
Expert hire: John Harrison Washington State University, Vancouver, Washington

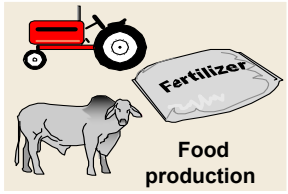
Outline of presentation

- Background
- Research directions and early results
  - Much new since 2008 SAB review
  - Implementation plan external review May 2009; Final version now in management approvals
  - National, Regional and Place-based work
- Science needs and the end goals

Why Nitrogen and Ecosystem Services?

- Nitrogen is a critical component of energy, food, and fiber production, benefiting humans in many ways.

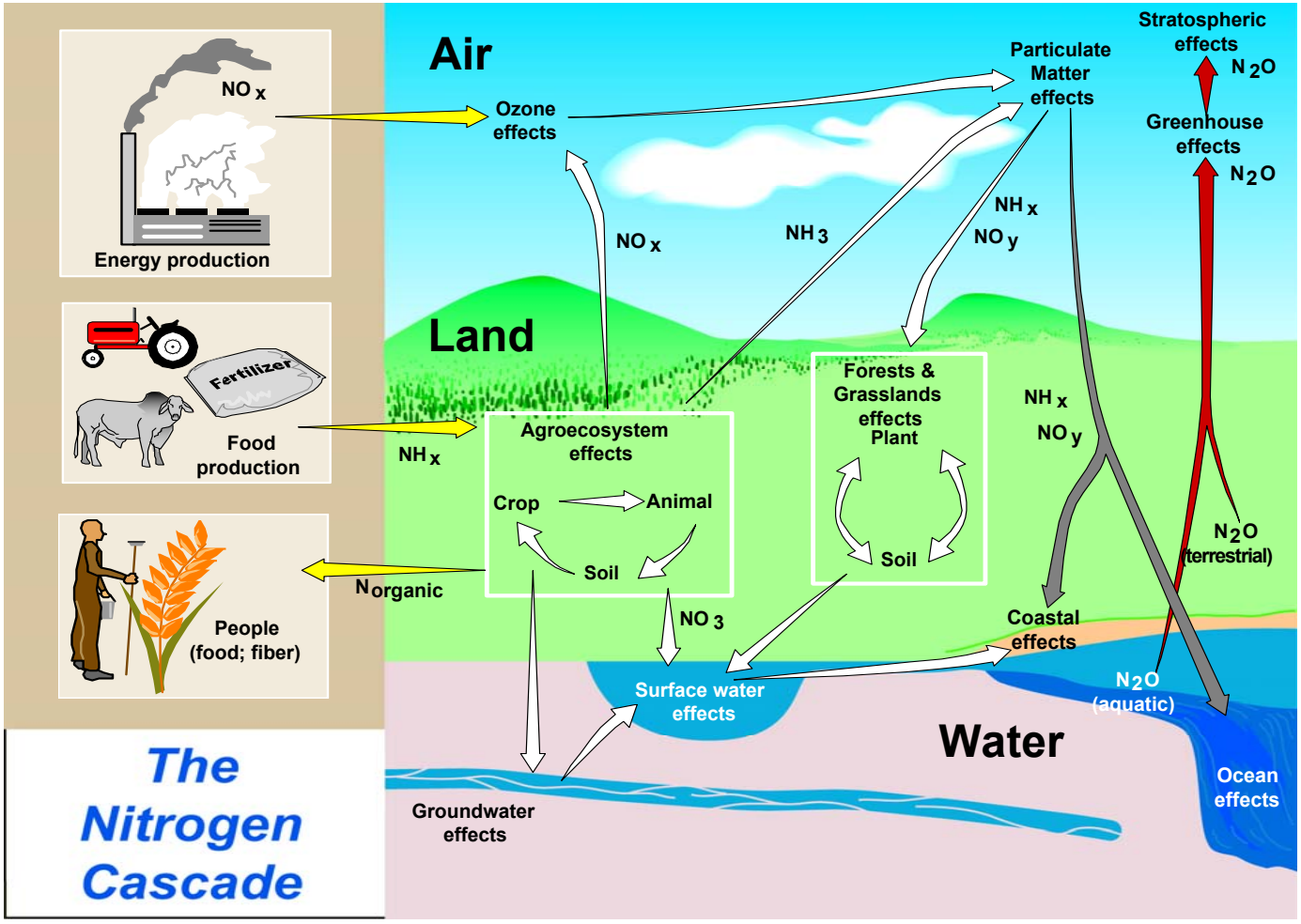




from Galloway et al. (2003)

Why Nitrogen and Ecosystem Services?

- However, N is a major stressor for many ecosystems.



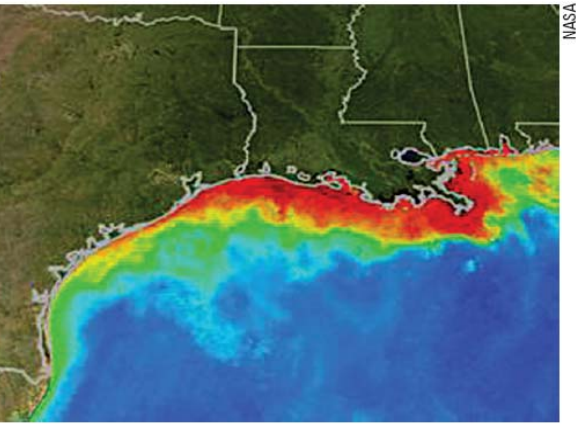
from Galloway et al. (2003)

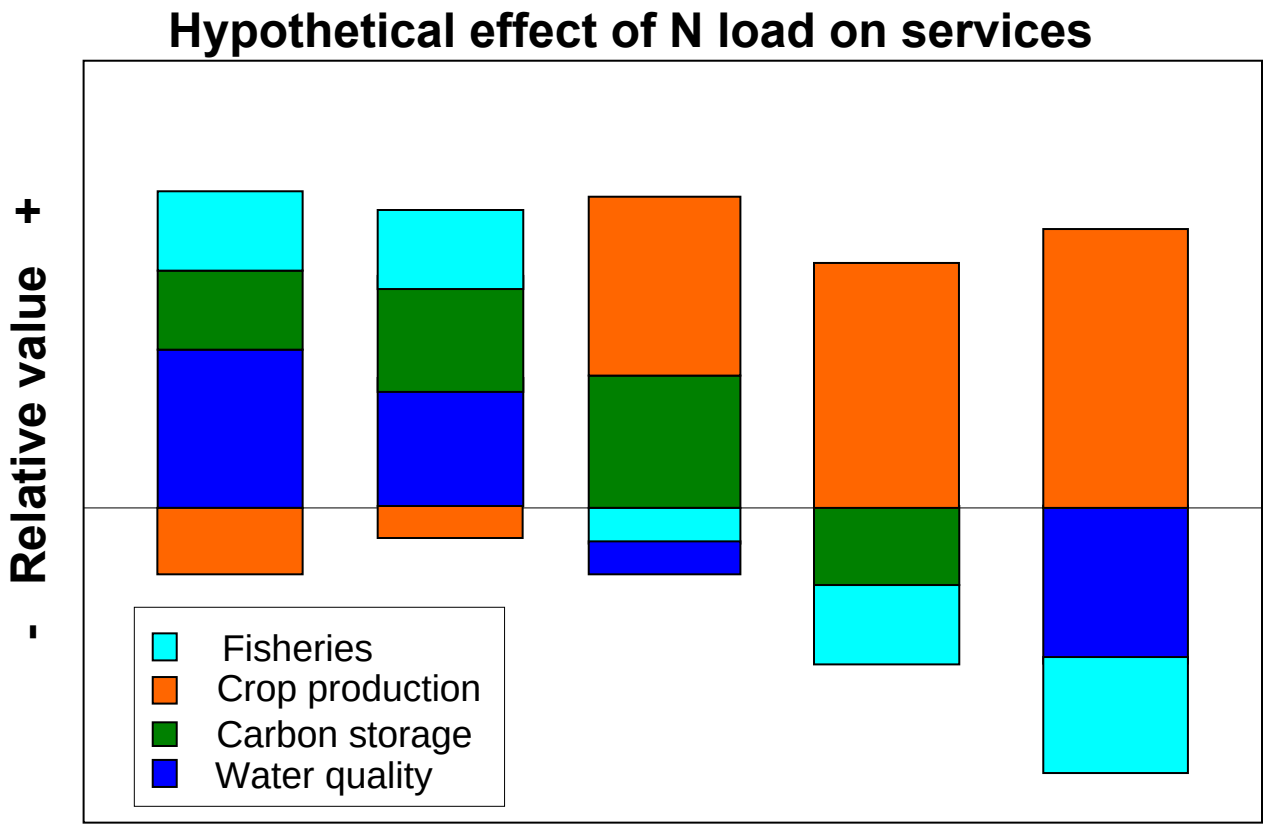
Why N and Ecosystem Services for EPA?

- Air quality regulations
  - Currently National Ambient Air Quality Standards review process underway for secondary NOxSOx standard (current standards set in 1971)
  - Ecosystem service impacts included in risk assessment
- Water quality regulations
  - Nitrogen in top 3 of stressors causing stream impairment
  - Nutrient criteria needed for many streams
  - Seasonal hypoxia, algal blooms, fisheries impact in many areas
- EPA's SAB Integrated Nitrogen Committee
  - Draft report calls for greater intra- and interagency cooperation
  - Ecosystem services viewed as one tool to improve management

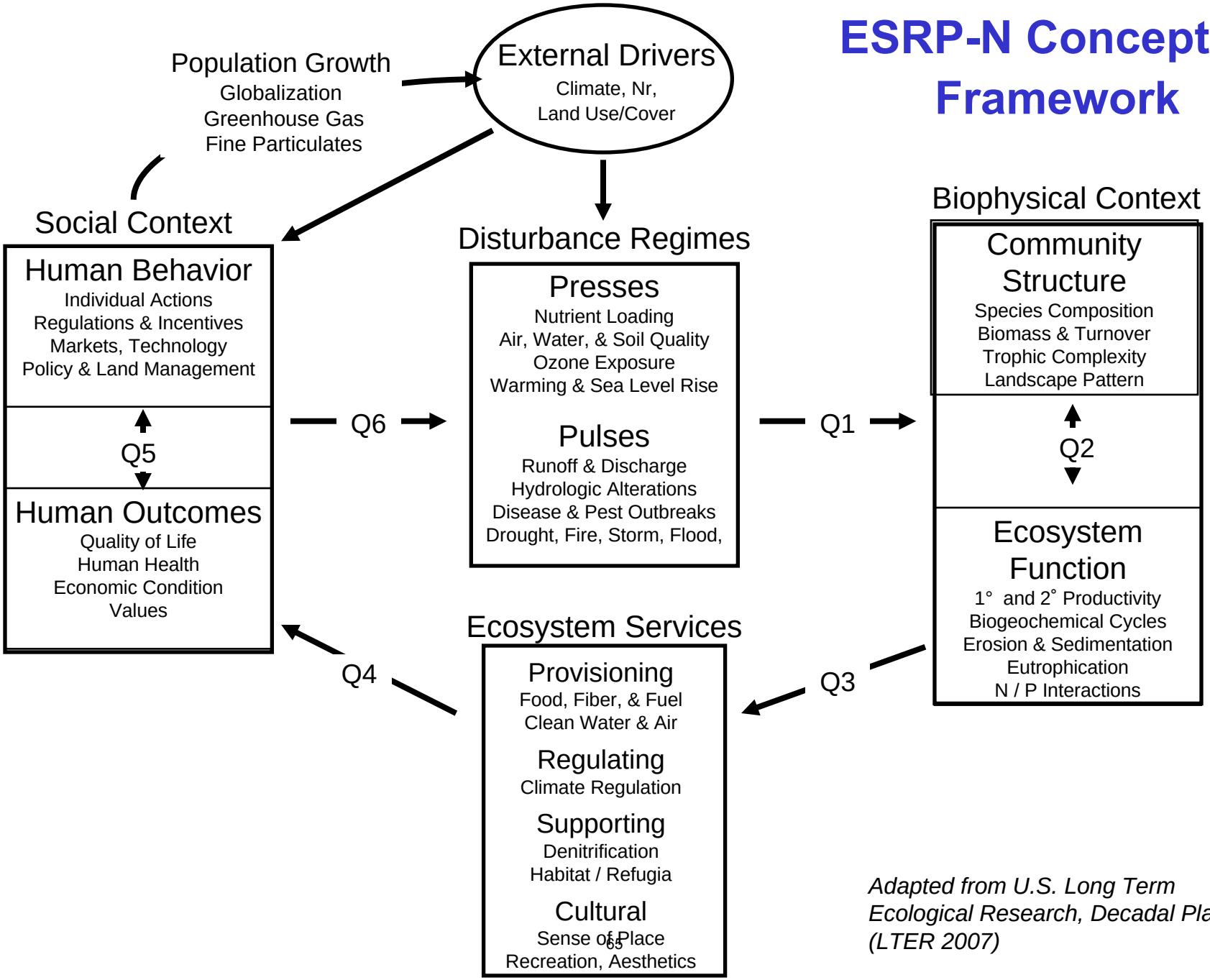
Key question for ESRP-Nitrogen:

How do we use nitrogen most efficiently to balance human needs with impacts on water, air and aquatic life?





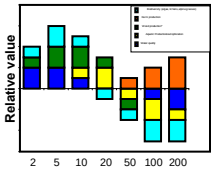
ESRP-N Conceptual Framework



Adapted from U.S. Long Term Ecological Research, Decadal Plan (LTER 2007)

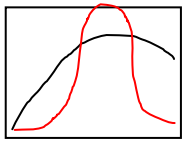
ESRP-N "Road Map"

Identify and bundle Services

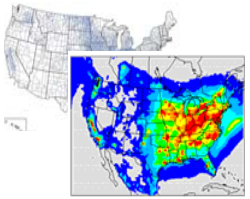


Decision Support

Develop ESRFs (effects of drivers on ES)



Maps of N loads

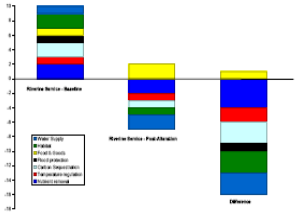


Mapping

Place-based Studies

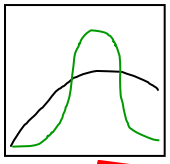
Response of ES bundles to mgmt/policy change

Modeling



Decision Support

Develop Ecological Response Functions

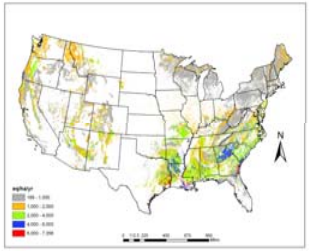


Place-based Studies

System-based Studies

- Terrestrial
- **Wetlands**
- Freshwater
- Coastal
- **Corals**

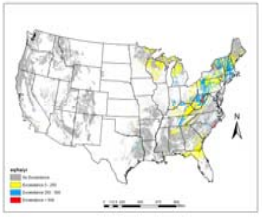
Available relationships of sensitive ecosystems
(e.g. Critical Loads, Indicators, TMDLs)



Monitoring

(plus NCEA assessment and OAR and Interagency work on Critical Loads)

Create maps of At risk Ecosystems



Colored boxes identify work with other ESRP themes

ESRP-N Research Themes

- **National Scale Themes**
  - Theme 1: Nutrient Loading (sources, flux and fate)
  - Theme 2: Identification of Services
- **Regional Scale Themes**
  - Theme 3: Nutrient Cycling and Ecosystem Services
  - Theme 4: Tipping Points in Ecosystem Condition and Services

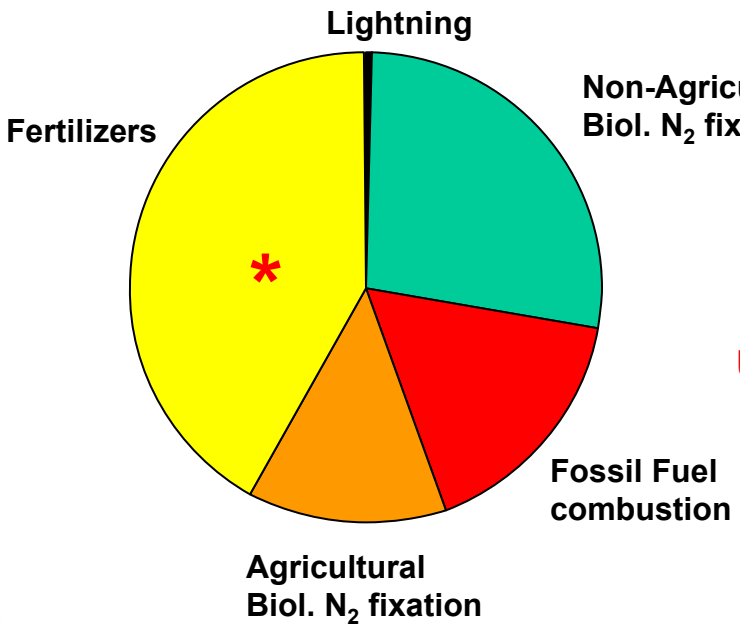
Will include phosphorus where possible. We hope this work will inform management of other nutrients.

Theme 1 – N sources and removal

- N sources at National Scale
  - Deposition - CMAQ
  - Confined Animal Feedlots - Mapping
  - Fertilizers – with Mapping
  - Sewage Treatment Plants - Mapping
- Modeling tools to estimate N removal
  - SPARROW (workshop fall 2009)
  - Global NEWS (with expert John Harrison)
  - Estuarine fate modeling (AED)

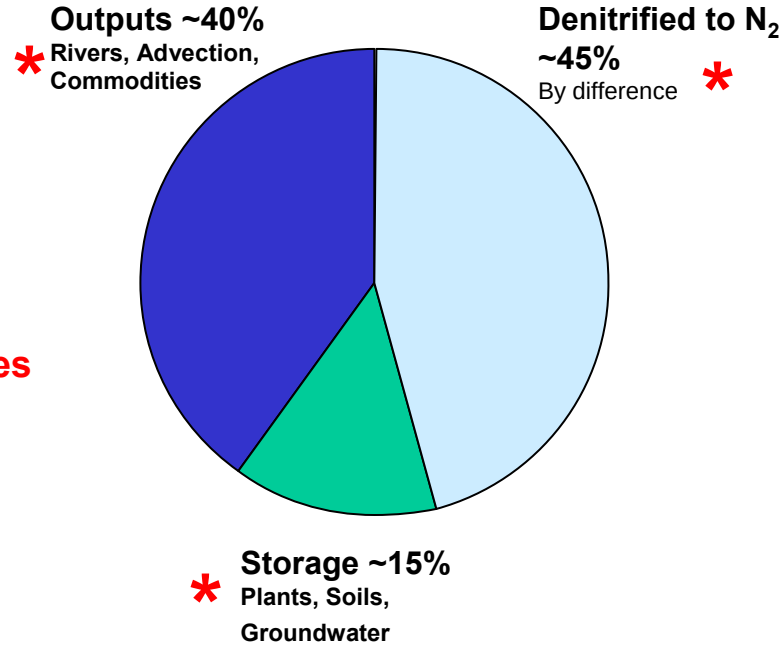
Human activities accelerated transfer of N from the atmosphere to biosphere

Nitrogen fixed from atmosphere
North America early 1990s
25 Tg N yr^{-1}



*Greatest Uncertainties

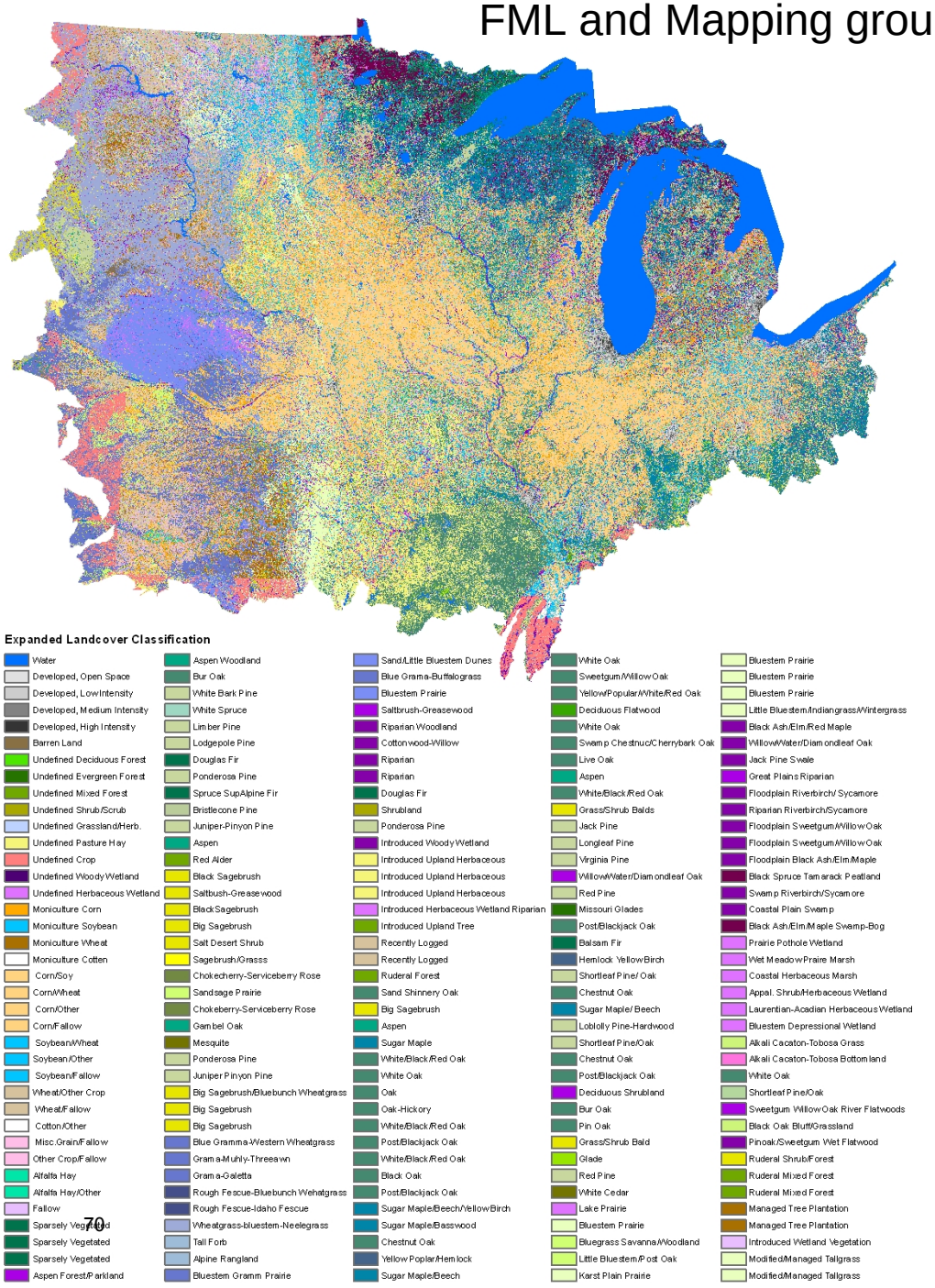
Fate of fixed N



Galloway et al. 2004 Biogeochemistry

Land use and N inputs

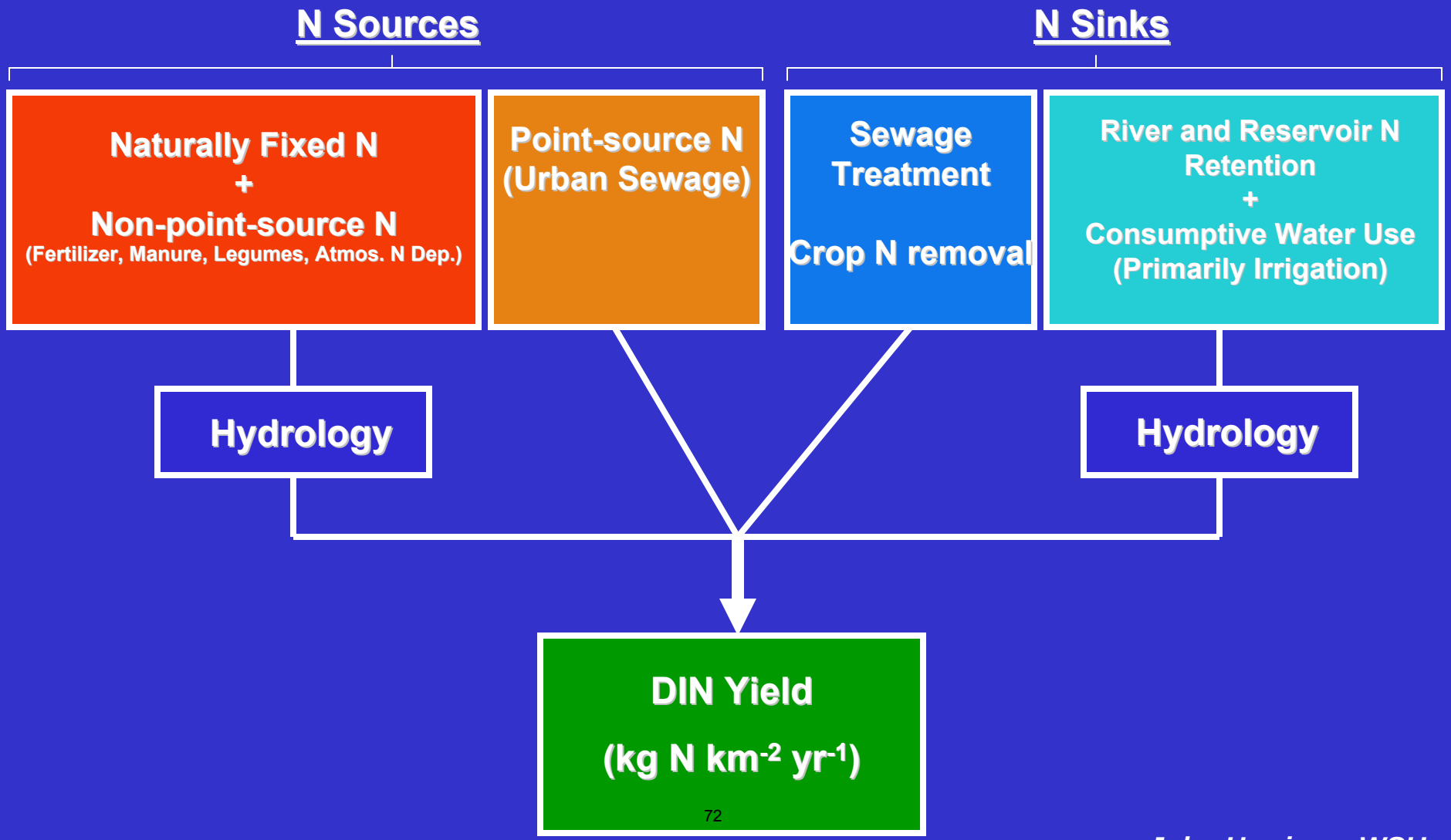
- **Better land use information and spatial resolution → better N accounting**
- **Partition fertilizer application by crop type**
- **National coverage 2011**



Modeling and ESRP-N

- National run of NEWS-DIN
- Regional run of NEWS-DIN for Mississippi Basin
- Approaches for estimating N removal by river networks, and lakes/reservoirs
- Comparisons of SPARROW, NEWS, AGNPS (& others) for “weight of evidence” approach to N removal and futures projections - similar to IPCC

NEWS-DIN Model Structure

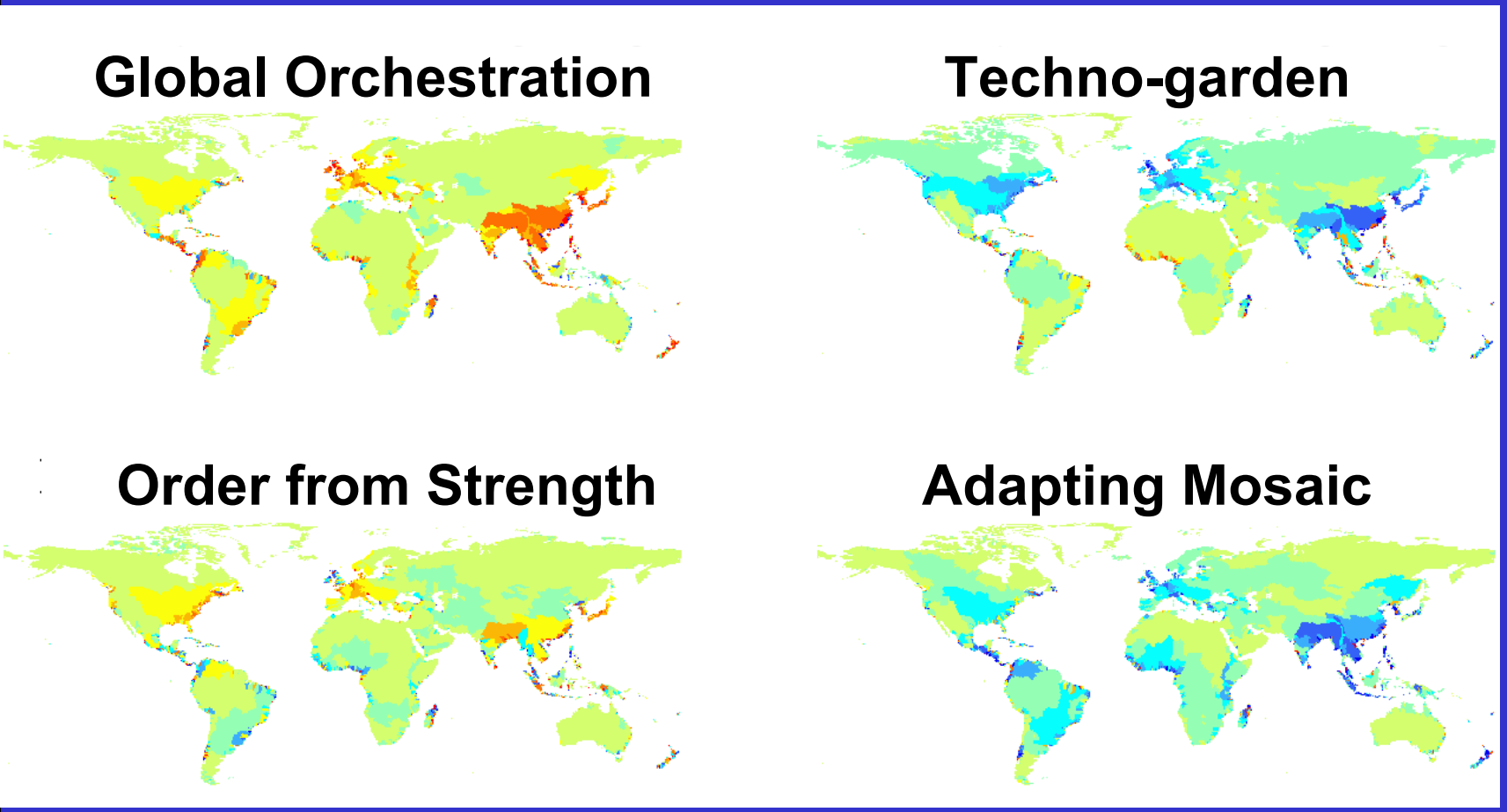


John Harrison, WSU

Scenario DIN yields (kg N/km^2/yr)

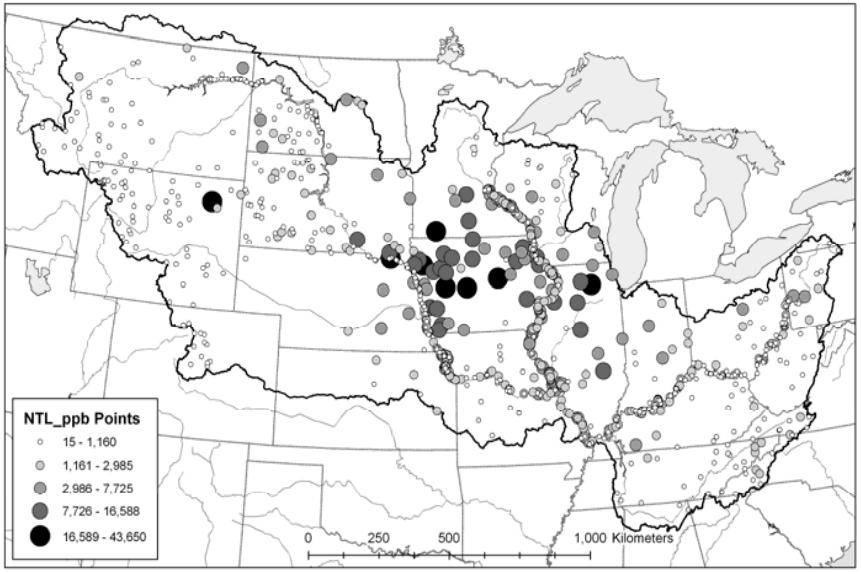
2030 scenarios vs. mean 2030 rate

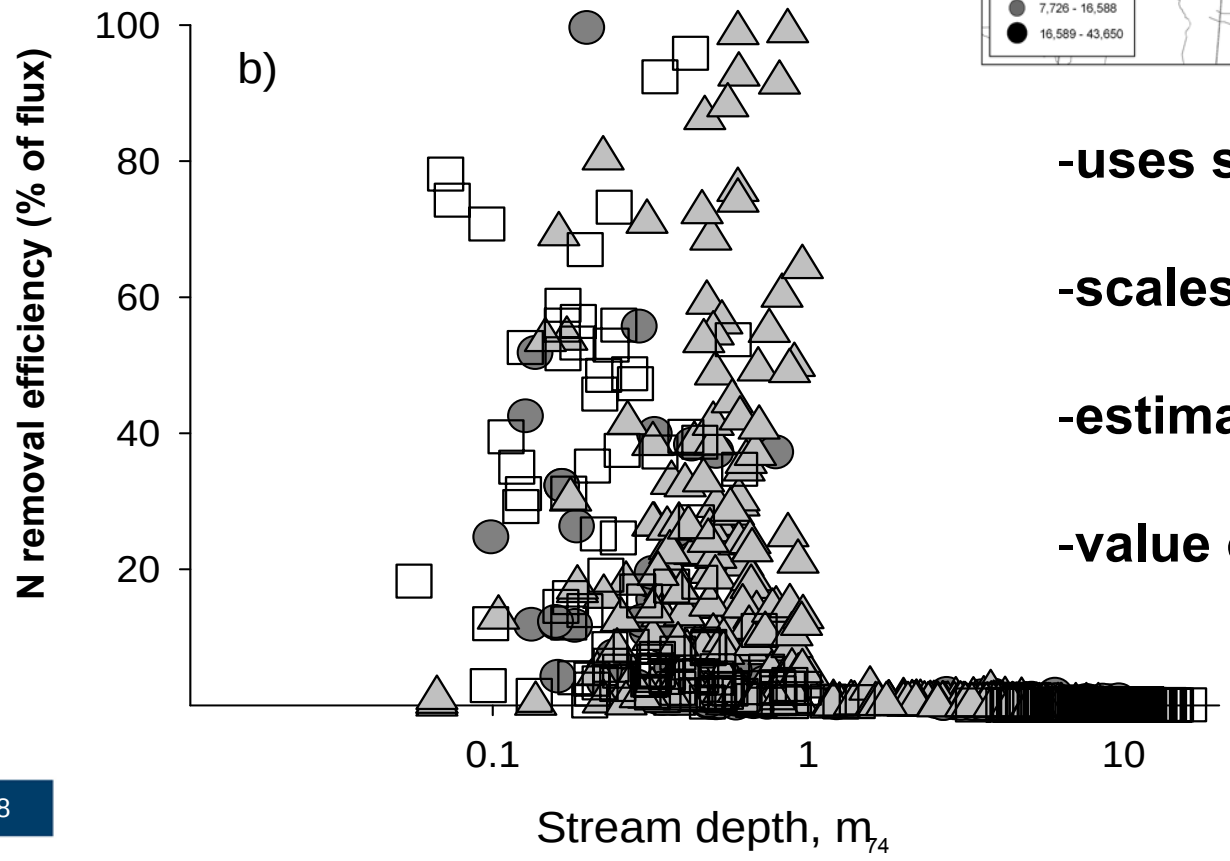
→ Different actions = very different outcomes



John Harrison, WSU

N removal: Ecosystem service

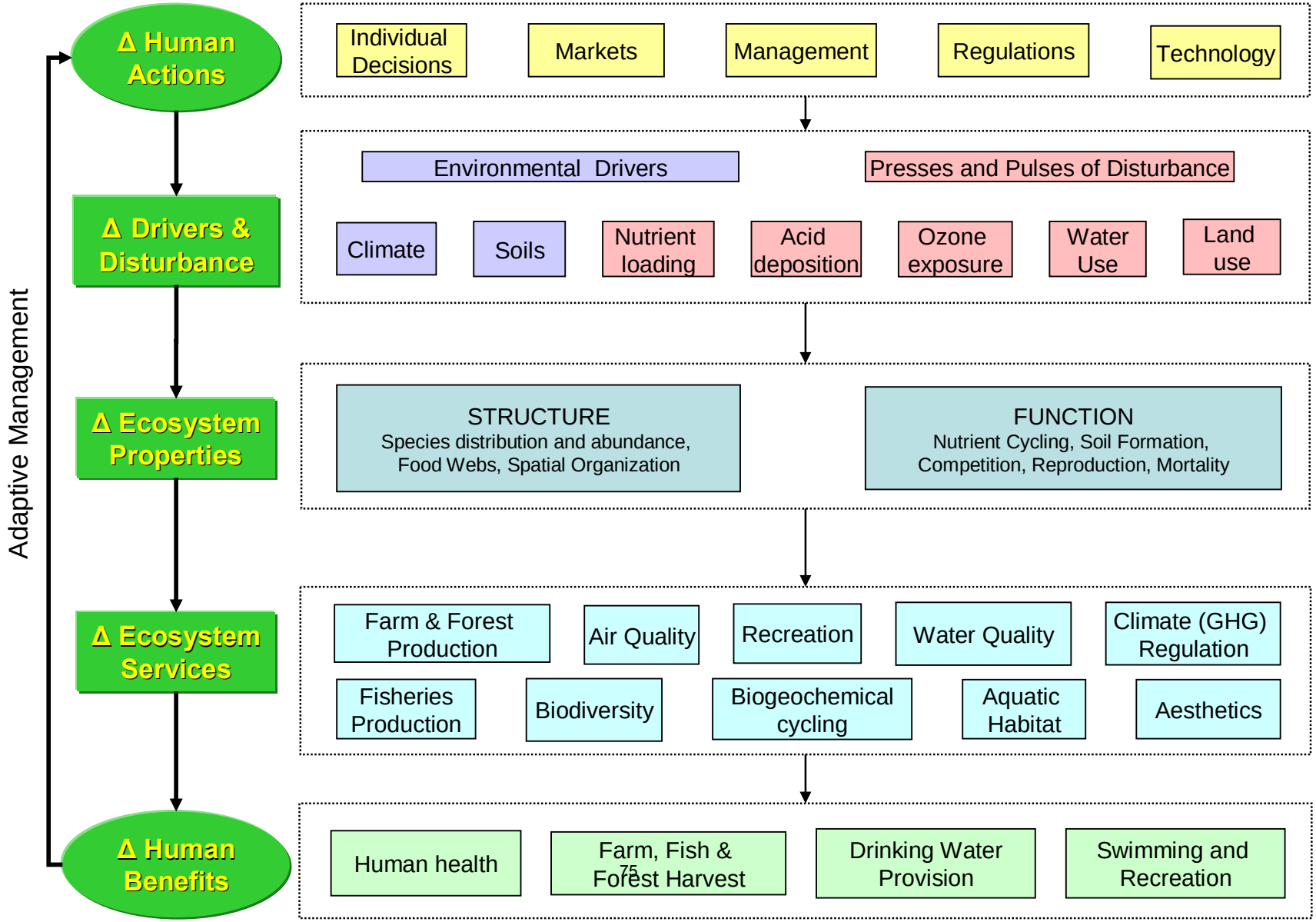




- -uses stream survey data
- -scales with stream depth
- -estimate for network
- -value of stream N removal

Brian Hill and Dave Bolgrien, in review

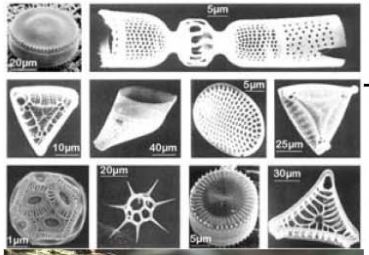
Theme 2: Identification of Services and Relationship to Nitrogen inputs



State of Science paper 2010 –sources

- ESRP-N literature survey
  - 1900+ references; with Holly Campbell (JD, LLM, MS)
- National Ambient Air Quality Standards process
  - Integrated Science Assessment (ISA) for Oxides of Nitrogen and Sulfur – Ecological Criteria (Final Report 12/08)
  - Risk and Policy Assessments underway
  - These include impacts on Ecosystem Services
- EPA's Science Advisory Board
  - Integrated Nitrogen Committee (final report Fall 2009)
  - Gulf of Mexico Hypoxia 2007 report
- Multiple recent special issues on denitrification

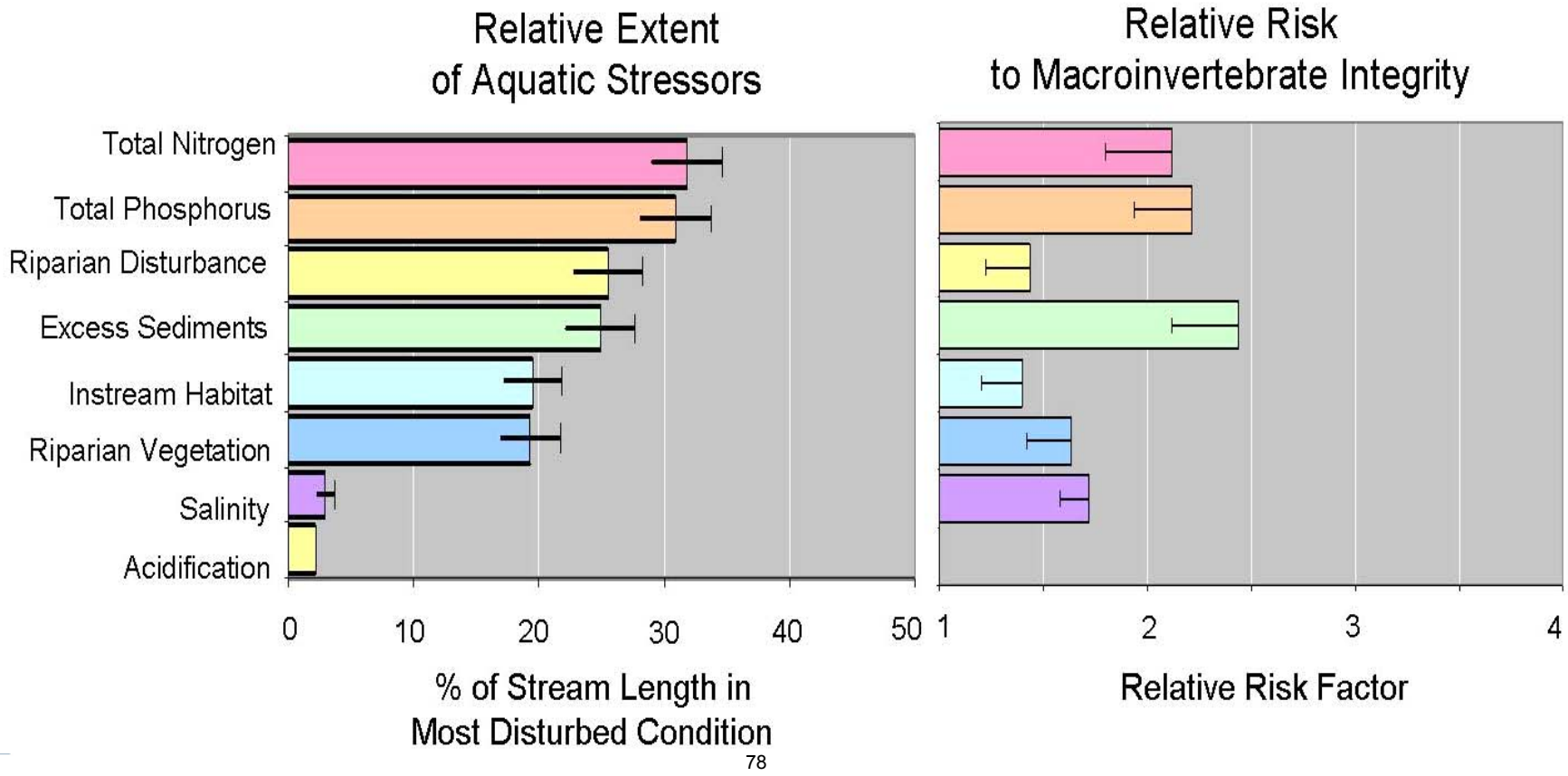
Deposition Levels & Ecological Effects



Kg N/ha/yr	Ecological effect
~1.5	Altered diatom communities in high elevation freshwater lakes and elevated N in tree leaf tissue high elevation forests in the western U.S.
3.1	Decline of sensitive lichen species in the western U.S.
4	Altered growth and coverage of alpine plant species in the western U.S.
5	Onset of decline of species richness in grasslands of the U.S. and U.K.
5.5-10	Onset of nitrate leaching in Eastern forests of the U.S.
5-10	Multiple effects in tundra, bogs and freshwater lakes in Europe

Integrated Science Assessment (ISA) for Oxides of Nitrogen and Sulfur - Ecological Criteria EPA 2008

EPA-Office of Water National Stream Survey
- Nitrogen is key stressor for stream impairment



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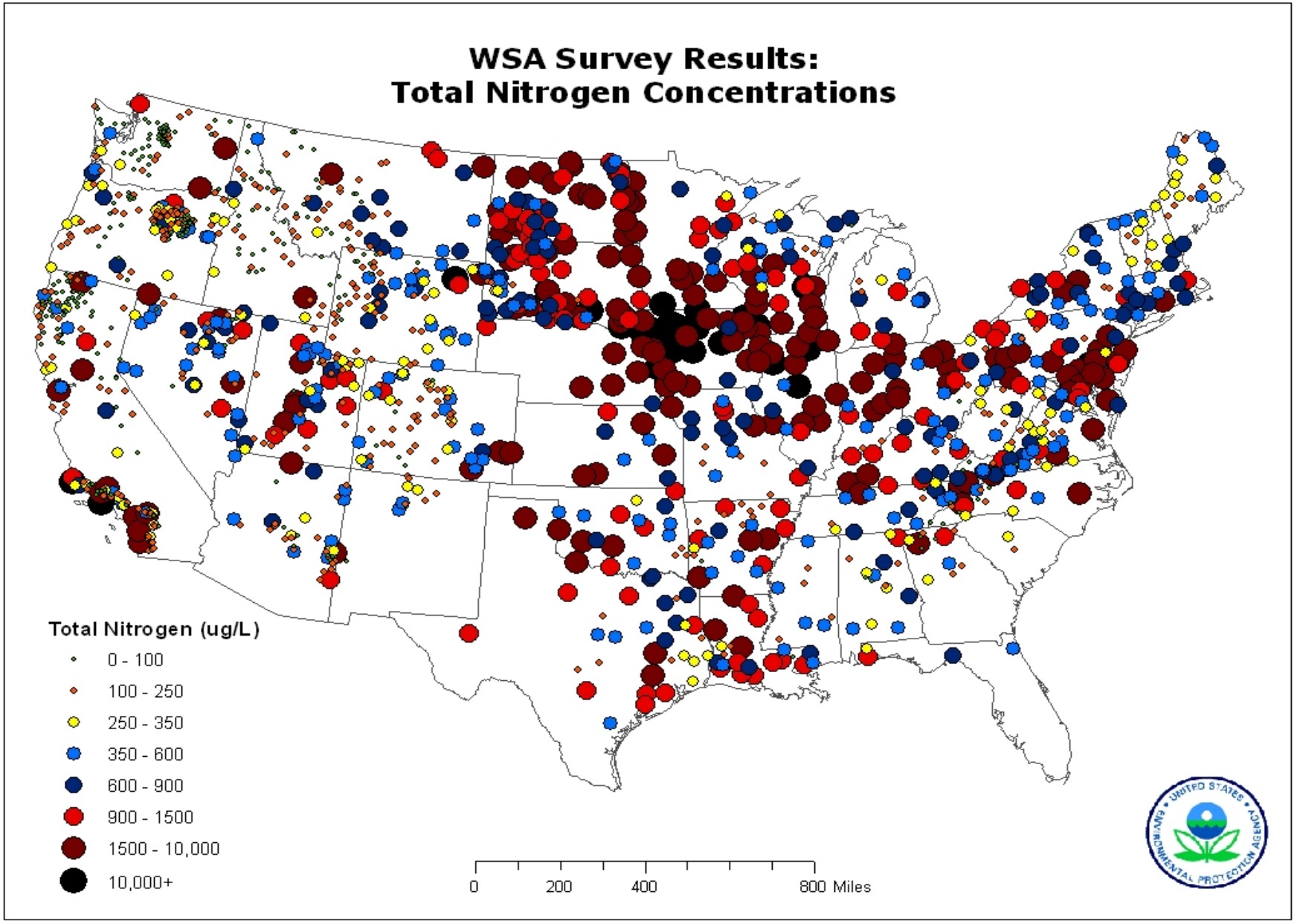
EPA Wadeable Streams Assessment (2006)



EPA Wadeable Streams Assessment (2006)

Wetland N service hierarchy

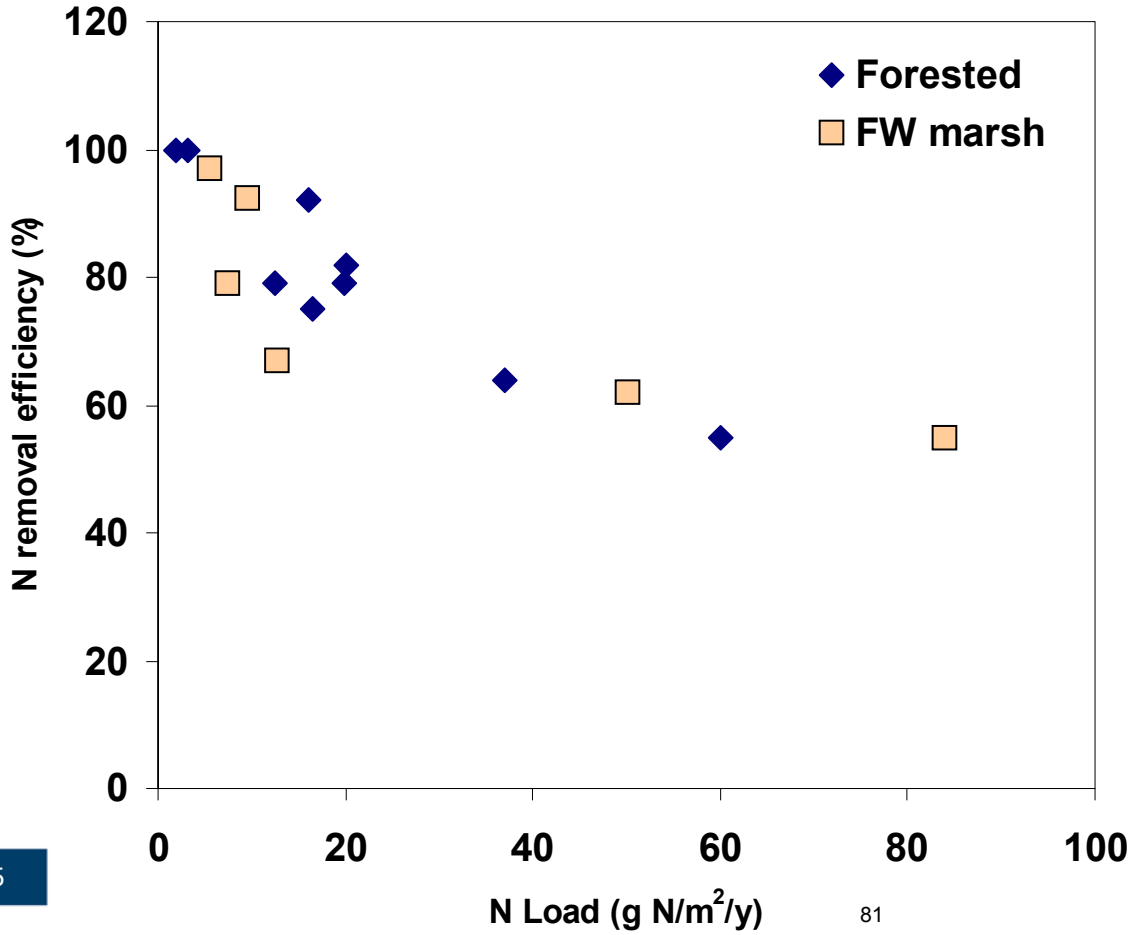
Nr	Affected Ecosys-tem	Ecosystem Effect	Primary Symptom	Secondary Symptom	Ecological Indicators	Impact on Ecological Endpoints	Affected Ecosystem Services	Economic Indicator of Affected Ecosystem Services
	Wetlands (N-limited)	Primary production	Fertiliza-tion	Above-ground biomass increase	Plant bio-mass, den-sity, species composition, denitrifica-tion, loss of sensitive species	Improved habitat, in-creased C se-questration, increased N removal, spe-cies shifts, changes in water storage[1]	Provisioning, regulating, cultural	C & N re-moval, fishery production, water storage, endangered species loss
	Wetlands (not N-limited)	Eutrophi-cation	Plant succes-sion	Soil and water quality degrada-tion	Species com-position, diversity, sulfides, algae blooms	Degraded habitat, HAB risk, decreased N removal, increased N_2O emission	Provisioning, regulating, cultural	N removal, fishery pro-duction, HABs, biodi-versity, aes-thetics, GHG increase

[1]Loss of N-sensitive species in bogs can reduce water retention and storage.

Steve Jordan, NHEERL-GED

Gulf of Mexico Coastal Wetlands

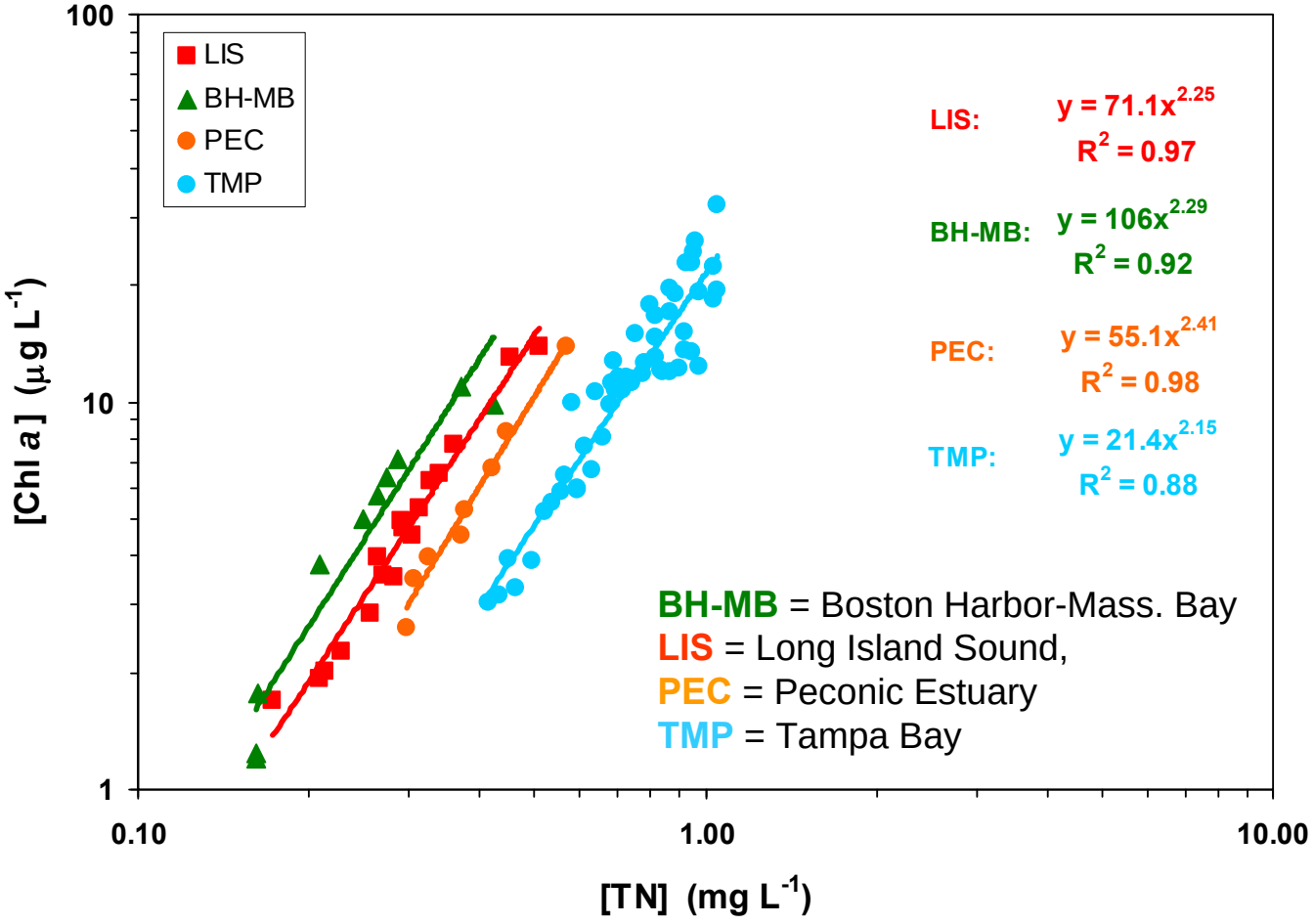
N removal efficiency



- Higher N load – less % N removed
- Values from literature, mostly LA & WWT
- Need values for salt marsh, mangroves, rest of GOM

Virginia Engle EPA-NHEERL-GED et al.

Chlorophyll *a* – TN relationships for Four Estuarine Embayments

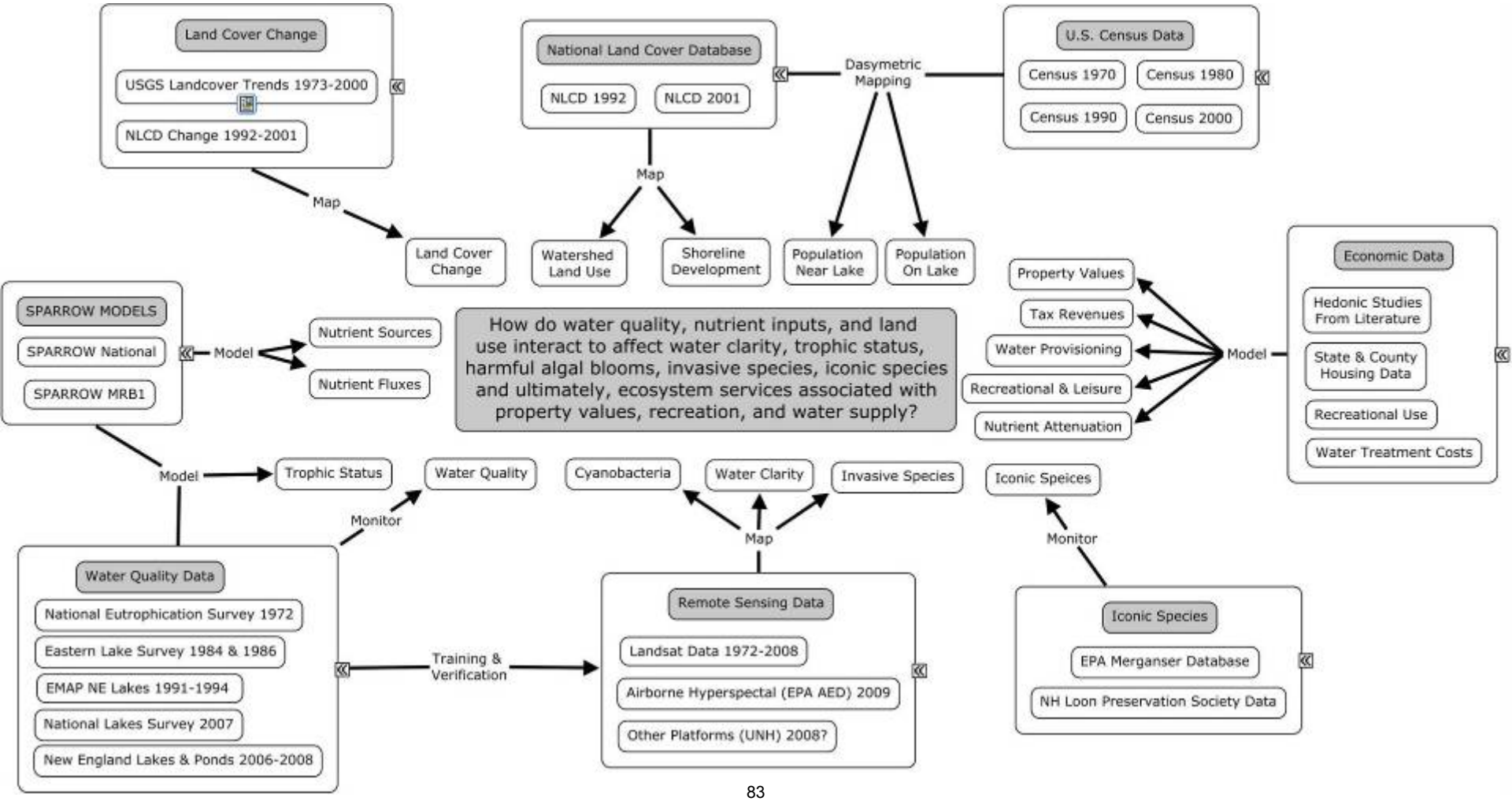


The vertical displacements of these four systems are quantitatively explained by water clarity.

Edward Dettmann et al. (EPA-NHEERL-AED)

The EPA Atlantic Ecology Division

Northeast Lakes Concept Map



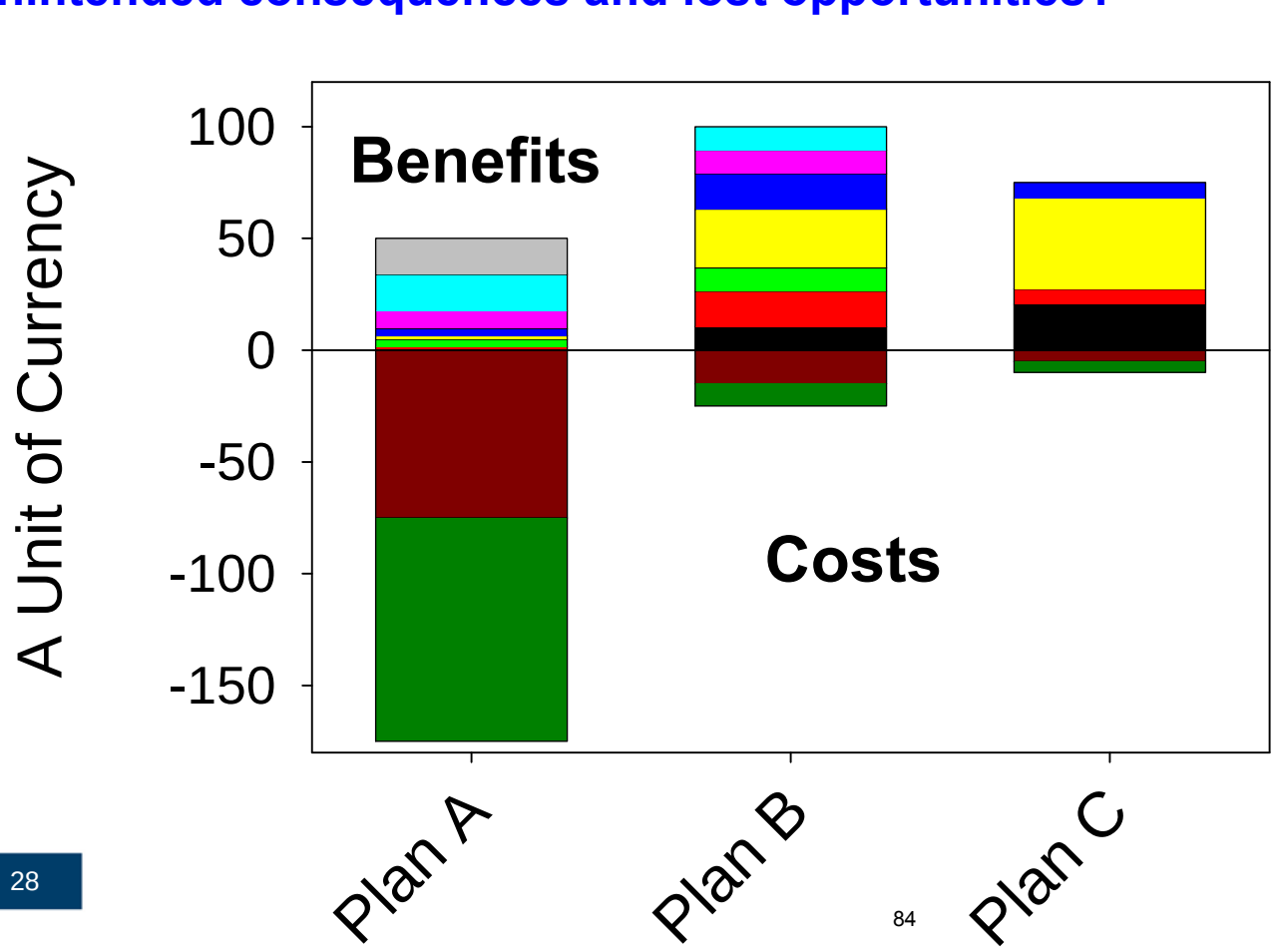
Hal Walker, Bryan Milstead NHEERL-AED

Northeastern Lakes Evaluation of Management Alternatives

How will local or regional management choices affect the delivery of ecosystem service benefits to stakeholders?

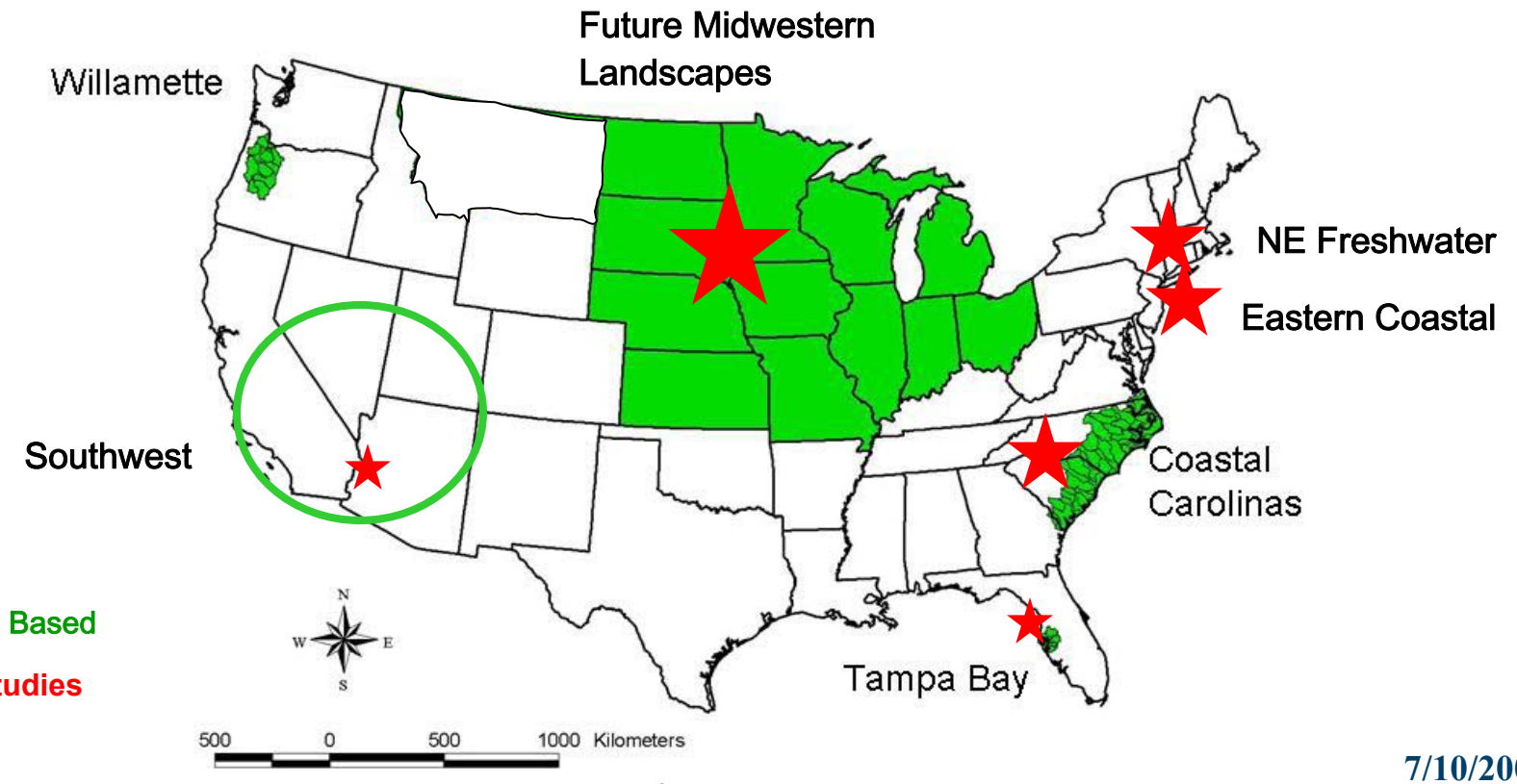
What tradeoff and conflicts will occur among users?

Who will benefit from management choices and who will pay the cost of unintended consequences and lost opportunities?



Hal Walker, Bryan Milstead NHEERL-AED

Place-based studies are being used to compare methods for a variety of environmental settings, scales, & stakeholder issues, and to look at future scenarios.



Research Questions	Theme 1: Nutrient loading	Theme 2: Service Measures	Theme 3: Nutrient cycling	Theme 4: Tipping Points	Place-Based FML	Place-Based Tampa	System-Based Wetlands
R1. N delivery and removal	■		■	■	■	■	
R2. N impacts on structure and function (ERF development)			■	■	■	■	■
R3. N impacts on multiple services (ESRF development)		■	■	■	■	■	
R4. Identification of key services impacted by N		■	■	■	■	■	■
R5. Human health and well-being impacts		■				■	
R6. Human benefits & decisions impacted by N		■			■	■	
R7. Tradeoffs between N and services		■			■	■	■
R8. Technology and restoration impacts on N		■			■	■	■
R9. Effectiveness of management and policy options to reduce N		■		■	■	■	■
R10. Human decisions and N delivery	■	■	■	■	■	■	

Challenges for ESRP-N

- **Nutrients are a substantial and persistent problem**
  - N removal may decrease with N load
  - Population growth and water treatment (→3°)
  - Climate change interactions
- **Strategic approach.** Nitrogen comes from many sources, has many processes, many fates, many systems impacted. Deciding where to focus our limited energy while not neglecting the whole is key.
  - ***Media -*** Land, air, water.
  - ***Sources -*** Power plants, mobile sources, fertilizers, etc.
  - ***Scale -*** Produce tools and information that can/will be used.
  - ***Spatial and temporal variability -*** Timing of inputs vs. impacts.
  - ***Regulatory and Management options*** - sewage treatment, wetland restoration, emission reductions, reducing fertilizer applications, better feedlot management, BMPs, etc.
- **Ecosystem services is new territory.** No reviews or models exist to link N and ecosystem services – we must create these.
- **Models.** How do we best use models to address our questions? Which models?

The end result of this work will be the development of credible, scientifically-based methods to:

- Inventory, measure and map ecosystem services related to reactive nitrogen at multiple scales;
- Connect the effects of reactive nitrogen to ecosystem services;
- Provide regulatory community with sound data and tools that represent the appropriate uncertainties in order to understand N impacts on ecological and human systems, so decisions can be made.

Thank you

Jana Compton, ESRP-N lead
compton.jana@epa.gov

Timeline for ESRP-N

FY09 FY10 FY11 FY12

Implementation Plan – April 2009

Review paper on ES and reactive N – draft fall 2009

Theme 1
Theme 2
Theme 3
Theme 4

National NEWS model – 2010

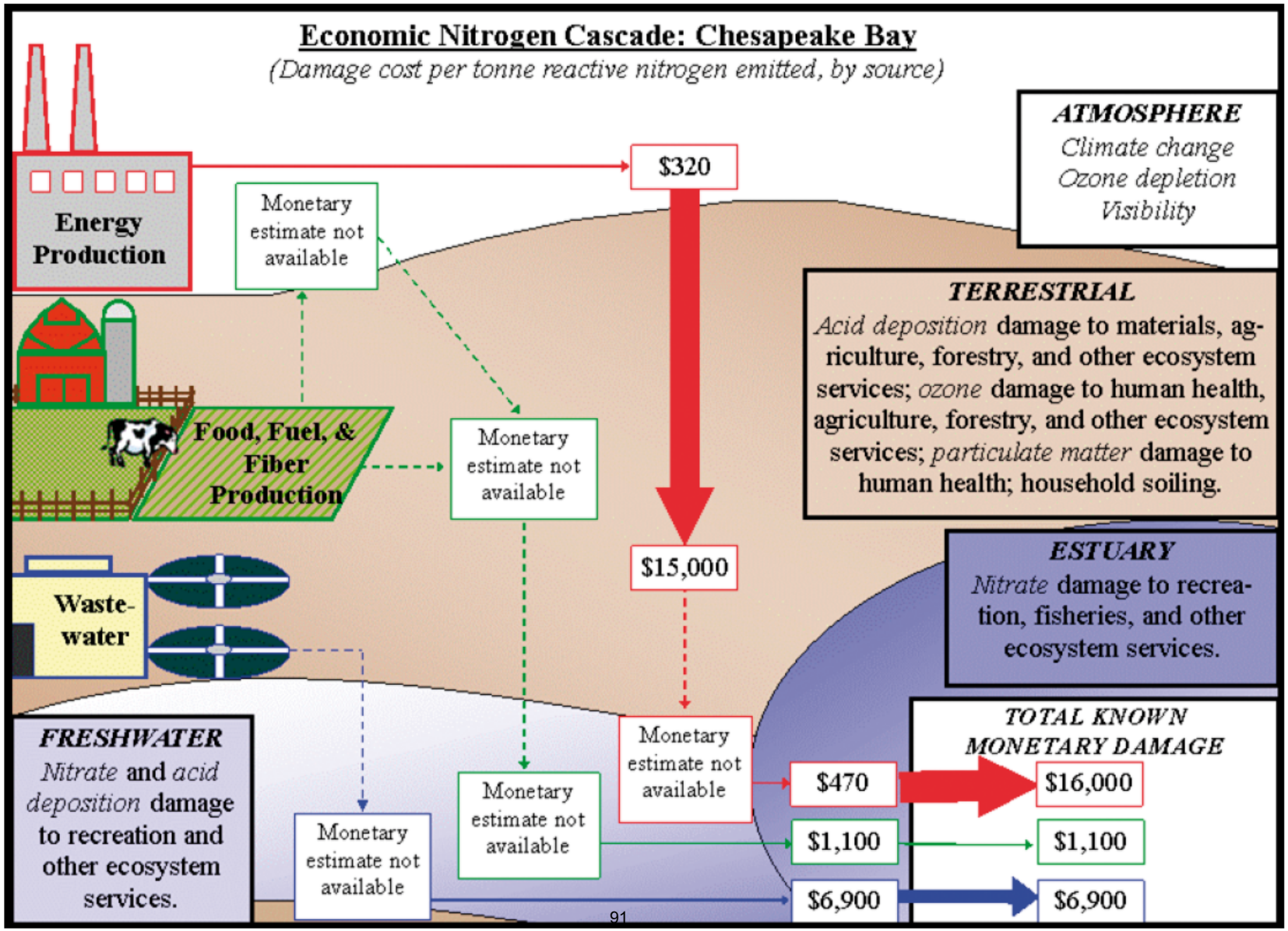
Regional NEWS (MidWest) – 2011

Ecosystem services and nutrient cycling – site-specific studies

Sensitive ecosystems and critical loads – 2011

Report on the value of ecological services provided by and affected by Nr - 2012

Economic N cascade



Moomaw and Birch 2005 Science in China

Appendix F – Presentation: Mapping and the National Atlas of Ecosystem Services (Annie Neale)

Mapping and the National Atlas of Ecosystem Services (NAtl-ES)

Annie Neale
Office of Research and Development
US EPA

Science Advisory Board Presentation
Environmental Processes and Effects Committee

July 14th, 2009
Washington, DC

EPA Mapping Team Members and Contributors

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Steve Jordan
Hal Walker
Chuck Lane
Laura Jackson
Anne Rea

Expert (Special EPA Employee)
Dr. Charles Vörösmarty, CUNY

Goals of the ESRP Landscape Characterization and Mapping Theme

To collaborate with, and to provide landscape science support to ESRP's, place-based, ecosystem-based, and pollutant-based projects

To develop a publicly accessible and scalable National Atlas of Ecosystem Services in order to inform decision-making

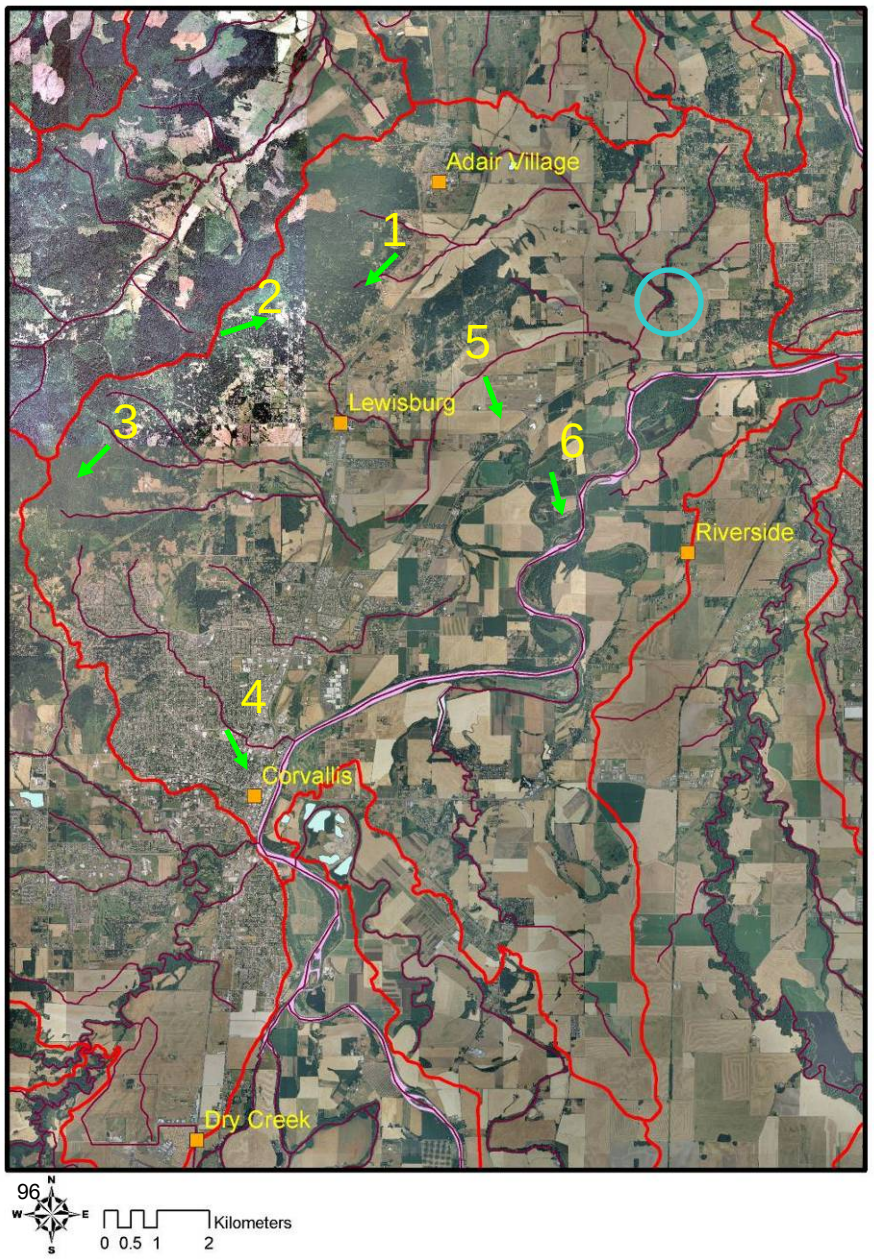
Vision for the National Atlas of Ecosystem Services

How many ecosystem services can you visualize in this image?

Imagine the flow of services into and out of this area

Now, imagine summarizing all of this somehow and mapping for nation!

Location, Location, Location!
(Spatial Pattern Matters)



Implementation Strategy embodies these principals:

- **Reliance on existing data, literature, models and tools while conducting additional research and keeping eye on future developments**
- **Emphasis on interaction with other ESRP projects and themes -- critical for linking functions to services**
- **Reliance on extramural participation**
- **Staged Implementation**

What have we been up to? Presentation Outline

Atlas Demonstration

Partnership Development

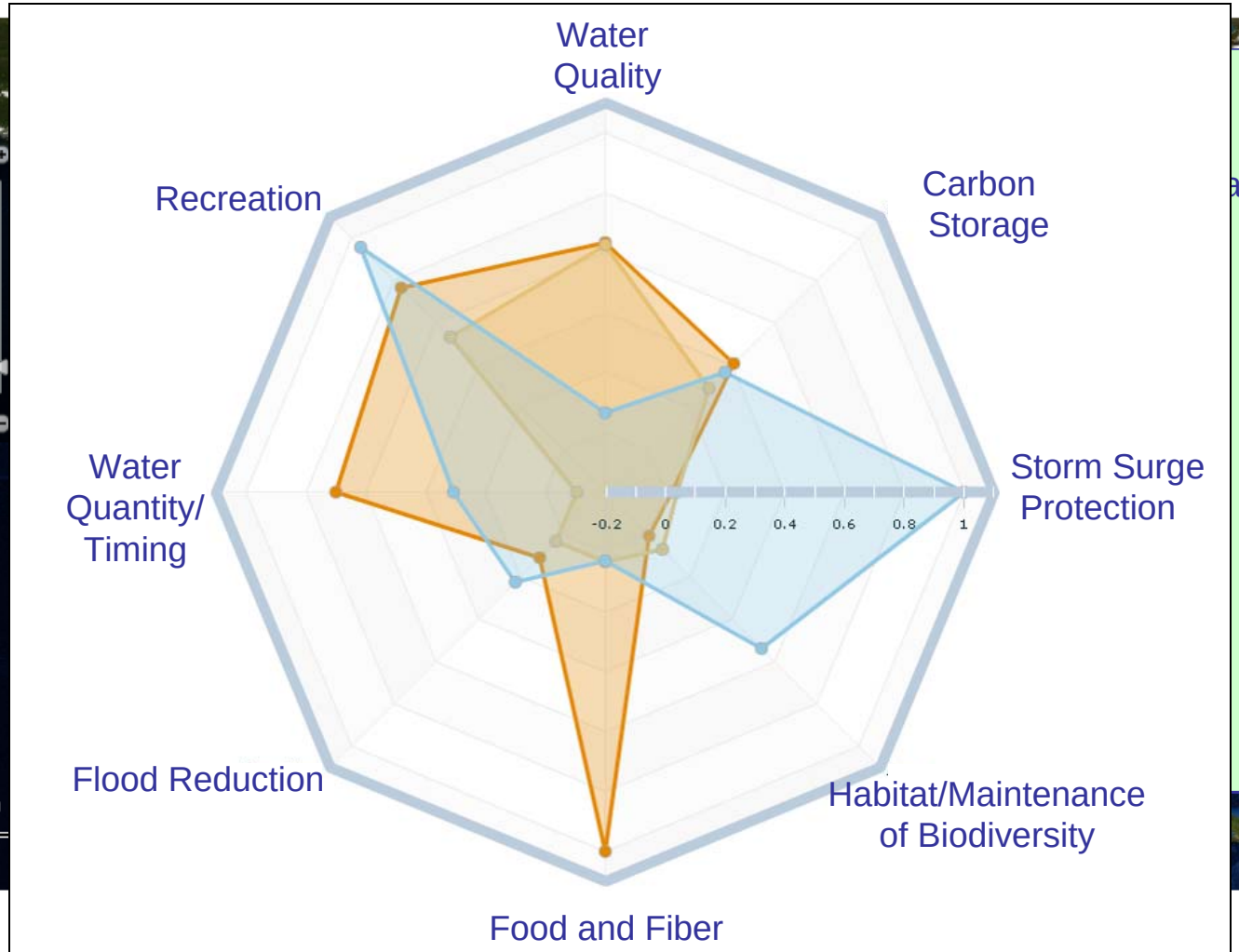
Ecosystems Services Indicators Calculation

National Data Set Development

Ecosystem Services Mapping Research

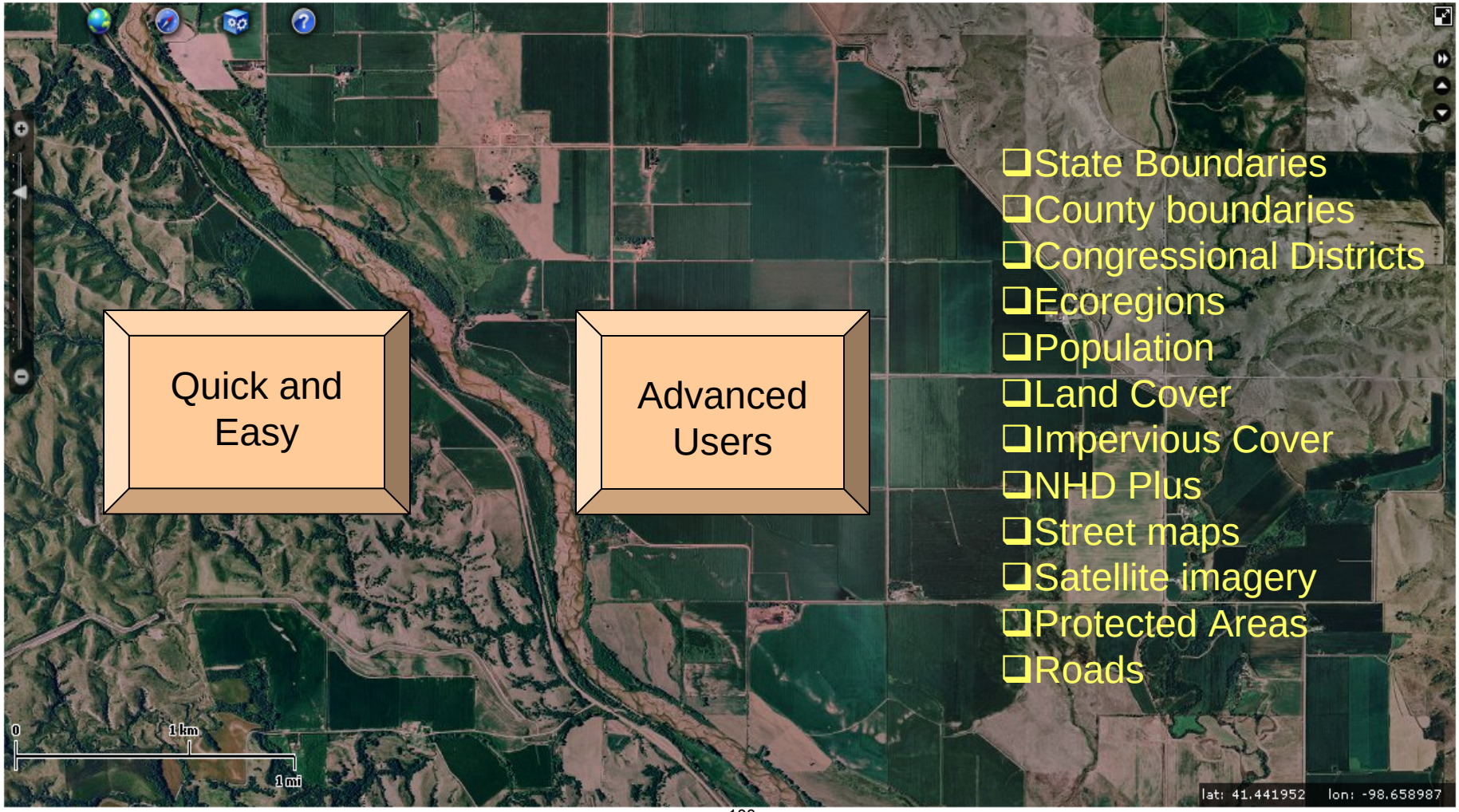
Atlas Demonstration Project

Atlas Demonstration -- Vision

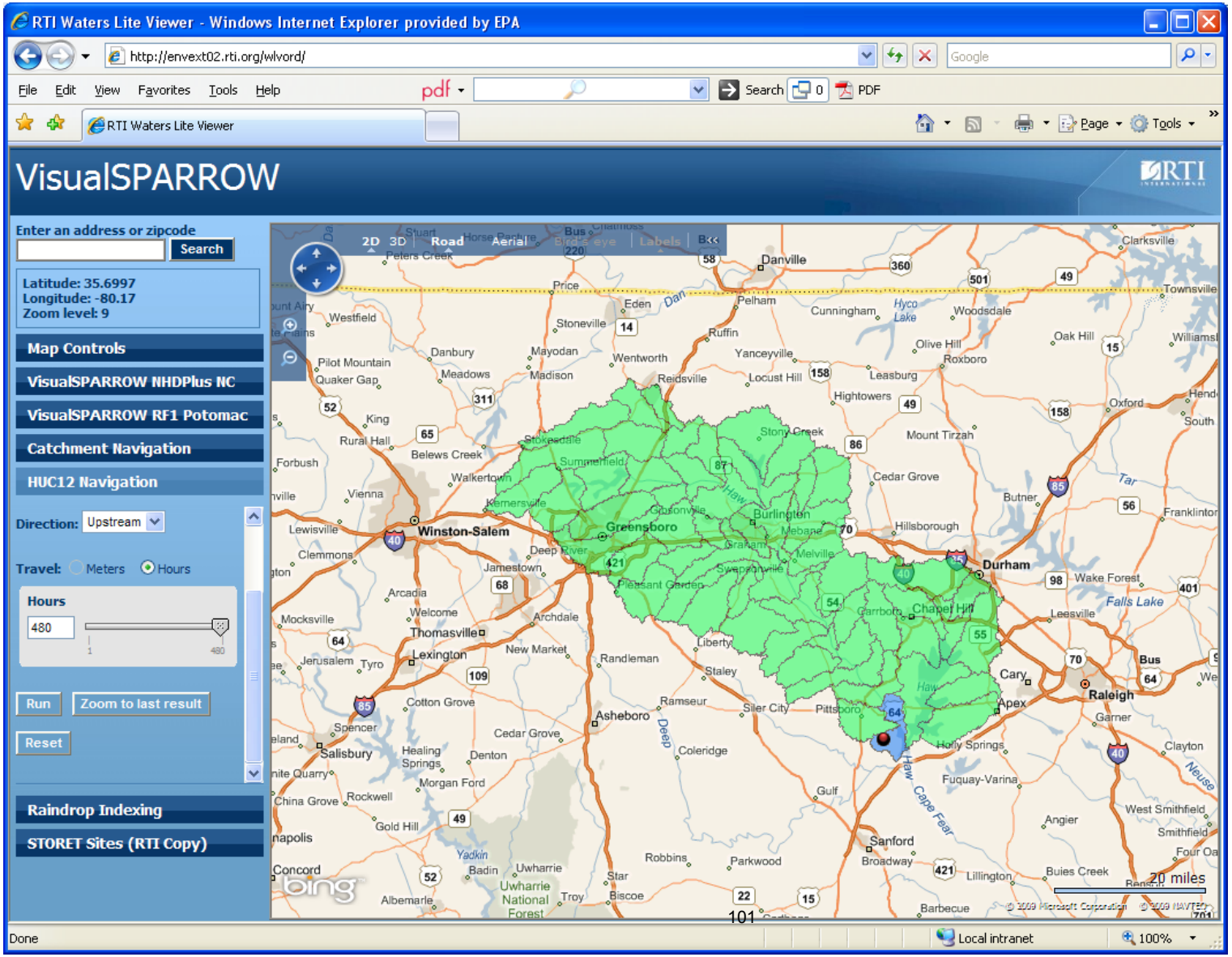


- User will zoom to geographic area
- Contain series of background maps
- Select ecosystem services from Table of Contents
- Scalable
- Include change and future scenarios
- Allow analysis of multiple services
- Allow user to place their “area” in context of others

Atlas Demonstration -- Vision

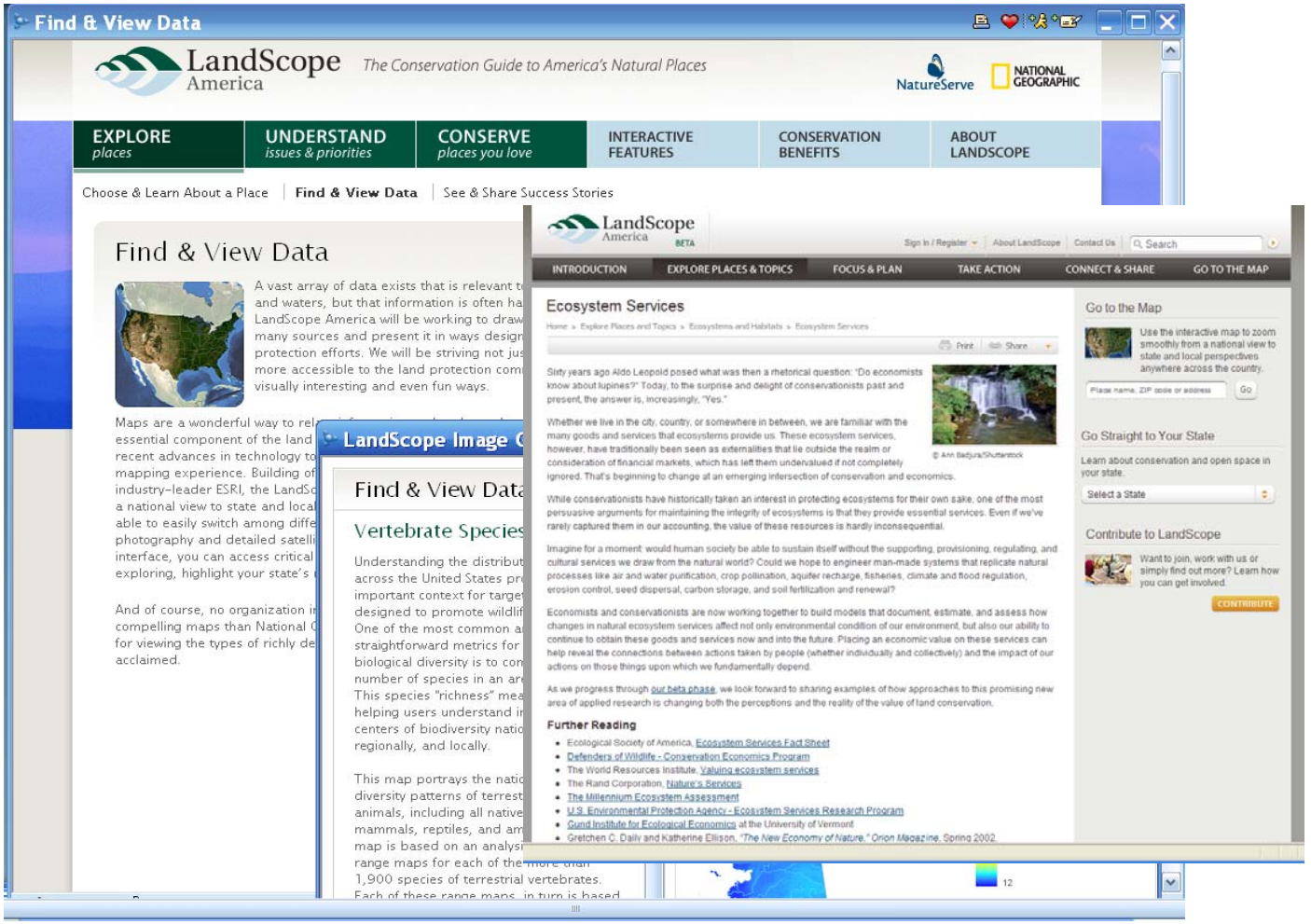


Atlas Demonstration -- Vision



Maintain upstream/ downstream connectivity

Atlas Demonstration



www.landscope.org

Partnership Development

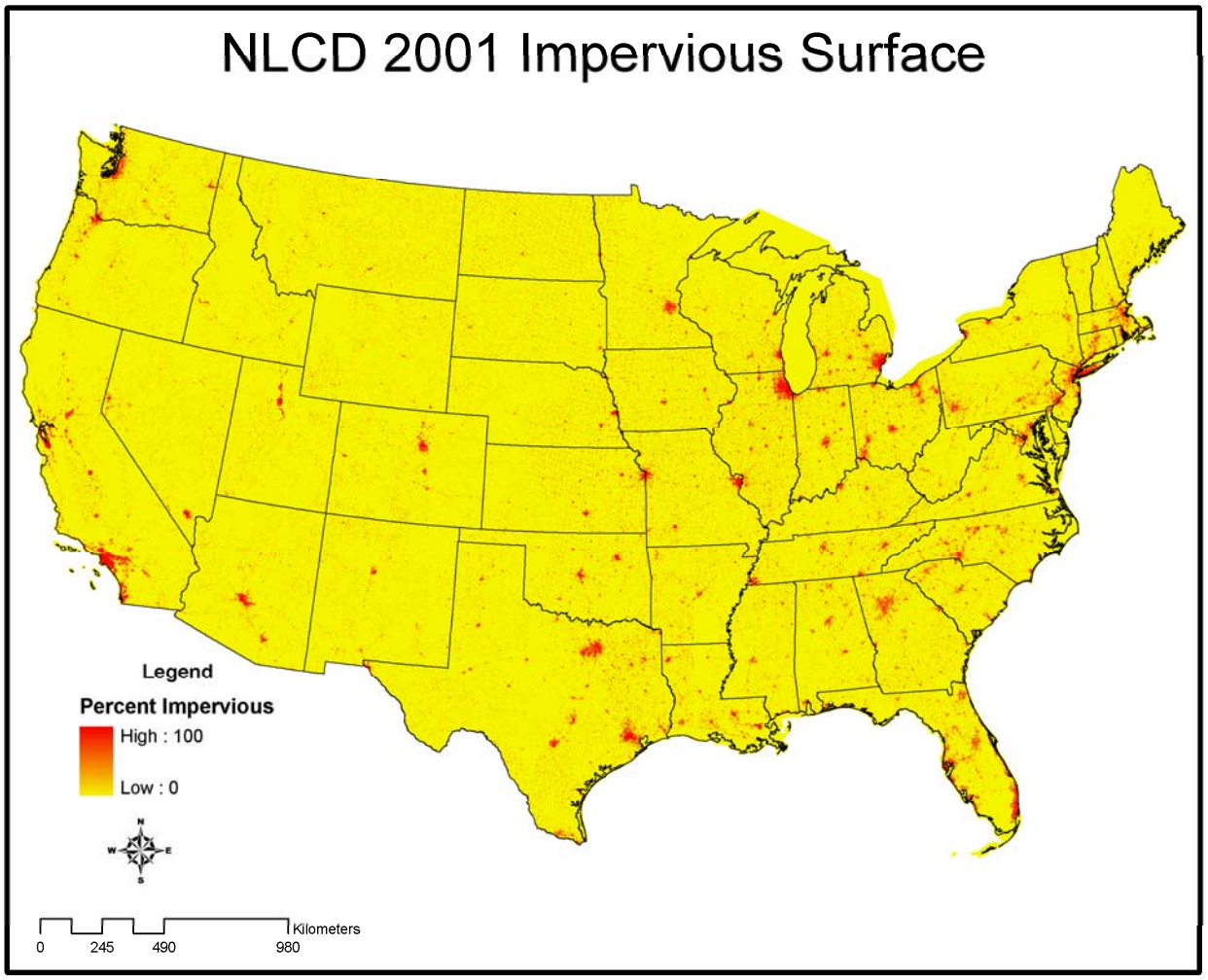
Vision of a National Atlas of Ecosystem Services Consortium

National Geographic, Frank Biasi
NatureServe, Kyle Kopas
GAP, USGS, Kevin Gergely
USGS, Geography, Roger Sayre
USGS, EROS Data Center
USGS SPARROW Group
USDA, USFS, David Nowak
USDA, USFS, David Wear
USDA, NASS, Rick Mueller
USDA, FSA, Rich Iovanna
Natural Capital Project
NRCS, Sharon Waltman
NCEAS
NOAA CREST

CUNY Environmental Cross-Roads Initiative
Iowa State University
UC Santa Barbara, Bren School of the Env.
University of Maryland
Duke University
Arizona State University
Rutgers University
University of Kiel

Ecosystem Services Indicators Calculation

Ecosystems Services Indicators Calculation



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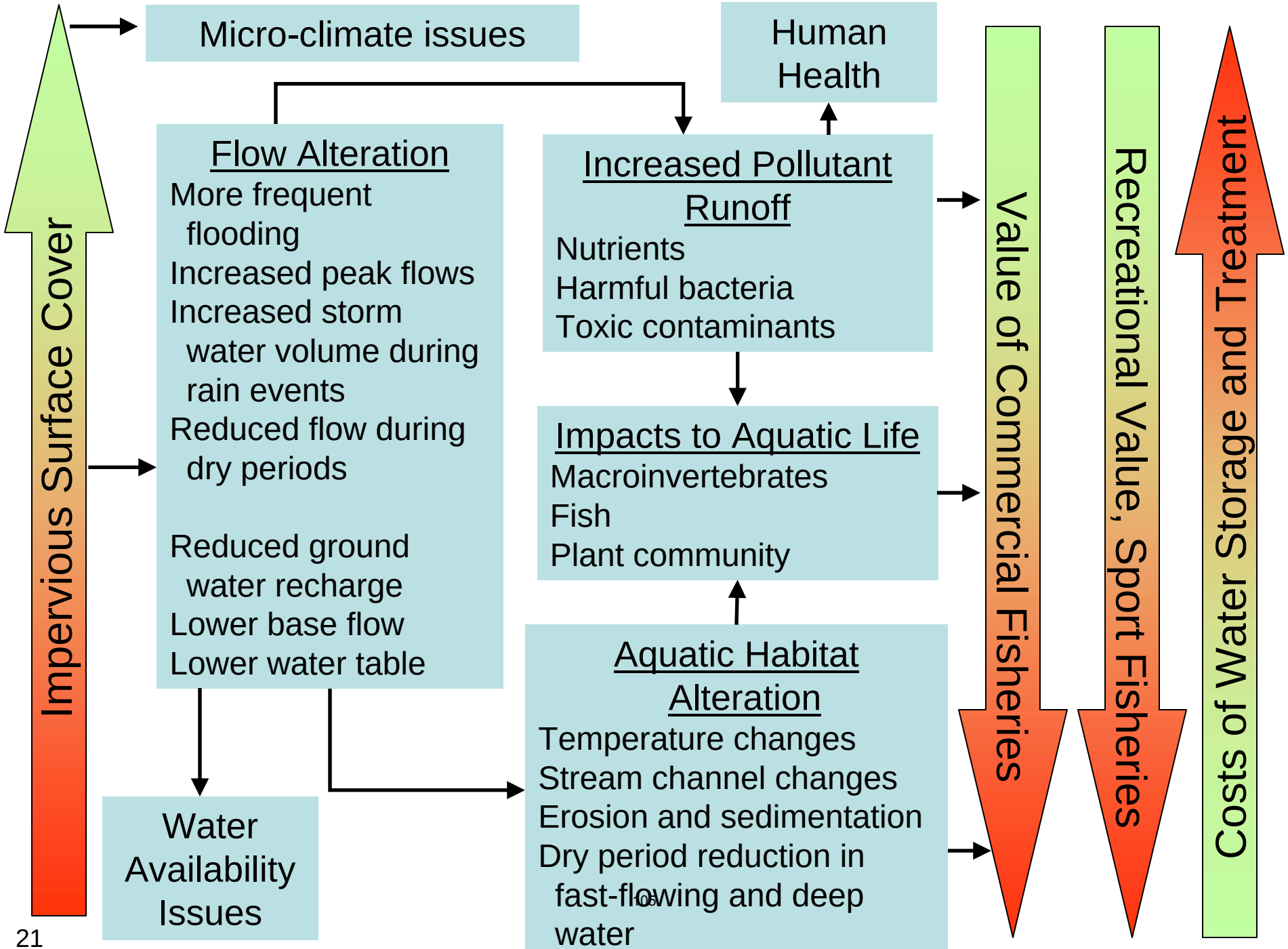
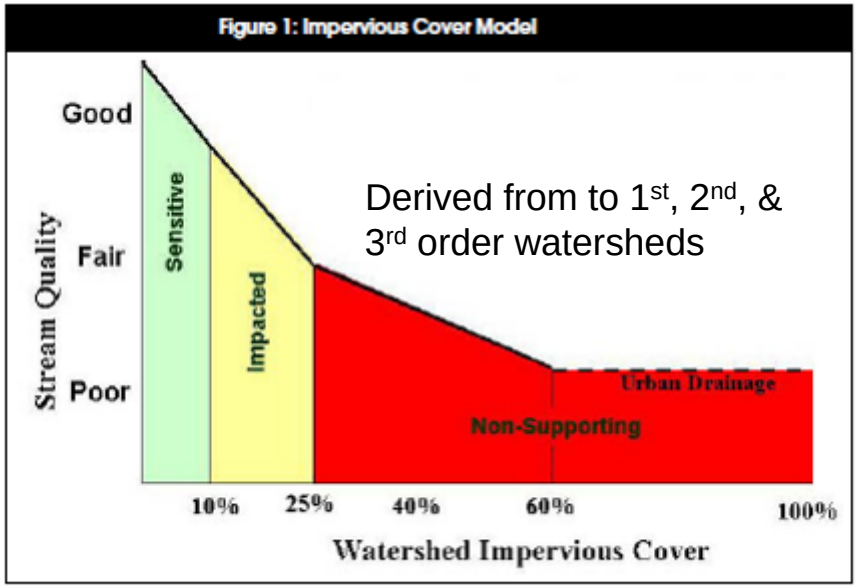
Don Ebert


Micro-climate issues
Human Health
Flow Alteration
More frequent flooding
Increased peak flows
Increased storm water volume during rain events
Reduced flow during dry periods
Reduced ground water recharge
Lower base flow
Lower water table
Increased Pollutant Runoff
Nutrients
Harmful bacteria
Toxic contaminants
Impacts to Aquatic Life
Macroinvertebrates
Fish
Plant community
Aquatic Habitat Alteration
Temperature changes
Stream channel changes
Erosion and sedimentation
Dry period reduction in fast-flowing and deep water
Water Availability Issues
Impervious Surface Cover
Value of Commercial Fisheries
Recreational Value, Sport Fisheries
Costs of Water Storage and Treatment

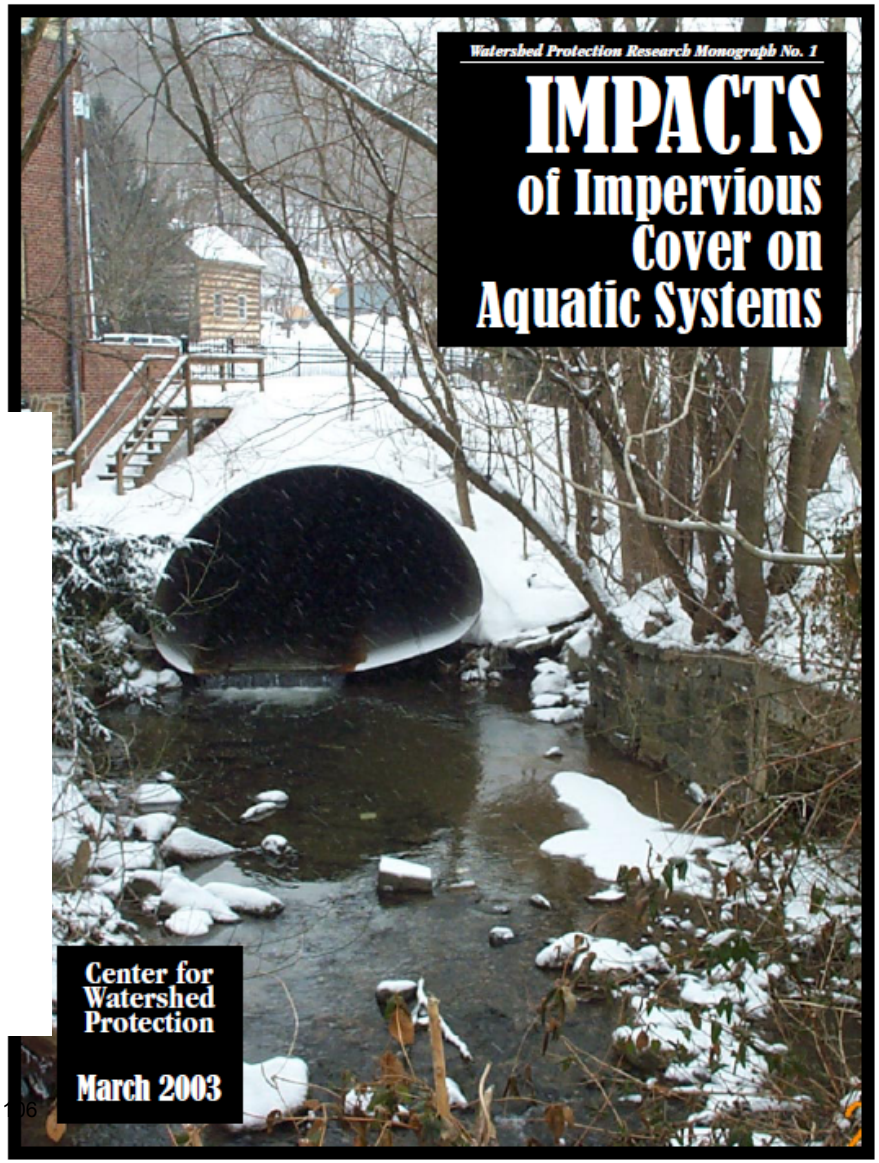
Landmark document published by Center for Watershed Protection in 2003

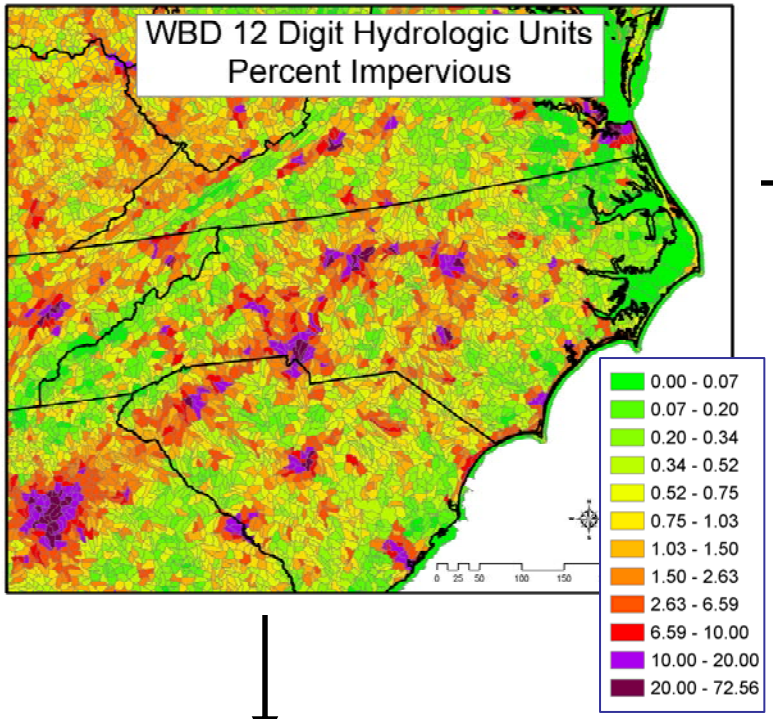
Reviewed and summarized 225 articles relating **impervious cover** to changes in hydrologic, physical, water quality or biological indicators of stream health

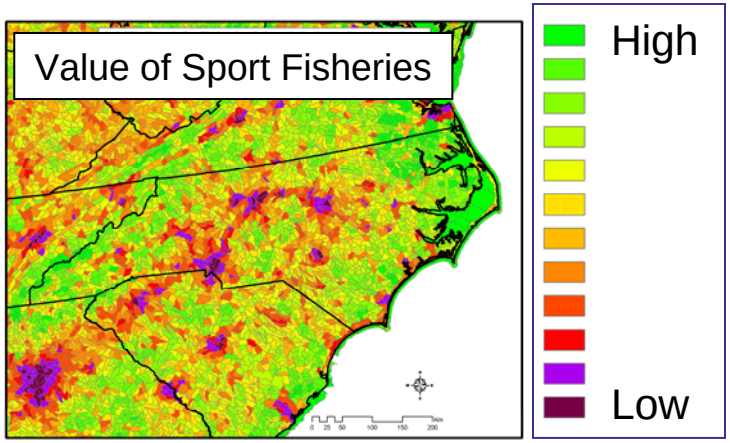


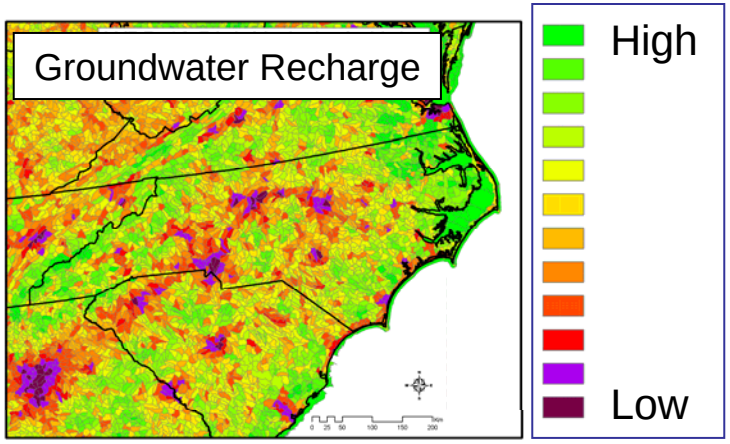
Derived from to 1st, 2nd, & 3rd order watersheds

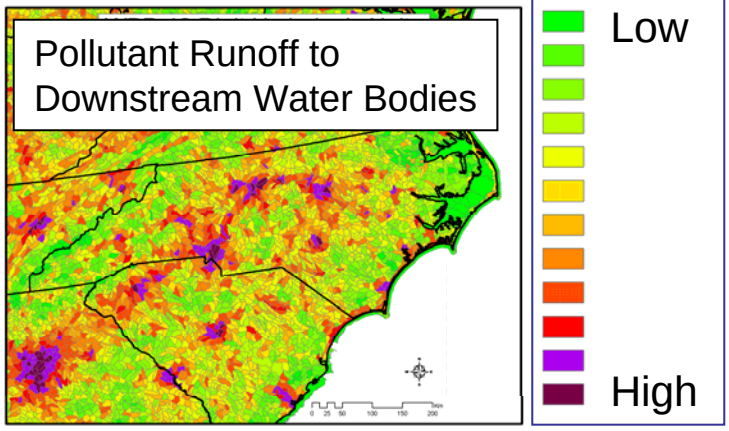
Schueler, 1994



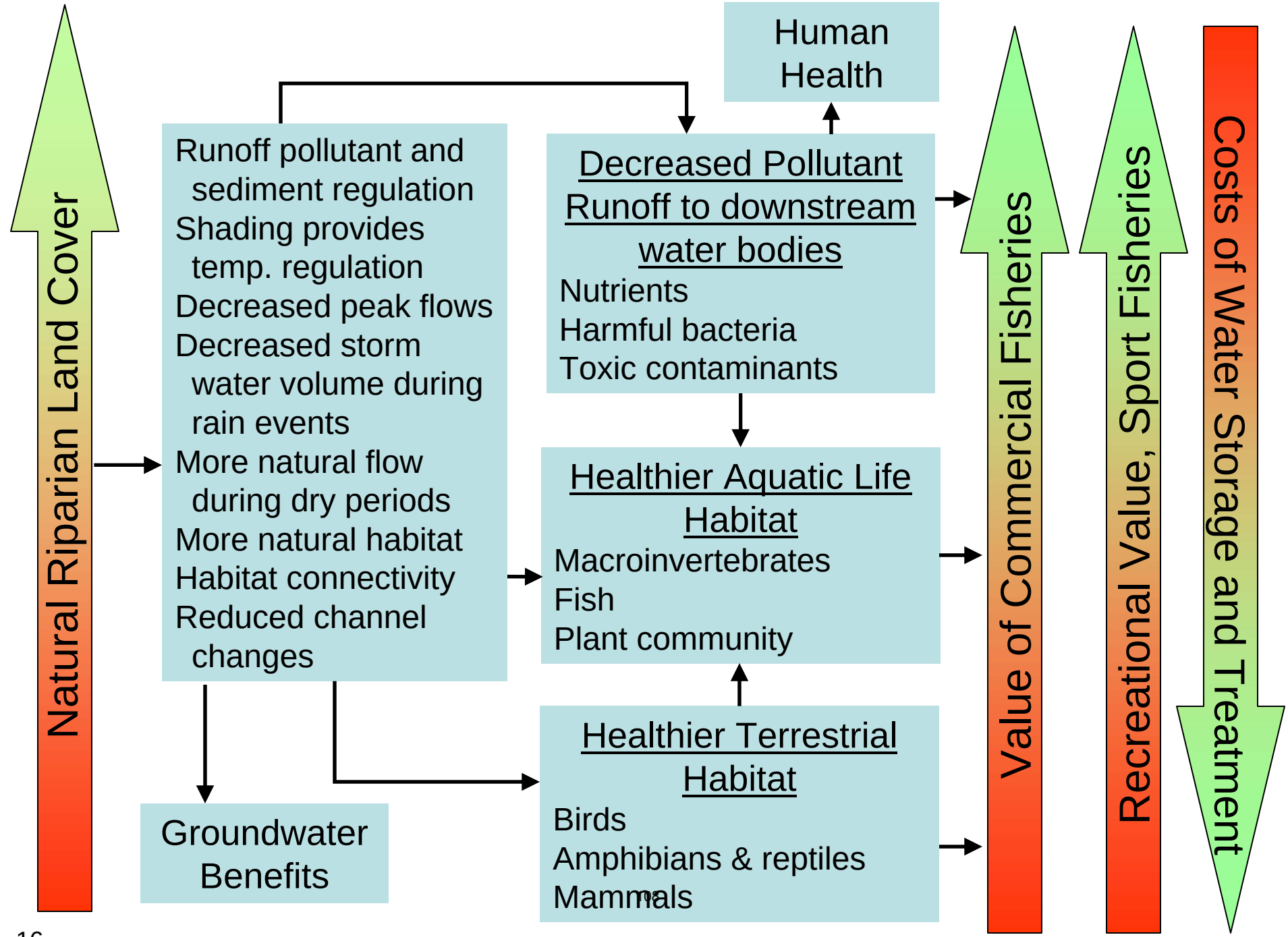


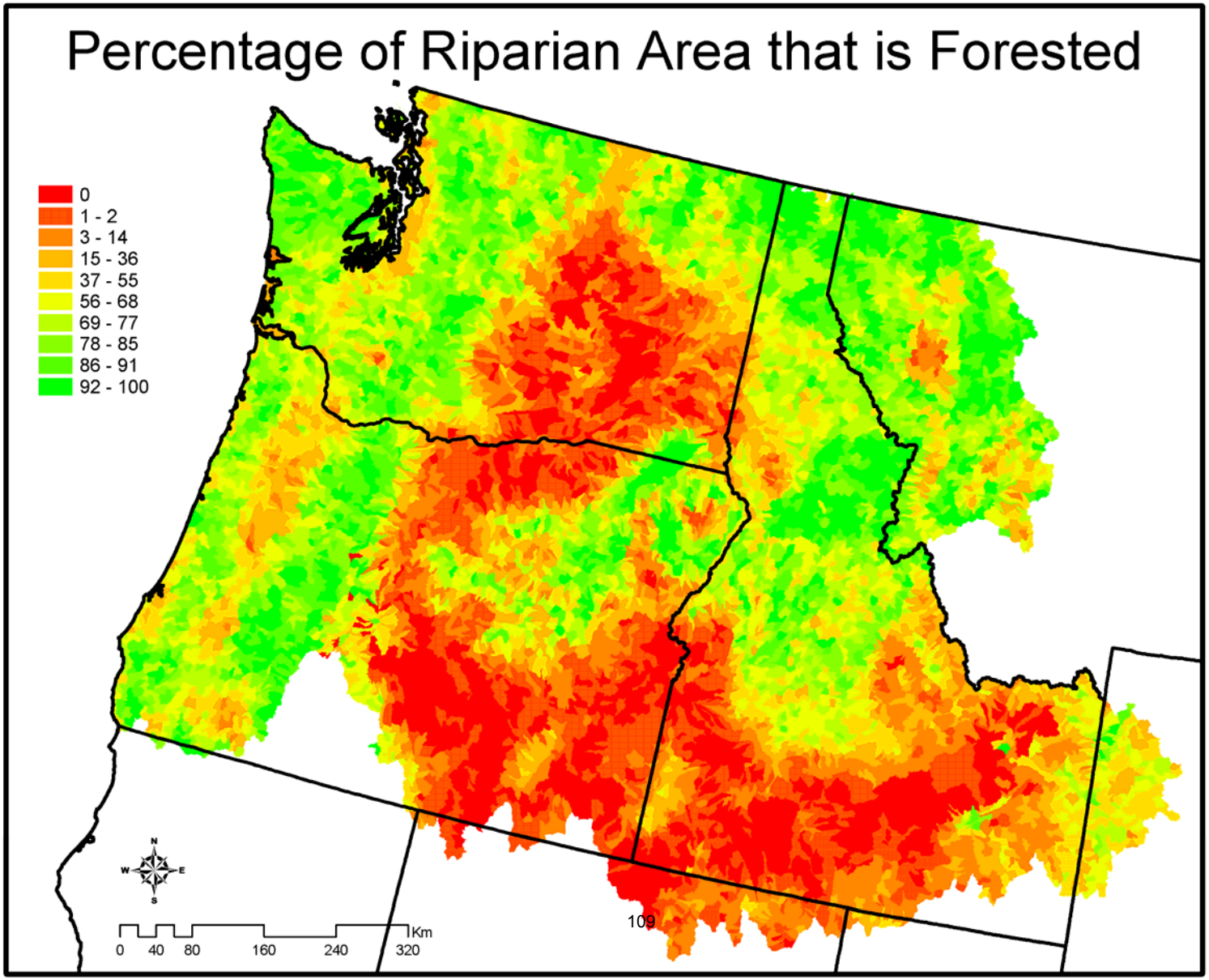






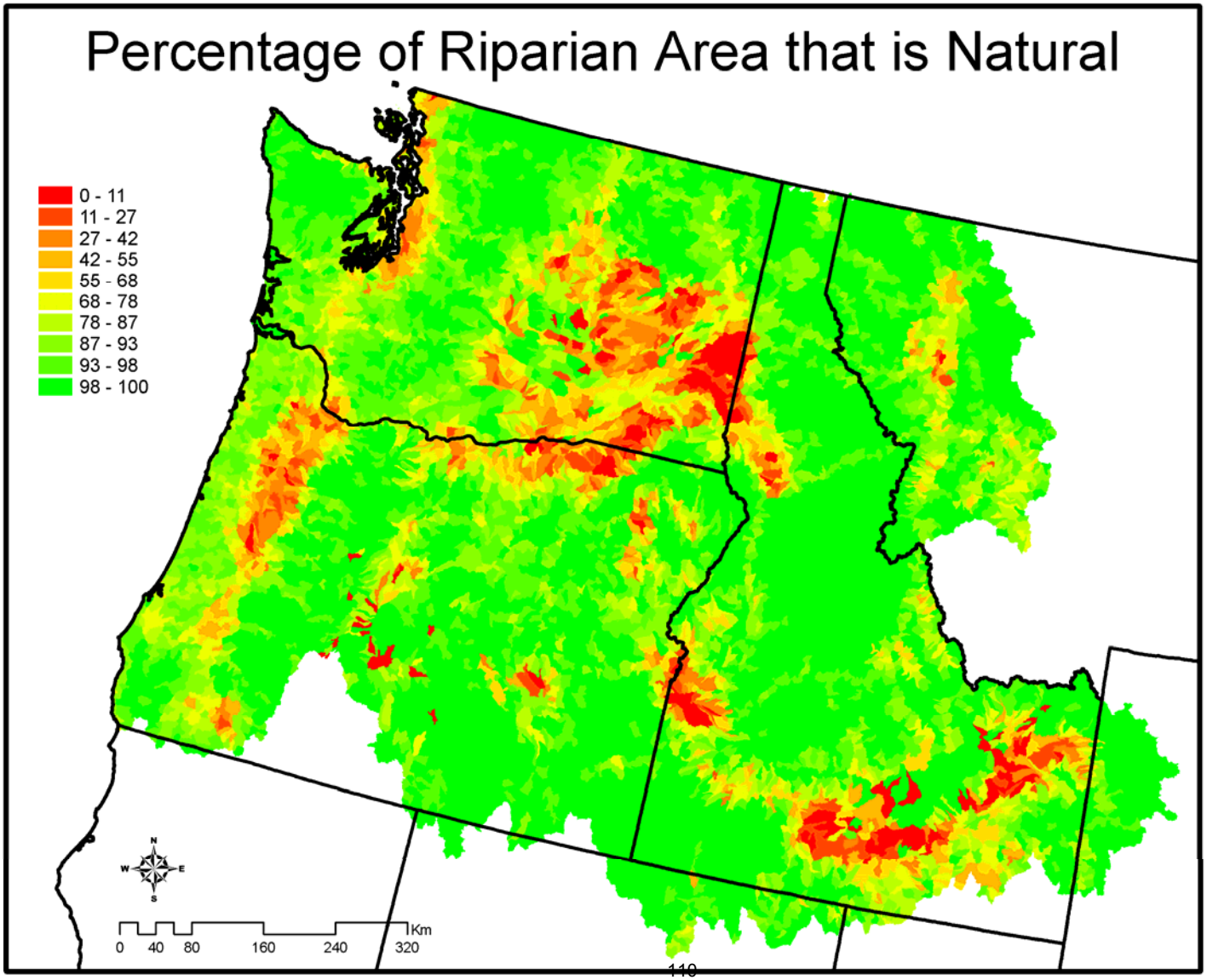
- Mock-up: Actual values for services will vary depending on biogeophysical settings (e.g., Omernik's Ecoregions)


Natural Riparian Land Cover
Human Health
Runoff pollutant and sediment regulation
Shading provides temp. regulation
Decreased peak flows
Decreased storm water volume during rain events
More natural flow during dry periods
More natural habitat
Habitat connectivity
Reduced channel changes
Decreased Pollutant Runoff to downstream water bodies
Nutrients
Harmful bacteria
Toxic contaminants
Healthier Aquatic Life Habitat
Macroinvertebrates
Fish
Plant community
Healthier Terrestrial Habitat
Birds
Amphibians & reptiles
Mammals
Groundwater Benefits
Value of Commercial Fisheries
Recreational Value, Sport Fisheries
Costs of Water Storage and Treatment



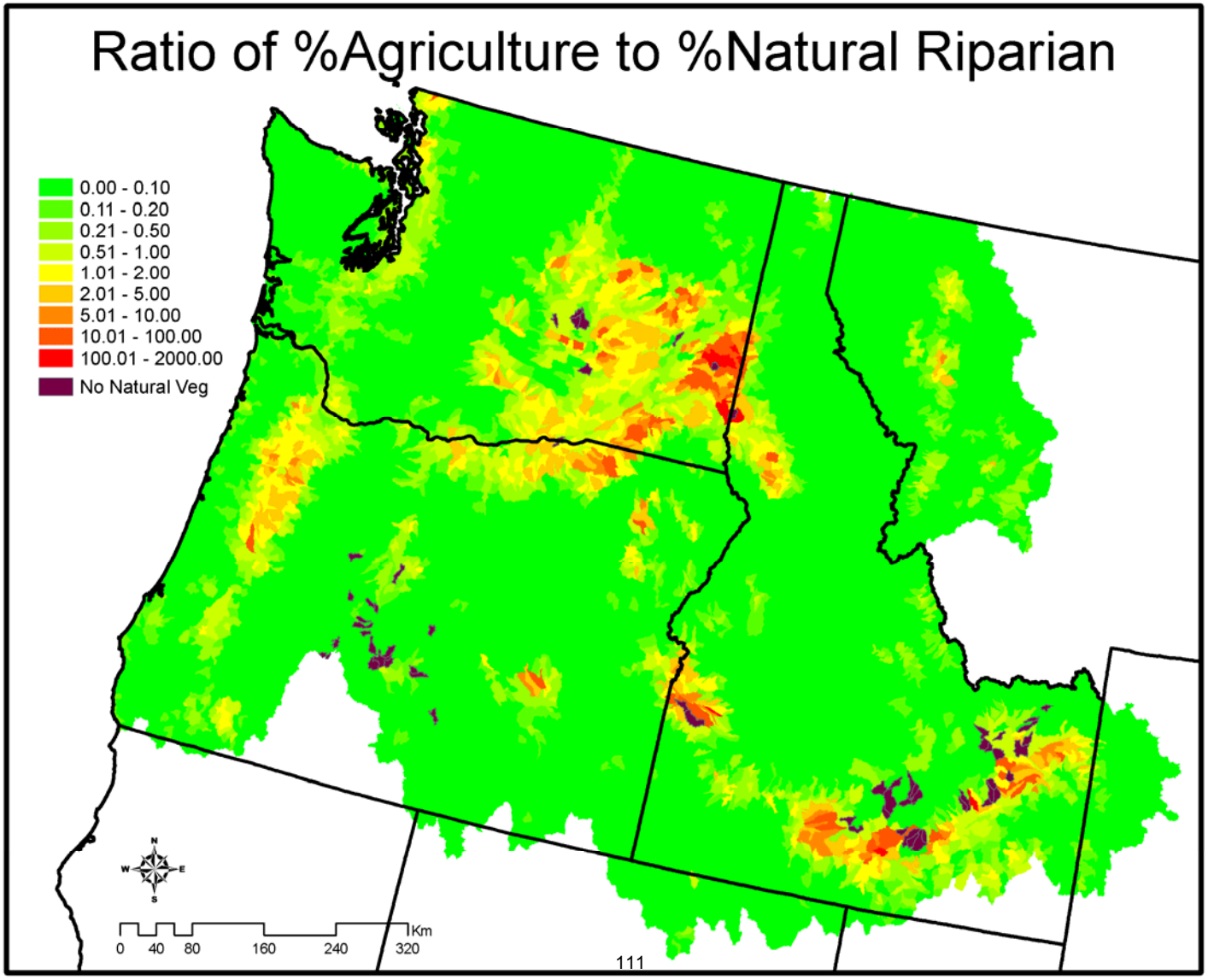
30 m buffer size

Don Ebert

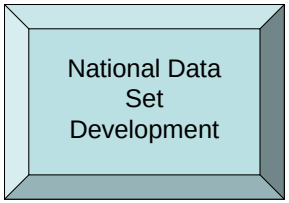


General indicator for multiple ecosystem services

Don Ebert


Ratio of %Agriculture to %Natural Riparian
0.00 - 0.10
0.11 - 0.20
0.21 - 0.50
0.51 - 1.00
1.01 - 2.00
2.01 - 5.00
5.01 - 10.00
10.01 - 100.00
100.01 - 2000.00
No Natural Veg
N
W
E
S
0 40 80 160 240 320
Km
111

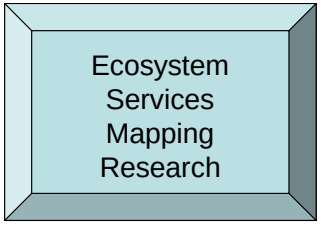
Don Ebert



Development Of National Data Sets Key To Mapping Ecosystem Services

- Soils Data – 30 m grids of soils variables for nation, joint effort EPA, NRCS, USGS
- 2009 Cropland Data Layer, 56 m grid of crop type for nation, joint effort, EPA, NASS
- Wetlands Data Layer, Joint venture with USGS EROS Data Center to attempt to develop an enhanced wetlands data layer for nation using predictive variable(s) to improve satellite-based remote sensing data classification accuracy:
  - Identified wetland locations/types (e.g., NWI)
  - Soil type (e.g., hydric soils)
  - Soil moisture
  - Topography (i.e., DEM-based)
  - Climate
  - Vegetation type (e.g., GAP, LANDFIRE)
  - Indices (e.g., Topographic Wetness Index)

Ecosystem Services Mapping Research -- Nutrient Attenuation



- Joint goal of the *nitrogen group* and the *mapping group* to map nutrient attenuation by the landscape nationally.
  - John Harrison's work on nitrogen attenuation by lakes and reservoirs
  - Brian Hill's (and several others) work on nitrogen attenuation by streams, incorporating role of headwater streams
  - Developing new metrics/models to calculate nutrient removal by terrestrial components, e.g., wetlands, buffer strips, stream buffers

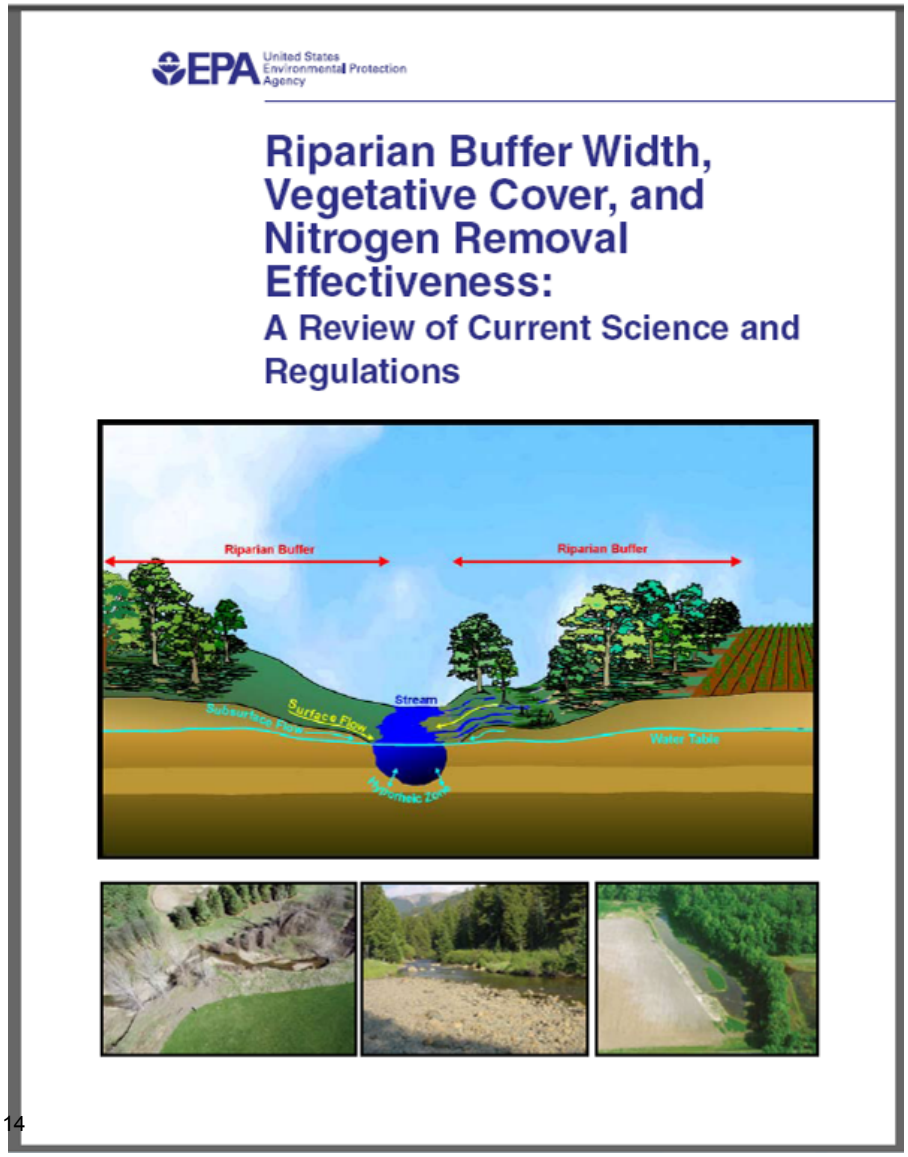
In 2005, Paul Mayer, Steven Reynolds, Jr. & Tim Canfield conducted an extensive literature review

- Soils
- Vegetation type
- Surface and subsurface benefits

Followed by paper in Journal of Environmental Quality in 2007 by Mayer et al.

Working with Paul Mayer and others to modify and use this effort in mapping nitrogen removal

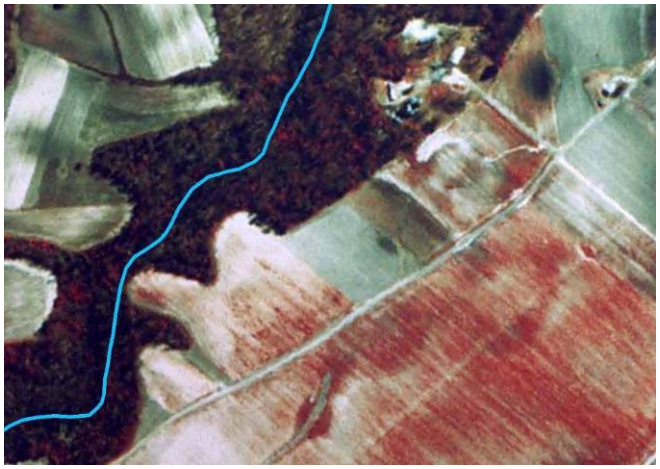
Steve Jordan is undertaking similar review for nutrient attenuation by wetlands



Developing New Metrics to Help Characterize Nutrient Attenuation/Removal by Riparian Buffers

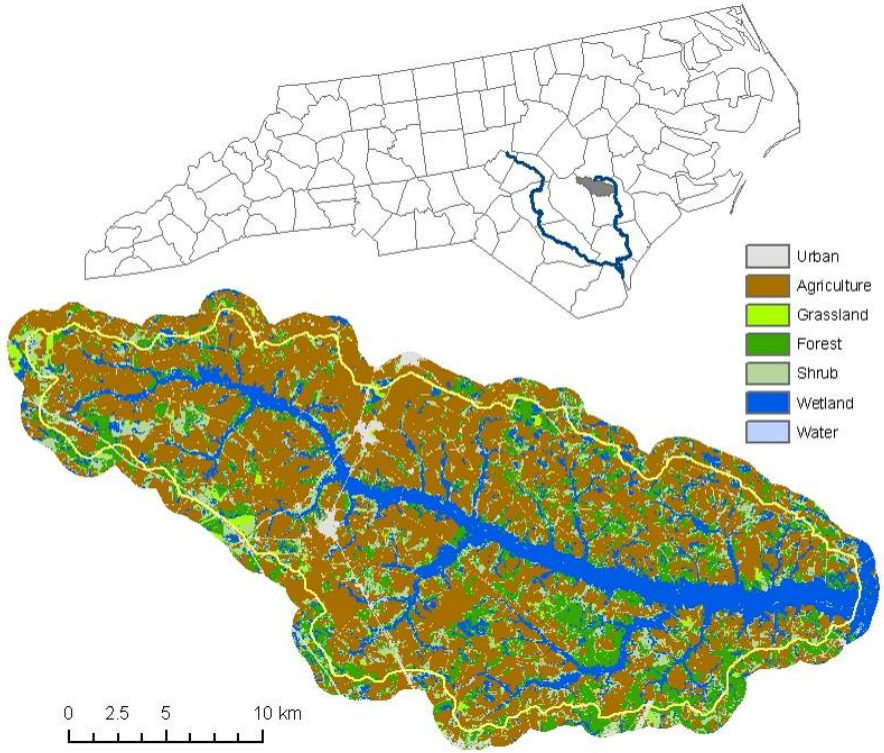
Jay Christensen, Ric Lopez, Annie Neale – Landscape Ecology Branch, ESD

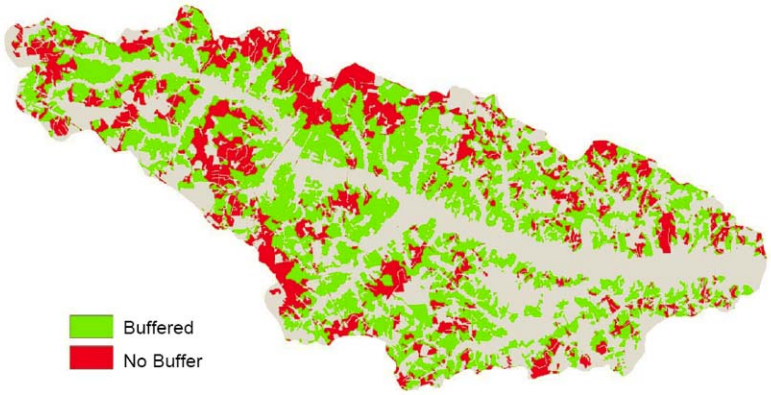
- Metric connecting riparian vegetation to upland sources of nutrients
- Test metric's ability to predict reduced nutrient loads
- Develop landscape model to determine nitrogen removal by riparian buffers
- Test using data of different resolutions
- Possibly test in SPARROW SE model
- Tie this work back to Mayer et al. literature review



Water Quality -- Nutrient Attenuation/Removal by Riparian Buffers

Goshen Swamp Tributary of NE Cape Fear River





67 % of Ag buffered
33 % not buffered

Jay Christensen

Water Quality -- Nutrient Attenuation/Removal by Riparian Buffers

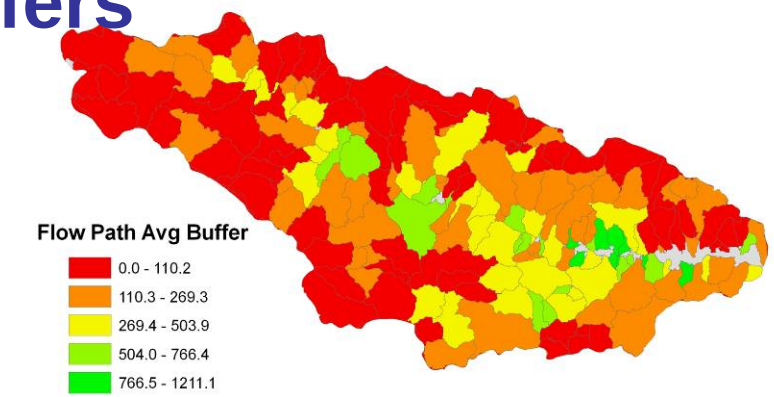
Riparian metrics being tested

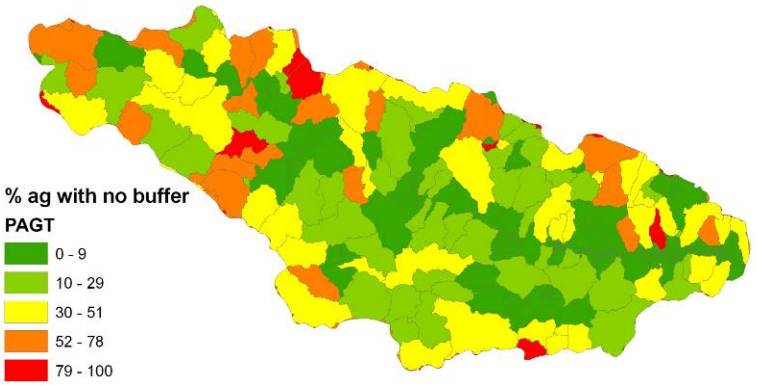
- Average Flow Path Buffer Width from Ag Cells (m)

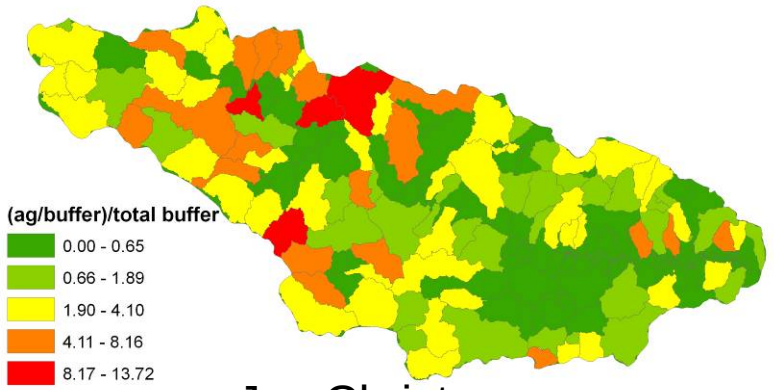
  Based on Baker et al 2006

- % Ag draining to stream without passing through naturally vegetated buffer

- Sum of Ag/Buffer Ratio / total buffer length



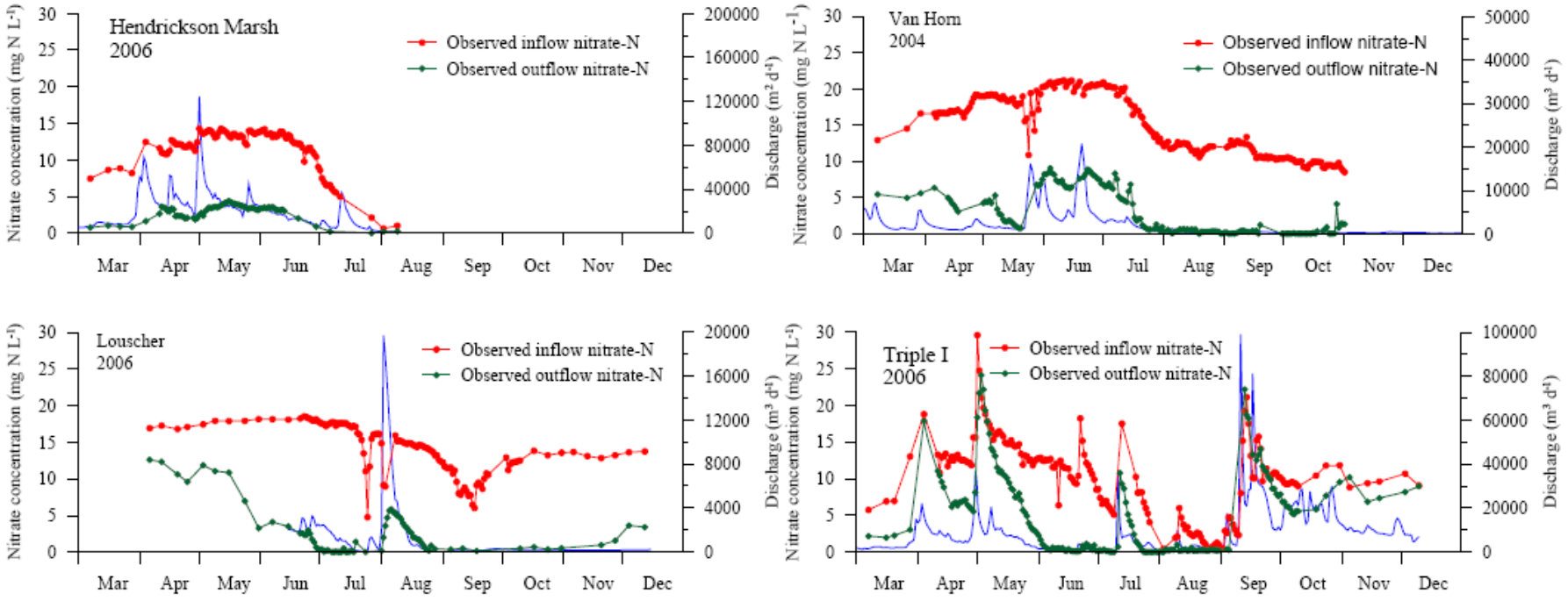




Jay Christensen

Benefits of Constructed Wetland Filters for Tile Drained Systems

0.5% - 2% wetland/watershed area ratio



Their results suggest that a 30% reduction in nitrate load from the UMR and Ohio River basins could be achieved using 210,000-450,000 ha of constructed wetlands

Potential Benefits of Wetland Filters for Tile Drainage Systems: Impact on Nitrate Loads to Mississippi River Sub-basins

U.S. Department of Agriculture

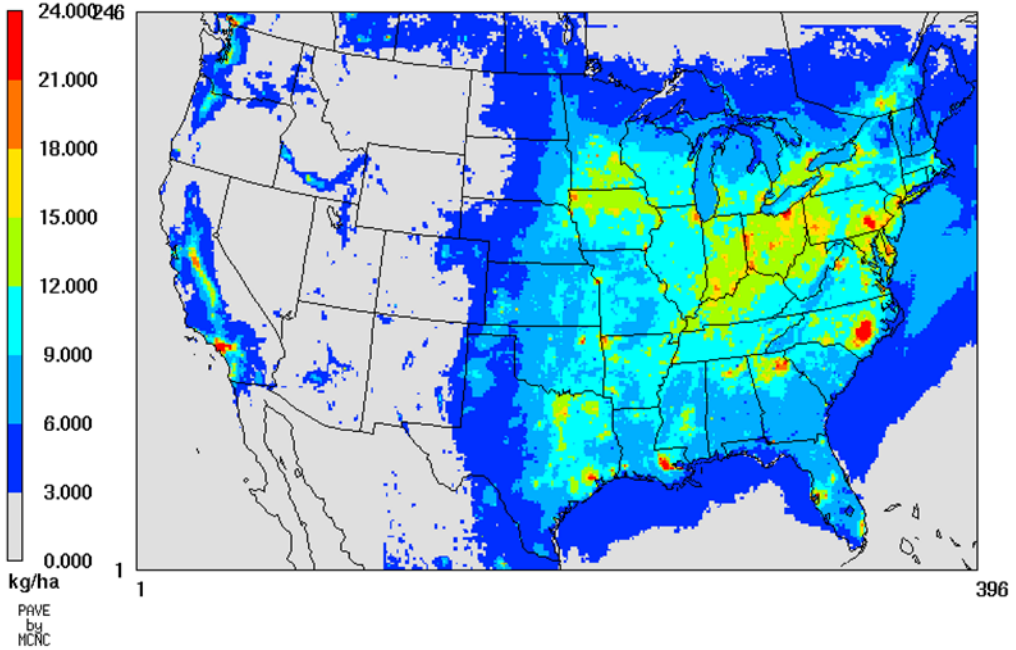
*Crumpton, W. G., G. A. Stenback, B. A. Miller, and M. J. Helmers

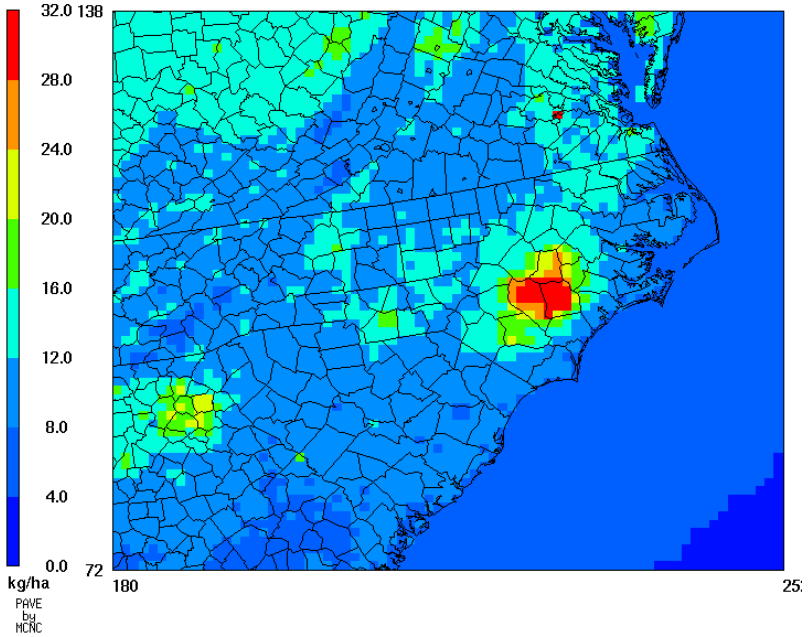
Nutrient Loads

- Joint goal of the nitrogen group and the mapping group to map nutrient loads nationally.
  - Cropland data layer + fertilizer application rates
  - Land use export coefficients and event mean concentrations (e.g., EPA PLOAD Users Manual, USDA MANAGE Data Base,)
  - Developing a CAFO coverage for nation
  - WWTP coverage for nation
  - GlobalNews Model, SPARROW, GWLF, WARMF
  - Atmospheric deposition -- CMAQ

Annual Total Deposition of Nitrogen (kg-N/ha)

Community Multiscale Air Quality (CMAQ) model

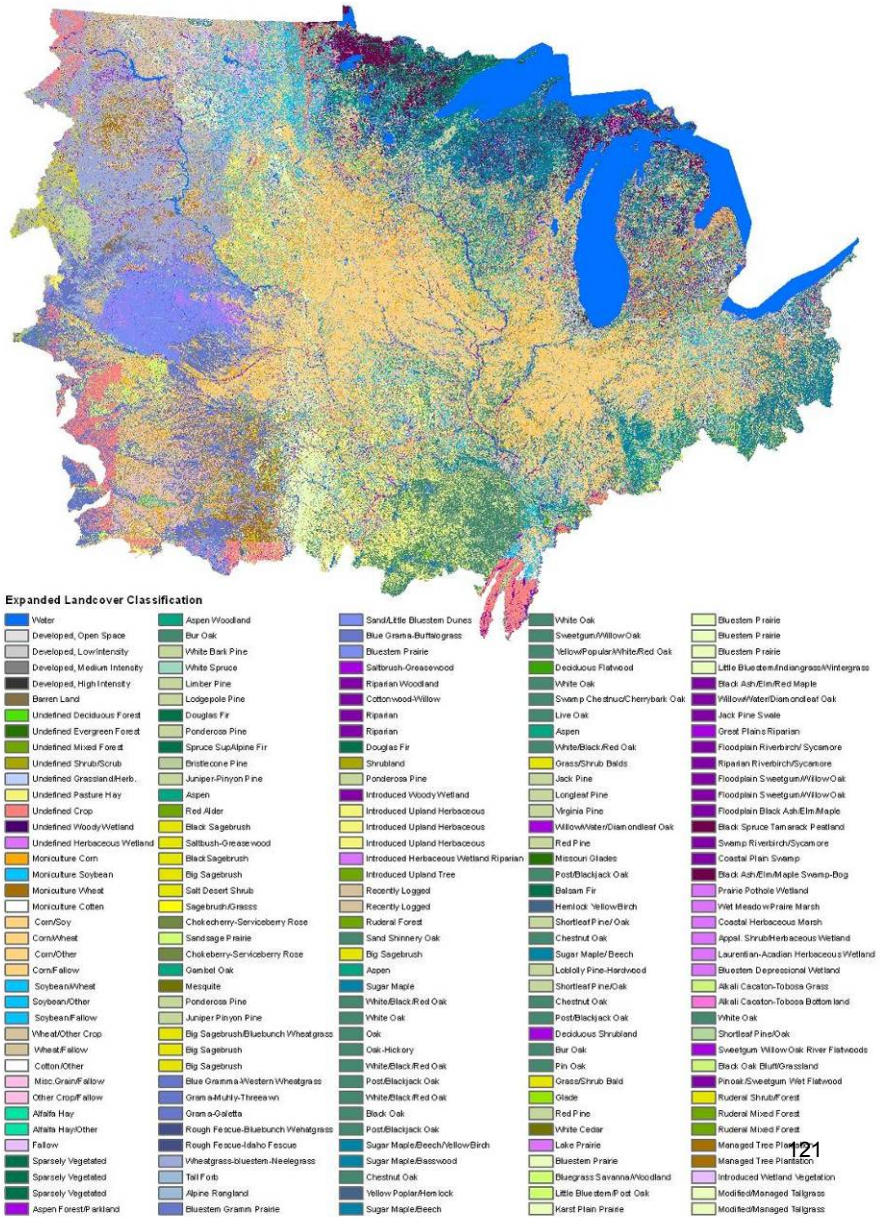




Models multiple air quality issues including nitrogen
Uses modeled meteorology data and 2002 National Emissions Inventory data
Outputs concentrations and deposition on an hourly basis.
Outputs data on a 12 X 12 Km^2 or 36 X 36 Km^2 grid cell basis.
Watershed Deposition Tool outputs to 8 or 12-digit HUC

Fertilizer Application

Megan Mehaffey – Landscape Ecology Branch, ESD



Enhanced Land Cover Data for FML– Combines the best of NLCD, NASS Crop Data Layer, and LANDFIRE using a set of rules

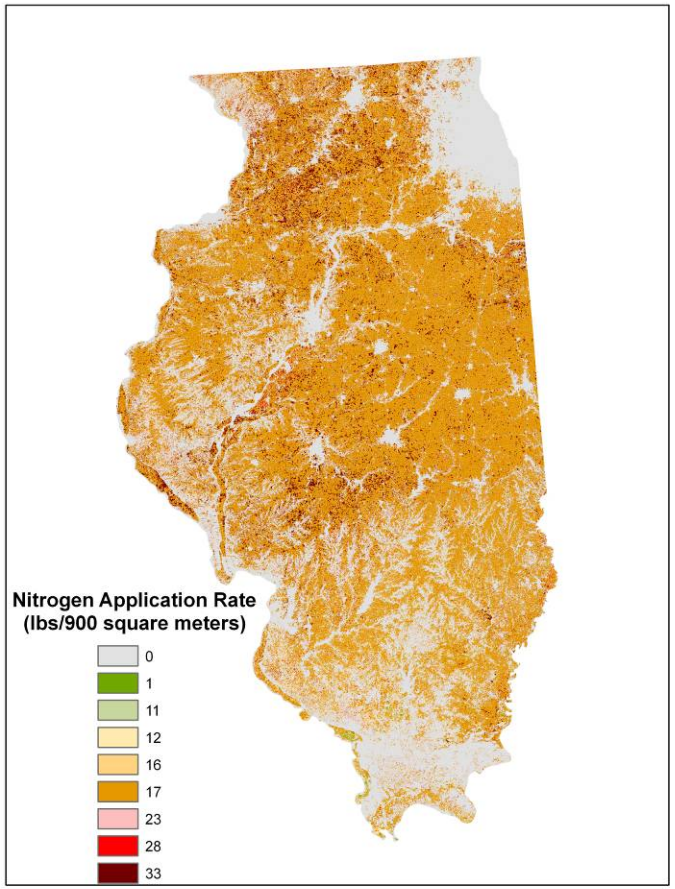
Includes crop type as well as rotation

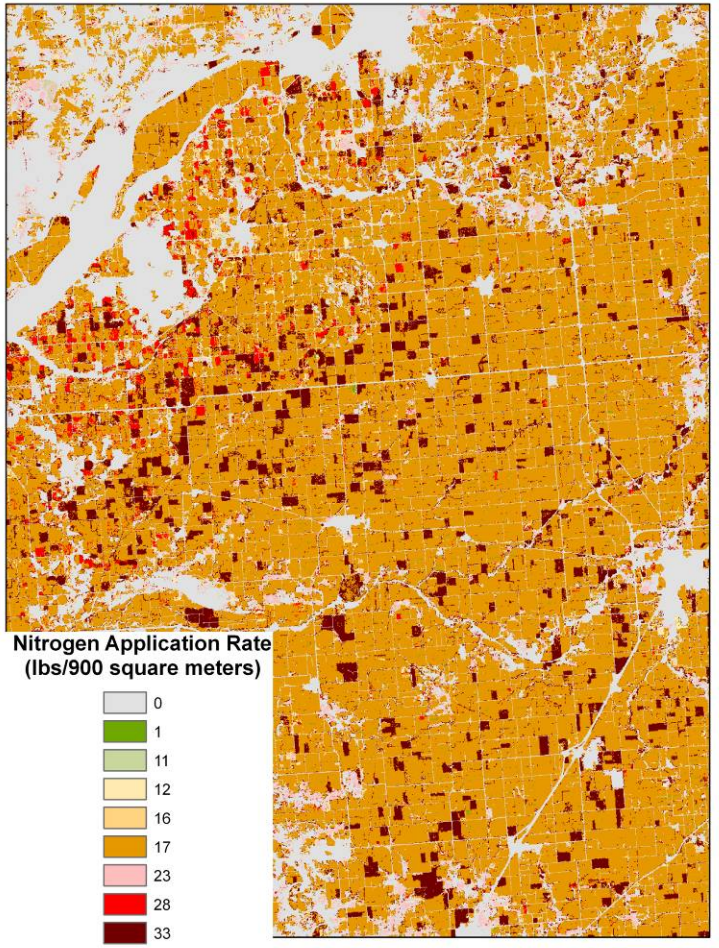
Implications for better estimation of nutrients and pesticides loads/export

Better assessment of crop yields

Fertilizer Application

Megan Mehaffey – Landscape Ecology Branch, ESD



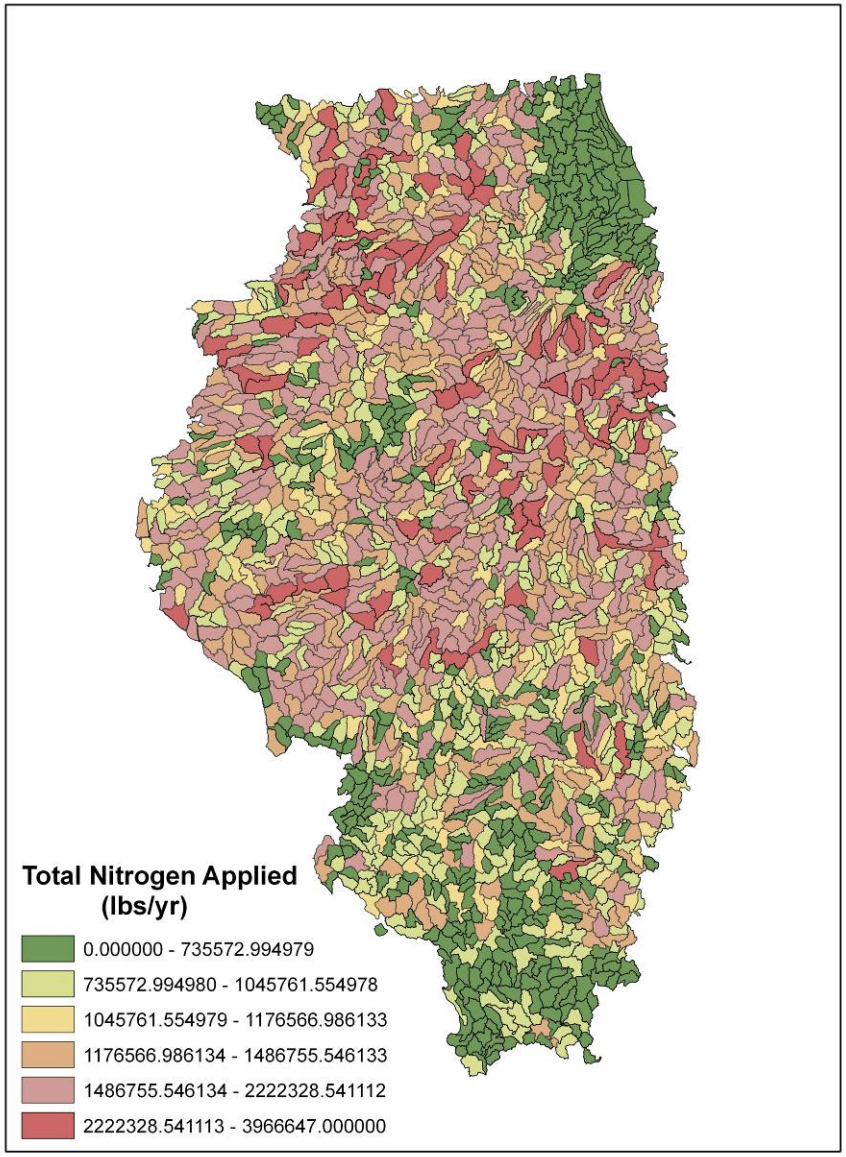


crop type X fertilizer application rate

Megan Mehaffey

Fertilizer Application

Megan Mehaffey – Landscape Ecology Branch, ESD



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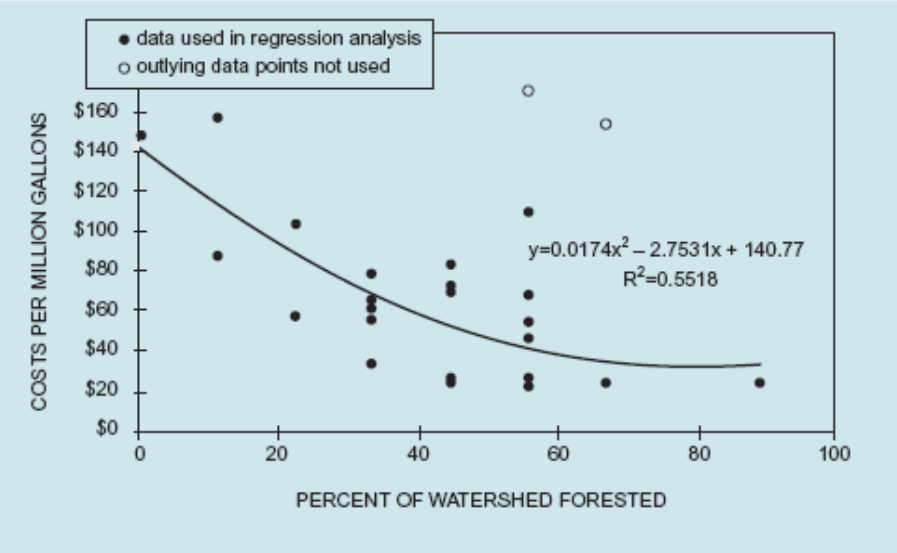
Megan Mehaffey

Water Quality -- Drinking Water Sustainability

Jim Wickham, Tim Wade



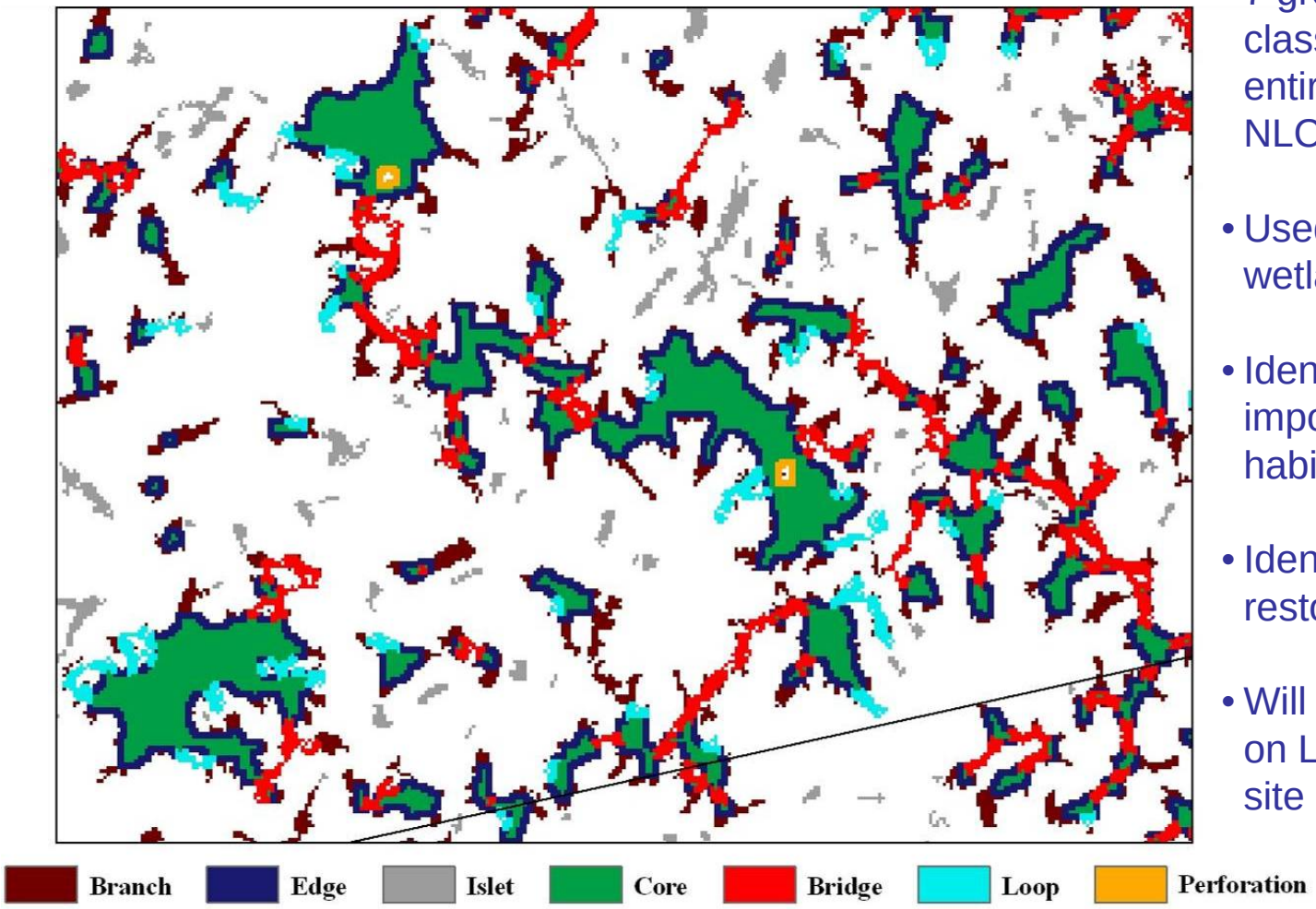
Source: Ernst (2004)
Finding: for every 10% loss of forest, treatment and chemical costs increased by 20%

- Acquired OW Drinking Water Source Water Intake points and wells for U.S. – Done
- Delineating watershed area contributing to those points – ~ 3500/6000 delineated
- Conduct landscape assessment of drinking water source areas
- Confidentiality issue
- Relate landscape metrics to intake water quality/degree of treatment required
- Relate to populations served & multiple benefits

Examples of Ongoing Atlas Work

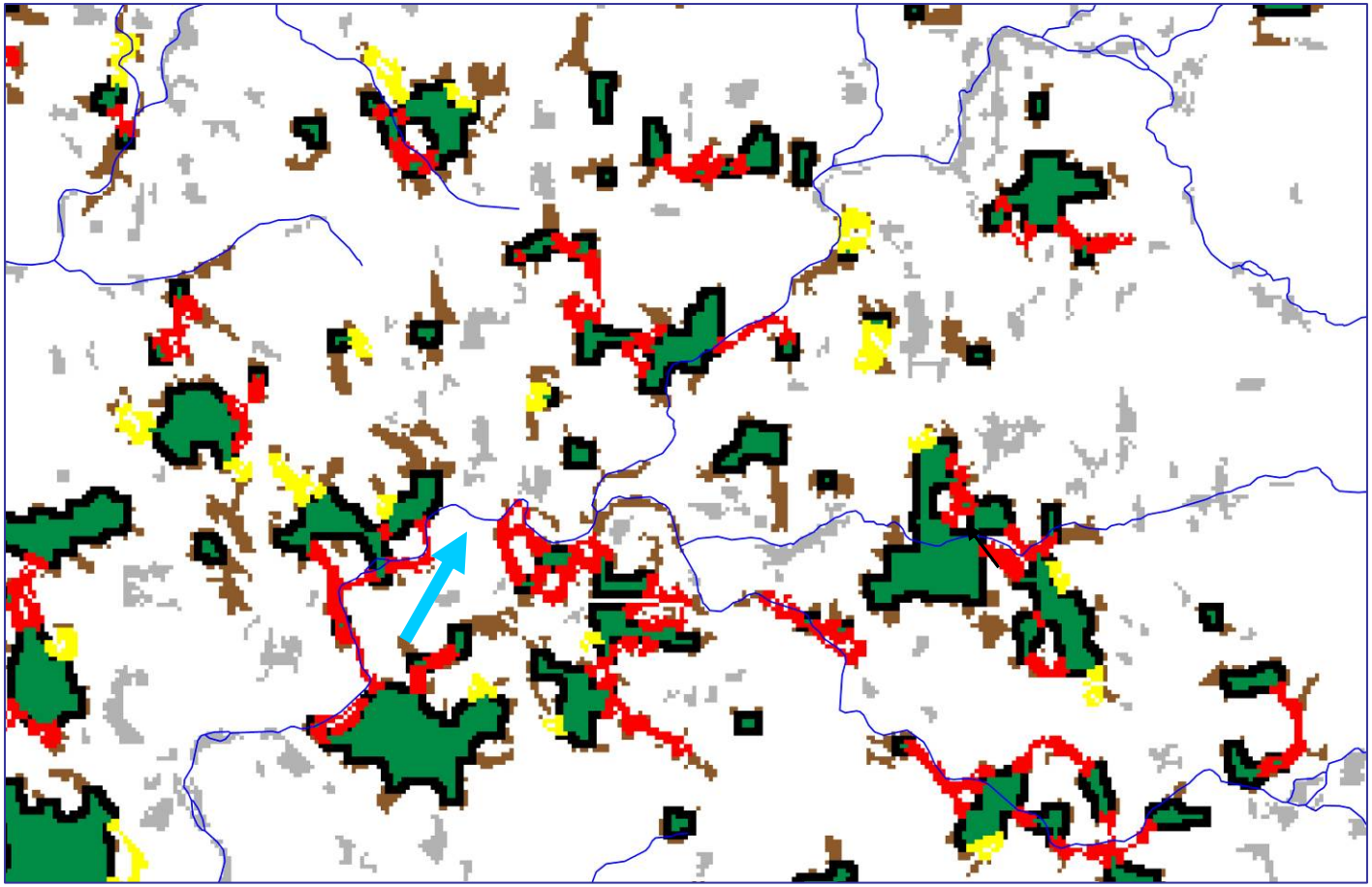
Terrestrial Habitat -- Green Infrastructure Approach (i.e., Hubs and Corridors

Jim Wickham, Tim Wade, Landscape Ecology Branch, ESD



- 7 green infrastructure classes mapped for entire US based on NLCD 30 m data
- Used NLCD forest and wetland classes only
- Identifies potentially important wildlife habitat
- Identifies areas for restoration/protection
- Will soon be included on LandScope web site

Developed from: Vogt P, Riitters KH, Iwanoski M, et al. 2007. Mapping landscape corridors. Ecol. Indic. 7:481-488. http://forest.jrc.ec.europa.eu/biodiversity/GUIDOS/



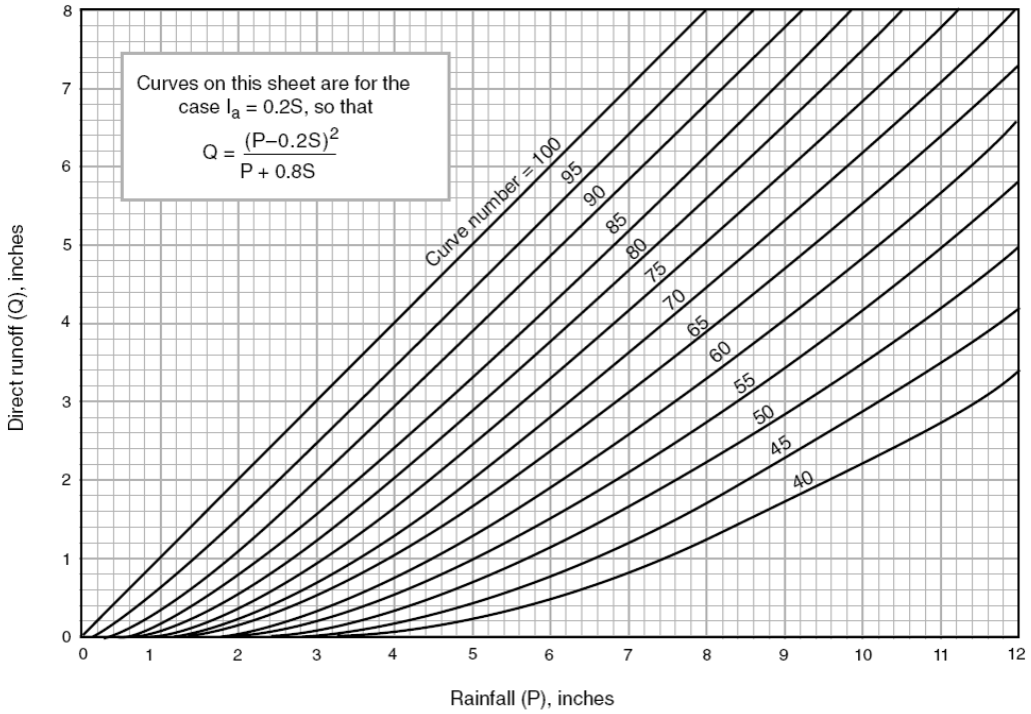
Core (hub) Bridge Loop Branch Islet (patch)

Can also add projected urban growth, impervious surface, etc.

Useful for land trusts in guiding land purchase

Examples of Ongoing Atlas Work
Water Quantity, Timing, Groundwater Recharge -- SCS Curve Number Approach

Jim Wickham, Tim Wade, Landscape Ecology Branch, ESD



Where $S = \frac{1000}{CN} - 10$

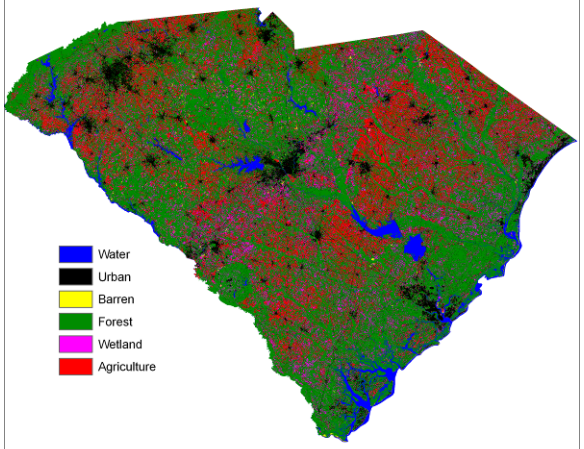
Generalized Curve Numbers

	Hydrologic Soil Group			
LC Class	A	B	C	D
Imp. Surf	98	98	98	98
Cropland	64	75	85	89
Pasture	39	61	74	80
Forest	30	55	70	77
Pin-jun		41	61	71
Wetlands			0-100	

Source: http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/other/TR55_documentation.pdf

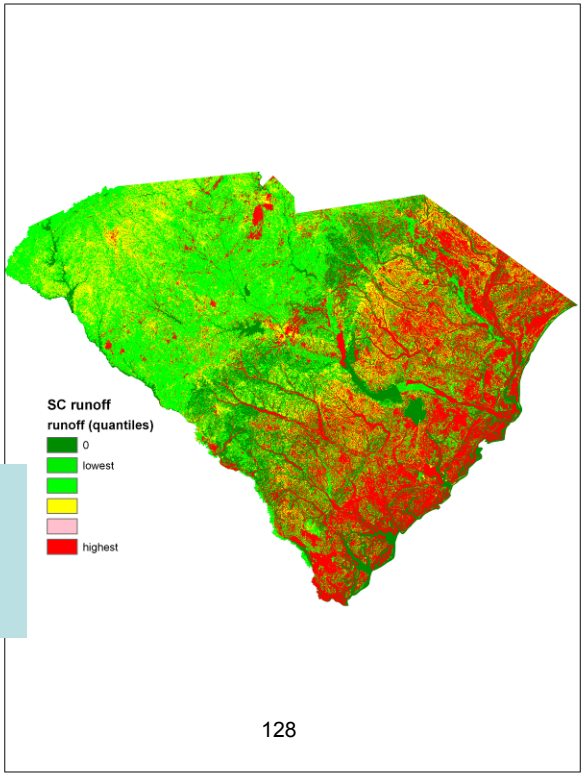
Water Yield using SCS Curve Number Approach

South Carolina Land Cover

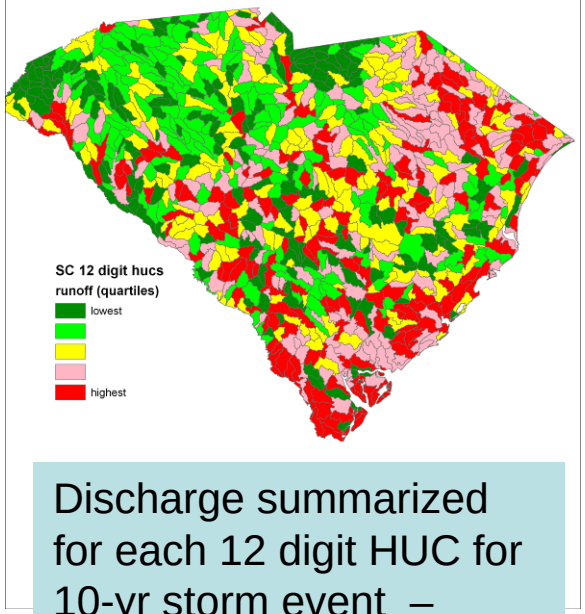


Calculations of CN based on NLCD land cover and SSURGO soils data

Discharge from 10 yr storm event (2 in) calculated for each 30 m pixel



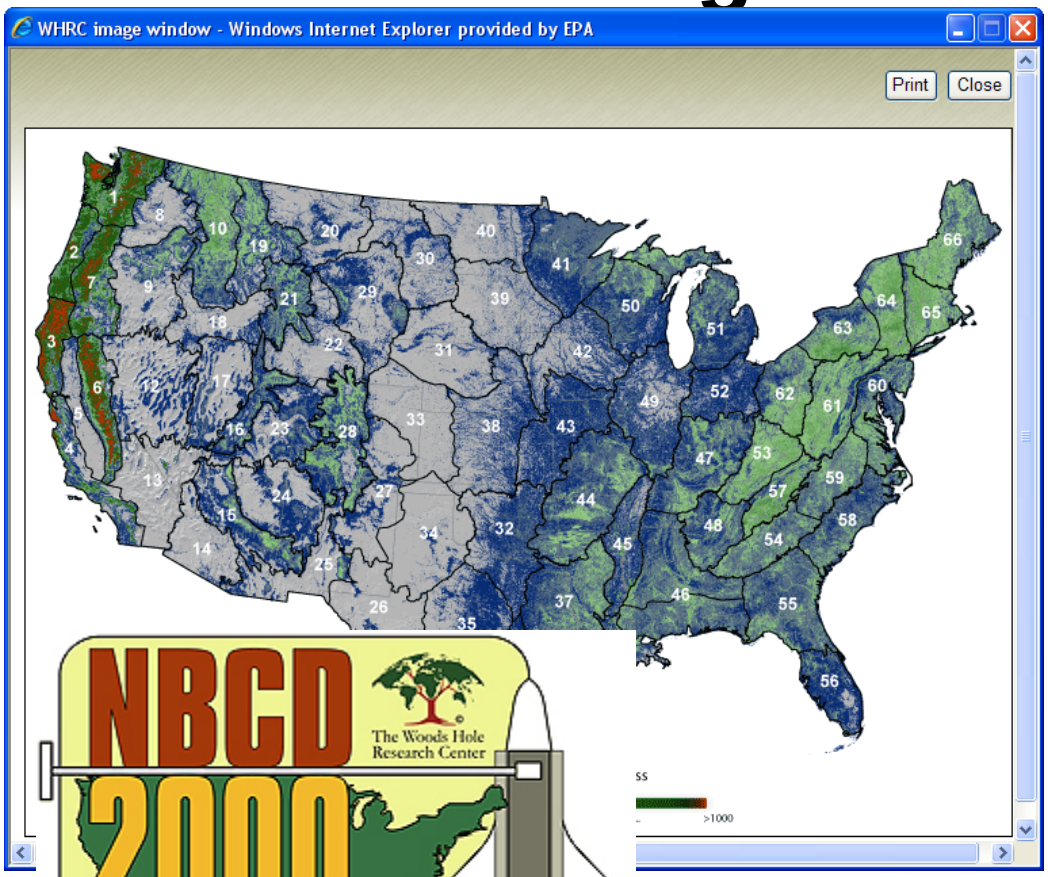
Discharge is routed from each 30 m pixel to the next until reaching HUC outlet



Discharge summarized for each 12 digit HUC for 10-yr storm event – investigating routing from one HUC to another to maintain hydrological network

Tim Wade

Carbon Storage and Sequestration

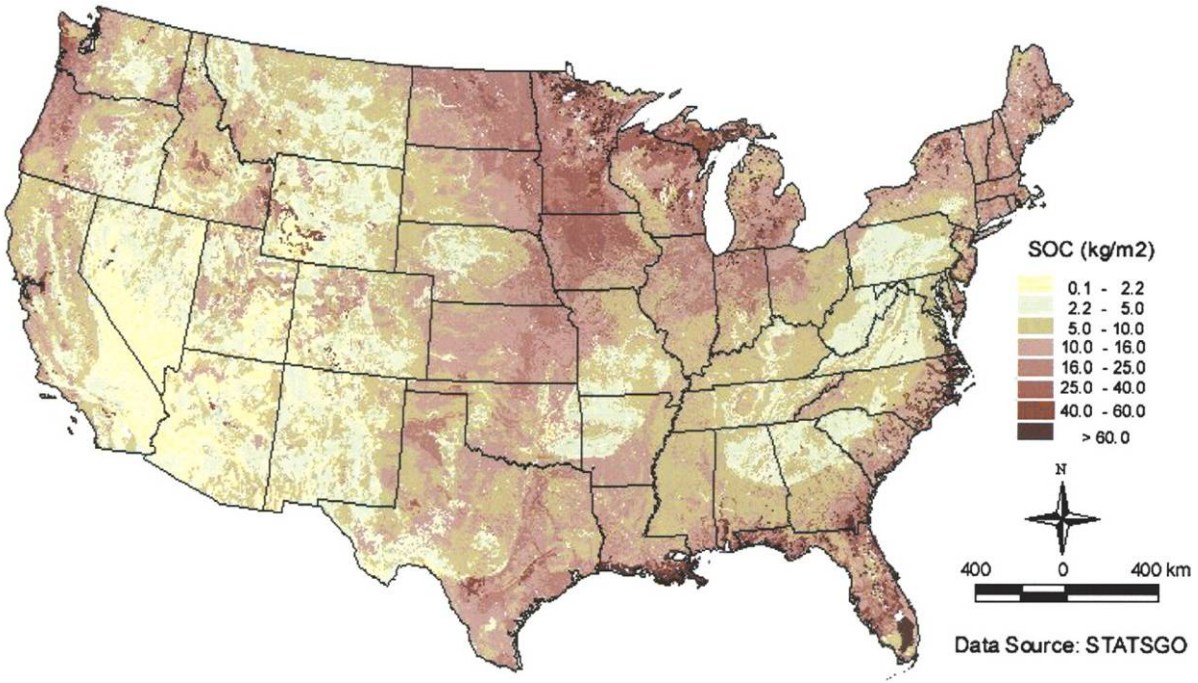


Empirical modeling effort using:

- USDA Forest Service Forest Inventory and Analysis
- High-resolution InSAR data (2000 Shuttle Radar Topography Mission)
- Optical remote sensing data acquired from the Landsat ETM+ sensor.
- National Land Cover Dataset 2001
- LANDFIRE
- National Elevation Dataset (NED)

Carbon Cycling – Carbon Storage

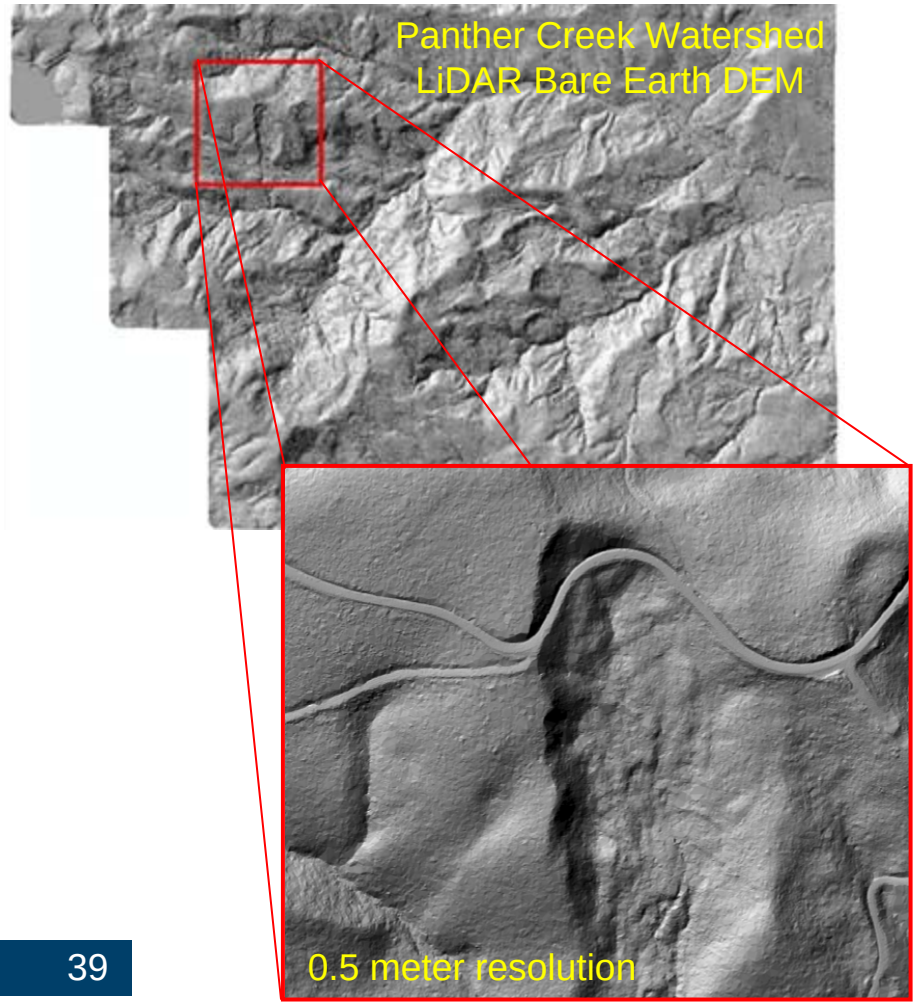
Spatial distribution of soil organic carbon (SOC) content to 2-m soil depths



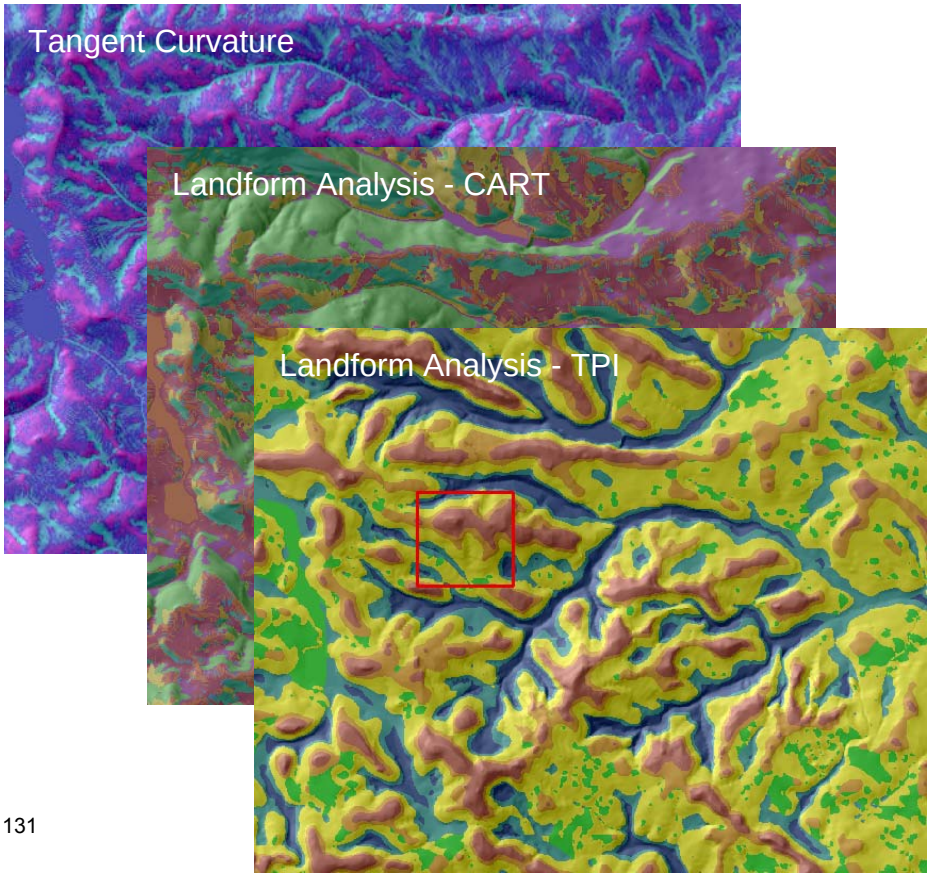
Developing similar using SSURGO

Source: Guo, Yinyan, Amundson, Ronald, Gong, Peng, Yu, Qian Quantity and Spatial Variability of Soil Carbon in the Conterminous United States Soil Science Society of America Journal. 2006 70: 590-600

WESP – Quantifing Soil Carbon Stocks

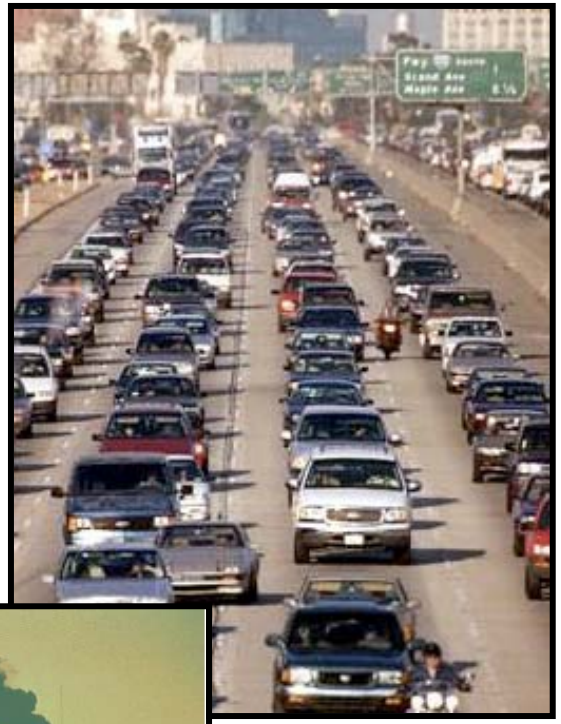


Approach: Use quantitative terrain analysis to characterize topographic and environmental features that control soil carbon distribution across the landscape.



Ecosystem Services provided by Urban Ecosystems

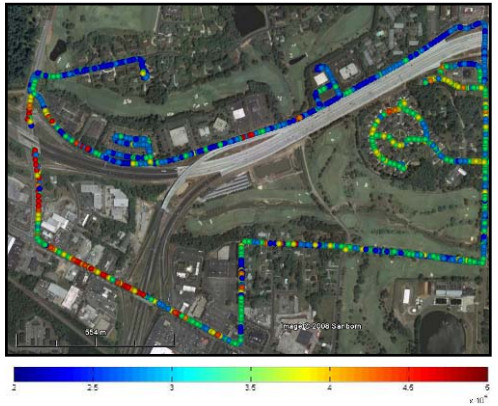
- In-depth analysis of urban areas with population ~> 100,000 using Urban Forest Effects Model (UFORE) and UFORE-Hydro in collaboration with USFS
  - Air pollutants removed by vegetation
  - Energy savings due to shading of buildings
  - Carbon storage benefits
  - Storm water runoff benefits
  - Water Quality benefits
- Near-roadway removal of pollutants by vegetation
- Developing other metrics
  - Heat Island Index
  - Indices of green places (parks)
  - Number of days exceeding air quality standards
  - Nighttime lights index
- Relate metrics to human health and possibly EJ
  - Bird diversity – West Nile Virus
  - $PM^{2.5}$ removal - Asthma



Mapping and human well-being

Monitoring and modeling to quantify pollutant filtration by near-roadway vegetative buffers



- **Stationary and mobile monitoring completed at two field sites in RTP, NC (n = 50 rush-hour periods).**
- **Data analysis begun on ambient concentrations of PM, CO, and black carbon downwind of roadside vegetation.**
- **Computational fluid dynamics modeling underway to simulate pollutant flow through various vegetation forms.**

Ecosystem service will be valued in ambient pollutant concentrations reduced and days of life extended.

Technical Challenges

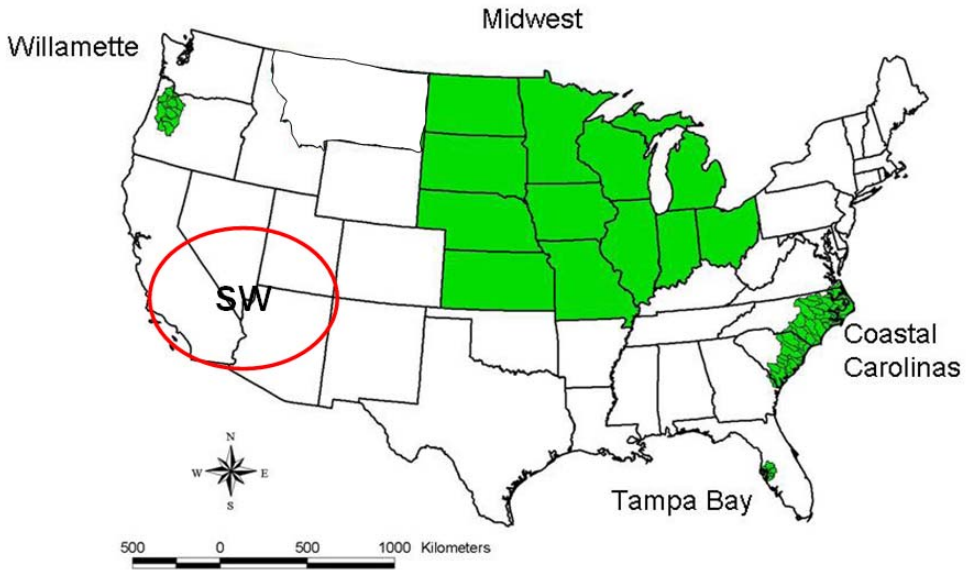
- Computing resources, technologically feasible but requires $$ investment
- Data accuracy –large national data sets are imperfect, will sometimes get it wrong. How do we convey that? How do we avoid, “my pixel is bad, the product is no good”
- Linking the services to beneficiaries ---how do we map this or is it enough to show the ontology?
- What can we do to best provide the foundational data for valuation?
- Data privacy issues – feasible to provide publicly available, fine-scale data, will there be privacy issues?
- Preferred modeling approach
  - Simple model applied fine-scale across the landscape vs.
  - Complex model applied to subset (by ecoregion), then extrapolated across landscape

Appendix G – Presentation: Implementation of Place-based Studies: Coordination with ESRP Themes (Hal Walker); Ecosystem Services Demonstration Project Tampa Bay (Marc Russell); Future Midwestern Landscapes Study (Betsy Smith and Randy Bruins)

Implementation of Place Based Studies: Coordination with ESRP Themes

7/14/2009

Hal Walker
ORD NHEERL Atlantic Ecology Division



ESRP Organizational Matrix

Projects and Long term Goals →		LTG 3 Pollutant-Specific Studies: 6%	LTG 4 Ecosystem Specific Studies: 23%		LTG 5: Community Based Demonstration Projects: For National, Regional State and Local Decisions 28%					Theme Leads
	Cross Program Themes and Research Objectives	Nitrogen (6%)	Wetlands (22%)	Coral Reefs (5%)	Willamette (11%)	Tampa Bay (4%)	Mid-West (4%)	Coastal Carolinas (8%)	Southwest (1%)	
Integration, Well-Being, Valuation, Decision Support, Outreach and Education LTG 1 9%	Ecosystem Services and Human Well-Being (3%)									Laura Jackson
	Valuation of Ecosystem Services									Wayne Munns--Consultation Committee
	Decision Support (6%)									Ann Vega
	Outreach & Education to									Open
Inventory, Map, and Forecast Ecosystem Services at multiple scales LTG 2 31%	Landscape Characterization and Mapping (12%)									Anne Neale
	Inventory and Monitoring of Services (14%)		M^3							Mike McDonald
	Modeling (5%)									Tom Fontaine--Consultation Committee
Pollutant Specific Studies LTG 3	Nitrogen (6%)									Jana Compton
Eco-system Specific Studies LTG 4	Wetlands (22%)									Janet Keough
Project Area Leads	Rick Linthurst and Iris Goodman	Jana Compton	Janet Keough	Bill Fisher	David Hammer	Marc Russell	Randy Bruins/ Betsy Smith	Deborah Mangis	Nita Tallent-Halsell	Rick Linthurst and Iris Goodman
				137	Hal Walker: Place Based Coordinator					

Implementation of Place Based Studies: Cross-Place Coordination with ESRP Themes

7/14/2009
Hal Walker
ORD NHEERL Atlantic Ecology Division

ESRP Themes ⟺ Place Based Projects

- Mapping
- Monitoring
- Modeling

} National, Regional, Local; M^3 / Bayesian approaches

- Pollutant Specific / Nitrogen
- Habitat Specific / Wetlands
- Decision Support Framework(s)

- Coastal Carolinas
- Future Midwestern Landscapes
- Southwest
- Tampa
- Willamette

1) Current emphasis is improving coordination between Themes & Places

2) Cross Place Coordination is not another ESRP Theme or Project

➔ *We do not have separate "cross-place research" implementation plans.*

Attributes of Place based research

- Initially PB studies were primarily “inward looking” focused on “within place” issues.
- Alternative futures orientation common to all PB studies.
  Conceptual Frameworks developed within each Place Based study.
- Some common drivers of change among the places: e.g. landuse change / governance, regional economies. FML not dealing with climate change.
- Some common themes (Nr, Wetlands) & ecosystem services & benefits trade-offs of concern in all the places: e.g. food & fiber production, water quality & quantity.
  Need for Mapping, Monitoring, & Modeling (M^3). Common regulatory issues.
- At this point, only a few planned ecological cross-place comparisons,
  e.g. for Nr, Wetlands. => Which structural & functional comparisons => ES Endpoints.
- Different biophysical, socio-economic & governance contexts among “places”.
  Some very interesting economics / benefits trade-off questions among “places”.
- Other cross-place research opportunities are being identified
  - e.g. regional comparisons of benefits trade-offs among major economic regions

Cross Place-based Research Coordination

Coordination Goals

- Identify what should be common research issues among the place-based studies, and what should not.
  What can be scaled down from national / regional scale (M^3), or up from PB scales?

- Develop common research activities (e.g. mapping spatial extent of core ecosystem services using similar methods across the places). Are there opportunities we need to consider? Intersections between ESRP Themes: 1) Mapping, 2) Nr (slide 8), 3) Wetlands, 4) possibilities related to mapping, monitoring, modeling & valuation

- Find other sites nationally, e.g. at Long Term Ecological Research (LTER) sites, other agencies' sites; and explore potential synergies and cost-effective collaborations.
  Nr Conceptual Framework (LTER DP 2007) & "Working Lands" Conceptual Framework (slide 11)
  Exploring collaborative opportunities with other agencies (e.g. USGS's ES research).

- Explore opportunities for ESRP to participate in Millennium Assessment Follow Up (MAFU) studies:
  A) advancing knowledge base on ecosystem services & human well-being;
  B) strengthening policy implementation at the country level; and
  C) outreach / disseminate of findings and framework to relevant stakeholders.
  MAFU is still getting organized. Deferred consideration of this until later.

Cross Place Coordination Approach

- **Approach (2009)**
  - Monthly coordination calls among Theme Leads & PB Leads
  - Theme "topic of the month" chosen by PB leads
  - Follow-up action items for PB & Theme leads.
  - Improvements in Theme research implementation plans (Mapping & Nr).
  - New PB efforts (Coastal Carolina & Southwest learning from planning & early successes of other more mature PB efforts)

- **Where we go next for cross place based approach (2010 and beyond)**
  - Cross place comparisons,
    e.g. Nr attenuation in stream networks, now built into Nr Imp Plan
  - Opportunities for cross PB comparison of other services provided by stream networks, wetlands, etc.
    e.g. being built into other theme research plans (e.g. wetlands)

  - EPA & States collecting information on variations in ecological conditions
    e.g. from ongoing Office of Water National Aquatic Resource Surveys useful for national assessment & regional comparisons: lakes & reservoirs , rivers & streams, coasts, wetlands.

} Regional M^3 comparisons

Place Based research approach:

Place Based Efforts are relating effects of multiple stressors on ecosystem services, at multiple scales (space and time) in multiple types of ecosystems.

Place Based Efforts are using future scenarios to characterize potential changes in these services & likely effects of human well-being. Scenarios need to be constrained to be manageable.

The value of these services could be expressed in monetary and non-monetary terms.

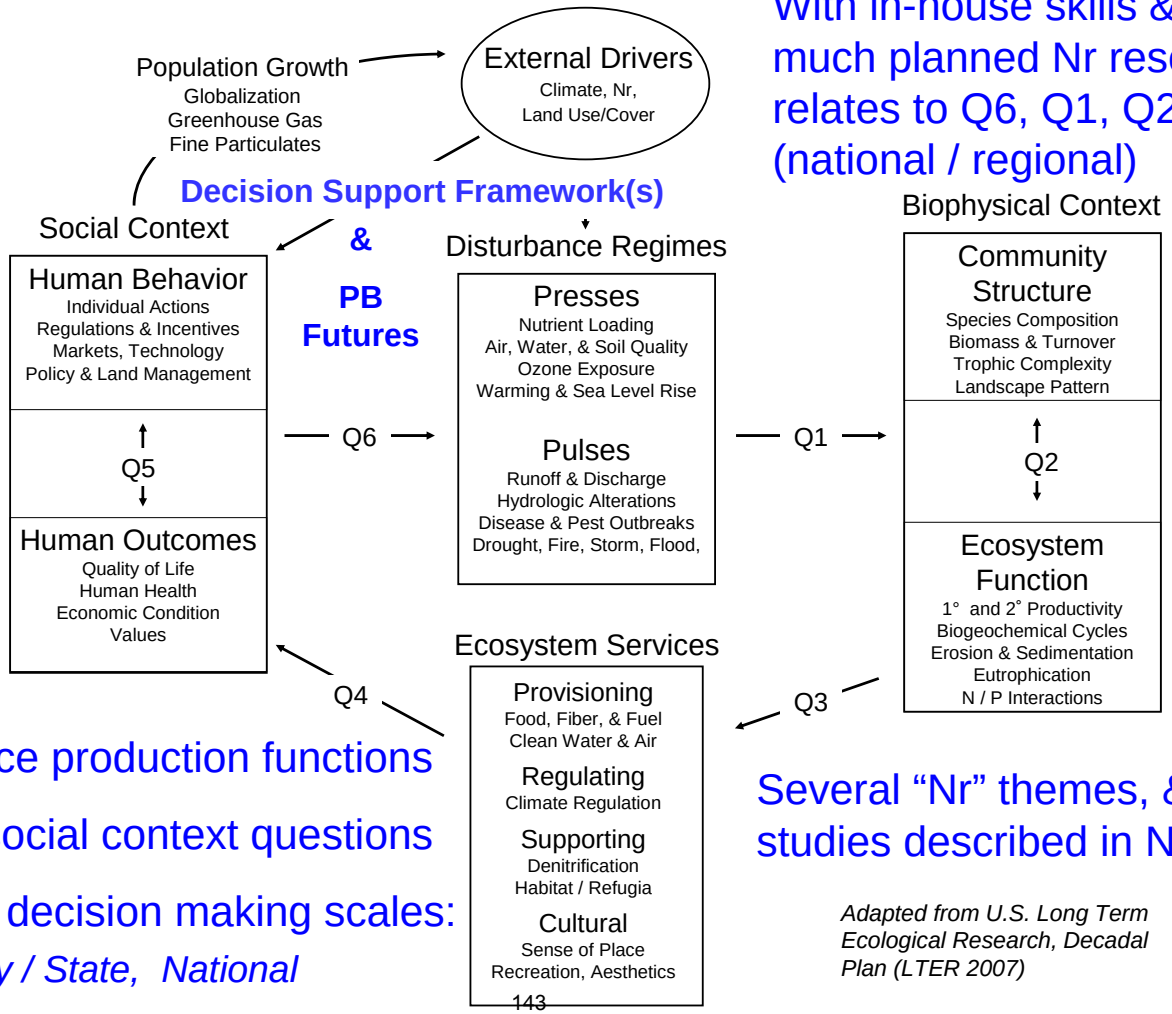
Given the complexities (mult- multi- multi-), what research activities should be common among the place-based studies, and what should not?

➔1st consider the Conceptual Framework for Nr

➔2nd consider the differences between FML and Tampa

Conceptual Framework for ESRP Pollutant Specific-Nitrogen for organizing causal pathway & research questions (modified from LTER decadal Plan 2007).

With in-house skills & capacity, much planned Nr research relates to Q6, Q1, Q2, & Q3 (national / regional)



Several "Nr" themes, & regional case studies described in Nr Imp. Plan

Adapted from U.S. Long Term Ecological Research, Decadal Plan (LTER 2007)

Expert Hires:
For PB studies, can help us build capacity to address economic and social context questions

PB efforts can get at:

- Q3 Ecosystem service production functions
- Q4 Connections to social context questions
- Q5 Futures oriented decision making scales: *Individual, County / State, National*

Comparing and contrasting two PB studies: FML (largest) & Tampa (smallest)

PB and other ESRP research can contribute to different MAFU components:

Drivers of Change: Landuse (e.g. biofuels, sprawl), Nr, etc.
PB Consequences Differ: Different biophysical and social contexts
Decision Making Scales: Individual, County / State, & National Policy

A) advancing knowledge base on ecosystem services & human well-being;
B) strengthening policy implementation at the national level; and
C) outreach / disseminate of findings and framework to relevant stakeholders

All PB Research involves A) & C). Some may strengthen national policy

What you will see in subsequent presentations

- PB research: Future Midwestern Landscapes (FML)
- PB research: Tampa *(scaling up from plat and lot level)*

- Major differences in biophysical and social contexts
- Major differences in issues of concern
- Major differences in spatial scales & research approaches (M^3)

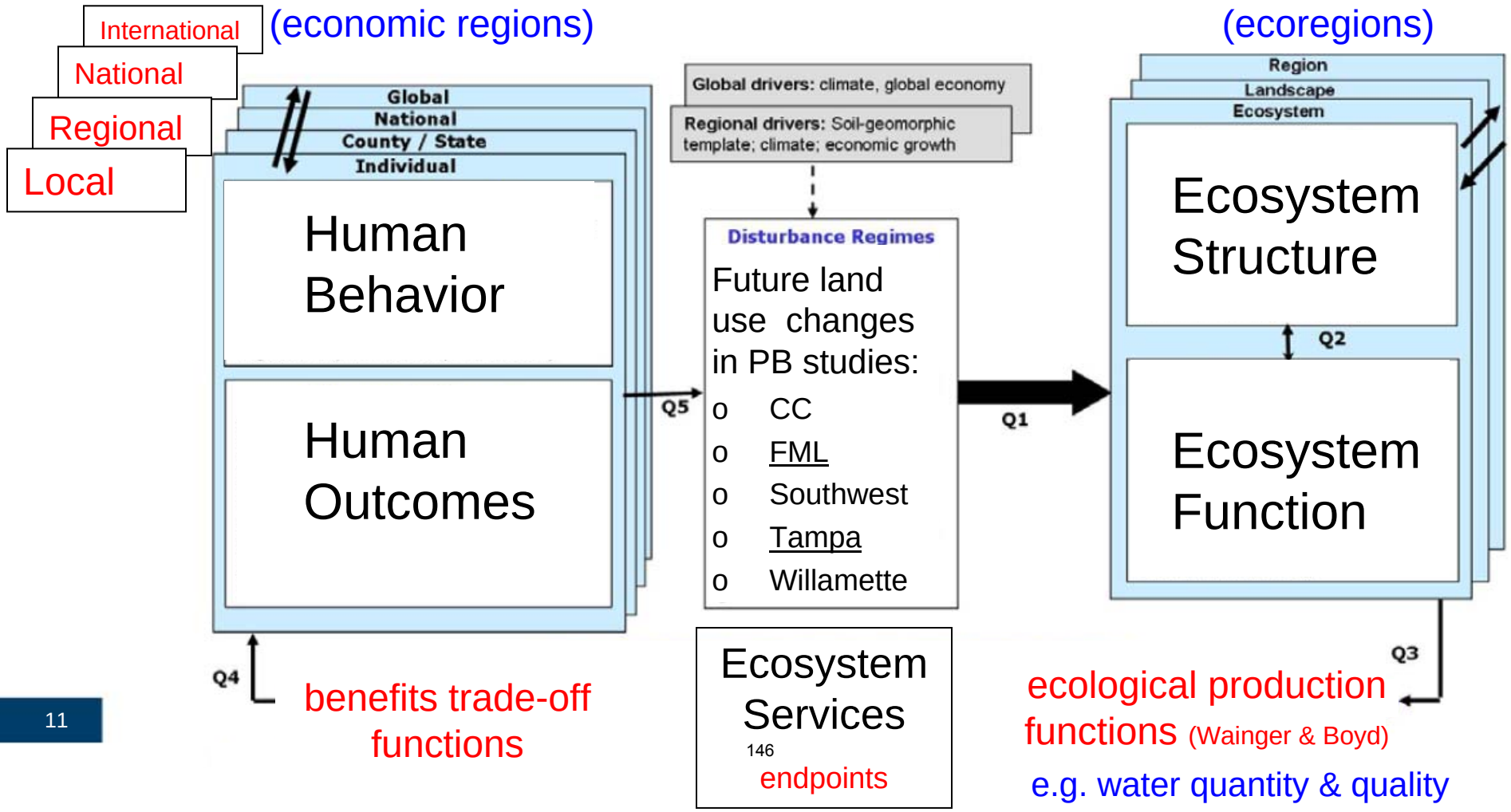
- Somewhat different conceptual frameworks and approaches needed to address different research questions, and different decisions

Comparability?

How to think about cross-place / cross-regional comparisons at a range of biophysical and social context scales

LTER Conceptual Framework for organizing causal pathway questions related to social and biophysical contexts in management of "working lands" (LTER DP 2007)

Regional comparisons: benefit trade-offs & ecosystem service production functions



Expected impacts of Place based research

- Short Term
  - Substantial progress within each PB effort (FMP & Tampa examples)
  - More coordination among PB efforts and ESRP Themes
  - PB estimation of a variety of ecological production functions
  - Benefit trade-off analyses within the “places”
  - Improved decision making within the “places”
  - Some results may be compared among places (e.g. Mapping, Nr, Wetlands).
  - PB links to regulatory (air, water) and non-regulatory decision making related to wetlands mitigation banking, and landuse, e.g:agricultural practices (FML), and landuse planning (Tampa)
  - Some PB findings will be relevant for improving national policy implementation

- Long-Term
  - Additional association & interaction with other agencies & NGOs
  - Opportunities for cross-place / cross-regional comparisons (e.g. for Nr using regional SPARROW, and NEWS models), coupled to Bayesian approaches to relate nutrient fluxes to ecosystem production functions and benefits trade-offs.
  - Association with international ecosystems service research, e.g. MAFU studies

Tampa Bay Desalinization Plant

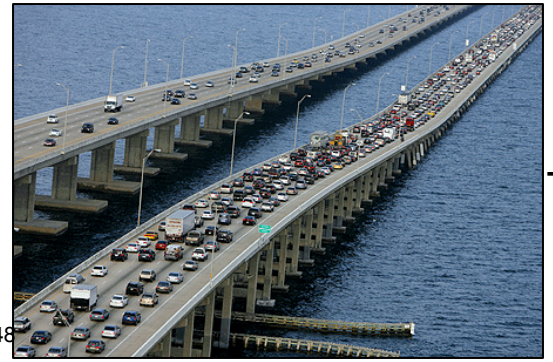
or

Hillsborough River Floodplain Forest

Ecosystem Services Demonstration Project:

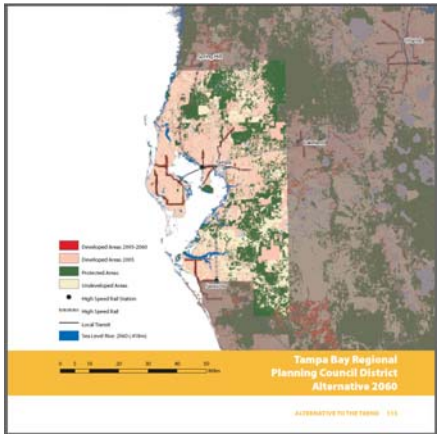
Tampa Bay, FL

7/14/2009
Marc Russell
Gulf Ecology Division



Tampa Bay Traffic

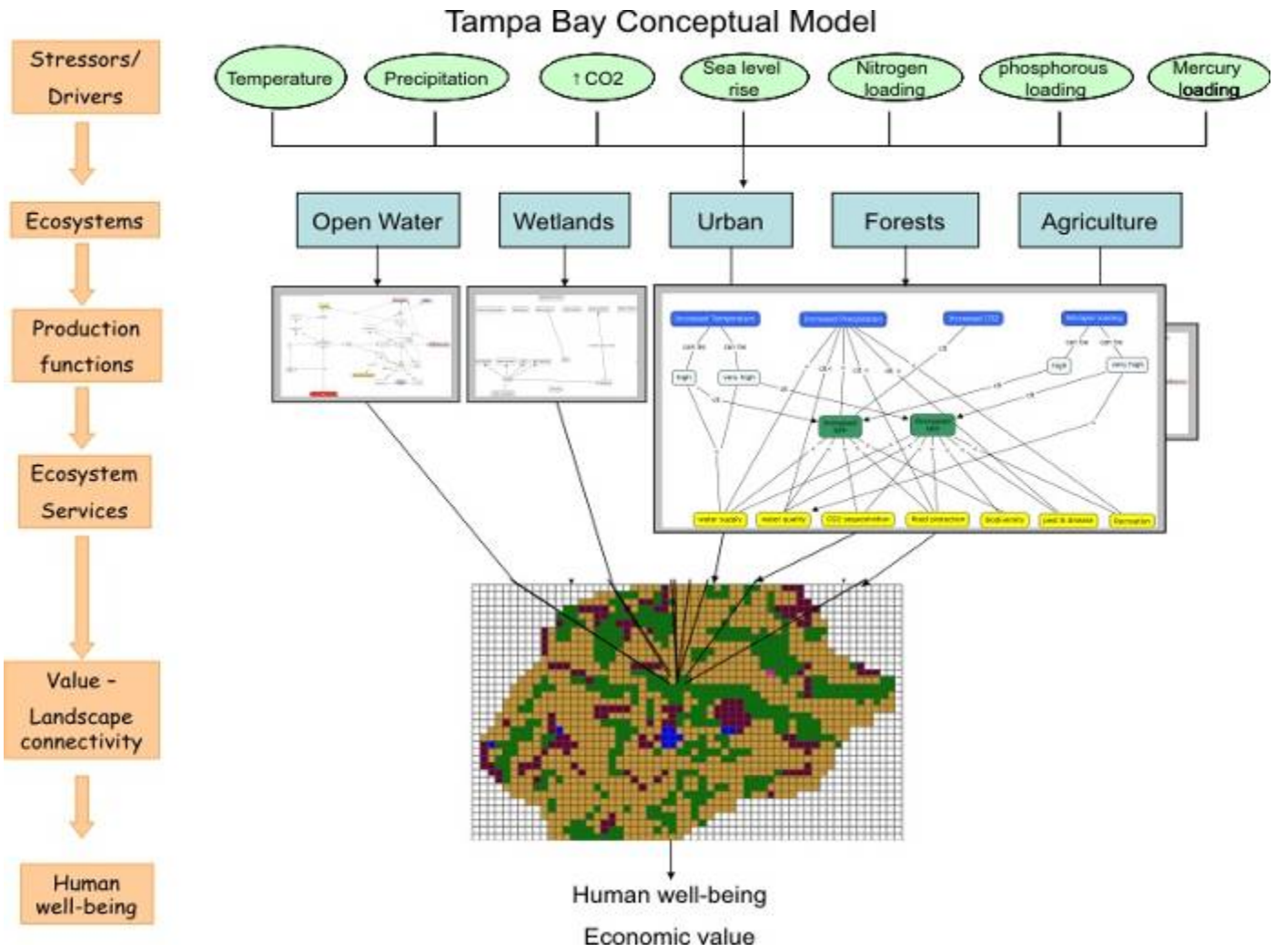
Introduction



Alternative Futures

Ecosystem Services

Benefits


Tampa Bay Conceptual Model
Stressors/ Drivers
Ecosystems
Production functions
Ecosystem Services
Value - Landscape connectivity
Human well-being
Temperature
Precipitation
↑ CO2
Sea level rise
Nitrogen loading
phosphorous loading
Mercury loading
Open Water
Wetlands
Urban
Forests
Agriculture
Human well-being
Economic value

Functions, Services, and, Benefits

Functions and Intermediate Services

=

Final Service

+

Use

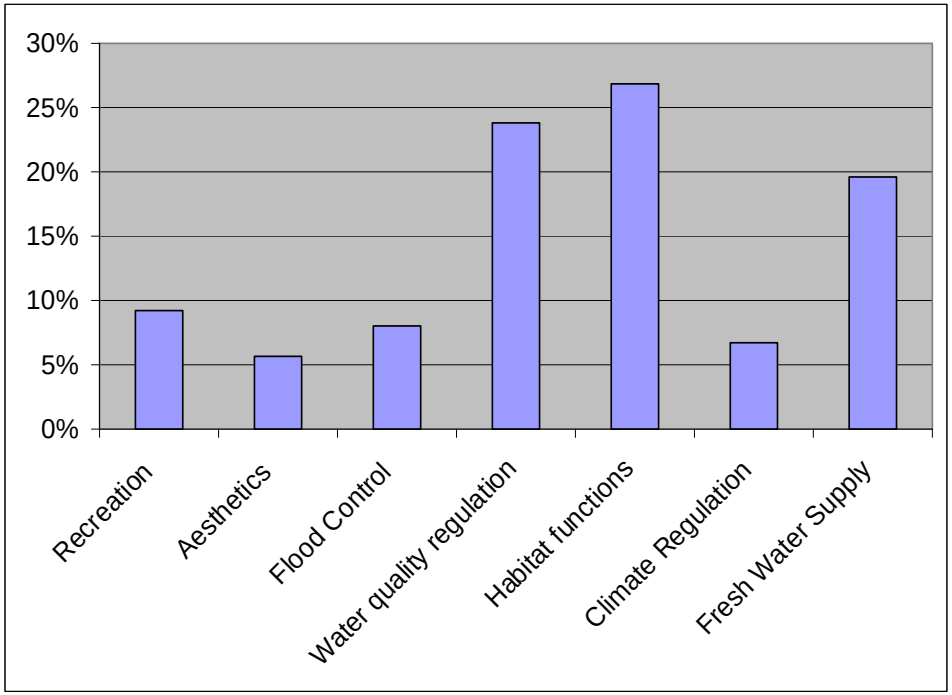
=

Benefit

Project Adjustments and Refinement

Research Focus Prioritization

- Technical advisory group
  - Steering committee and local expert input
- Economic value
  - Collaboration with Economist = Initial valuation index
- Local needs
  - Workshop with stakeholder representatives
  - Identified priority management questions to address with research
- State of the science
  - Bibliometric analysis of knowledge gaps for important and valued ecosystem services



Jordan et al. Submitted. Accounting for Natural Resources and Environmental Sustainability: Linking Ecosystem Services to Human Well-Being

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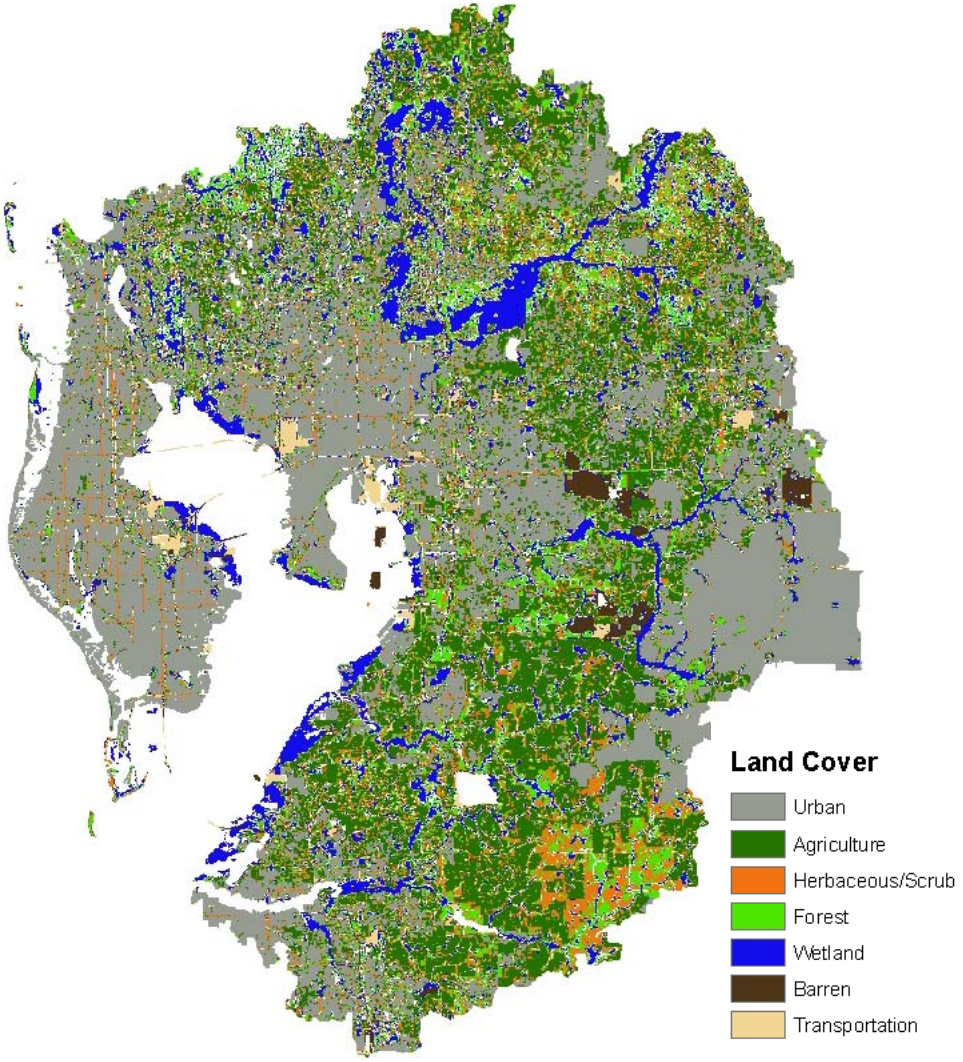
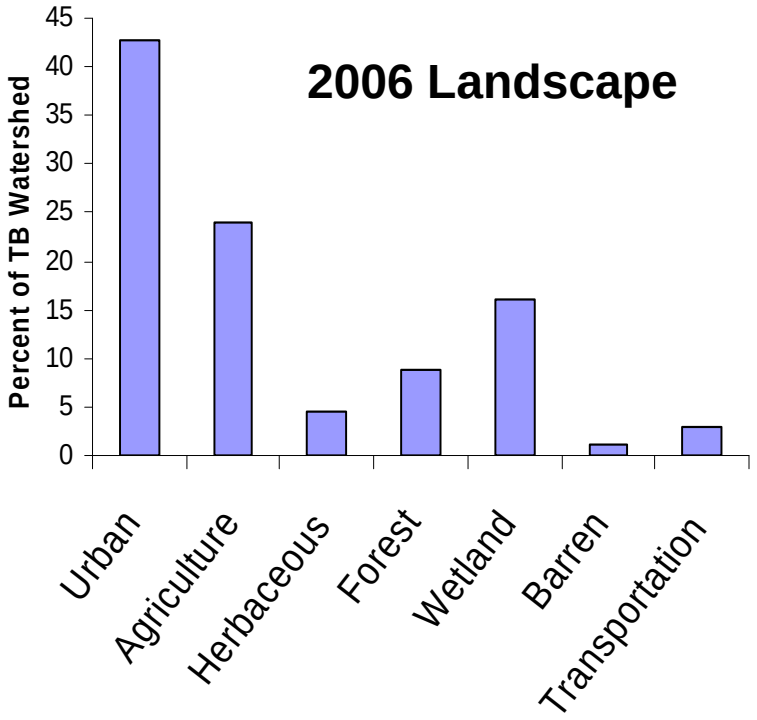
Tampa Bay – Landscape Characteristics

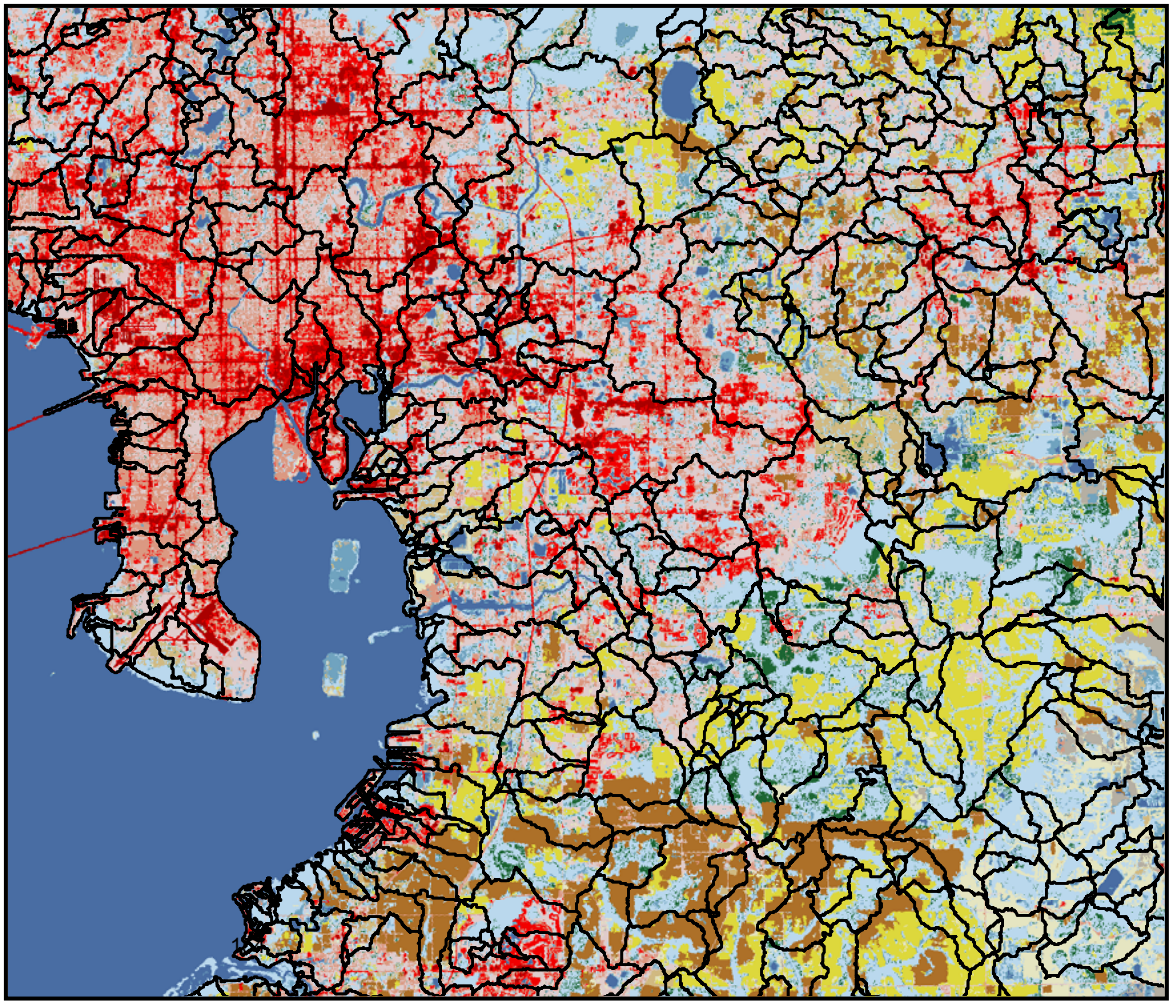




ES Spatial Accounting Units

NHD+ Basins

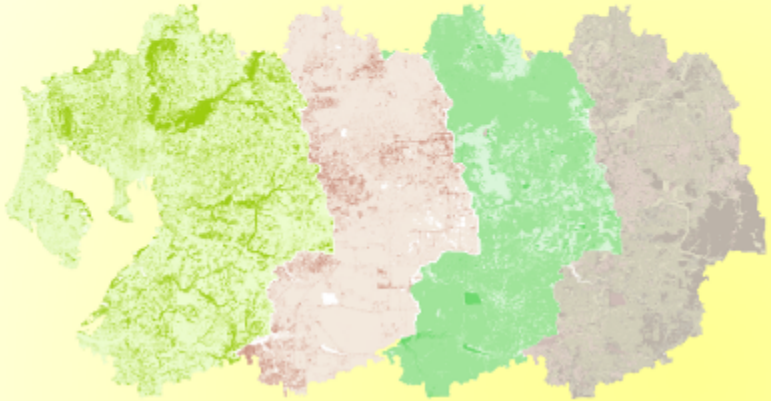
- Neighborhood scale
- Linked to larger hydro-network
- Ancillary info available



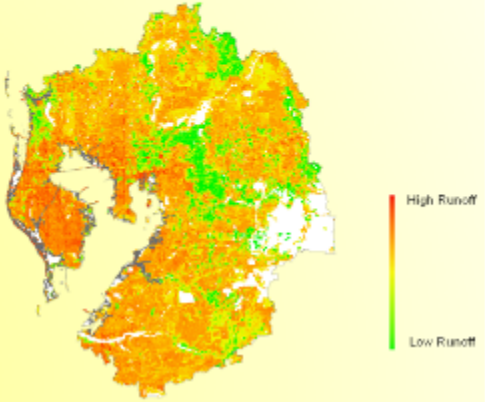
Mapping Changes In Stormwater Mitigation Ecoservices

Joe Reistetter Marc Russell
US EPA - Gulf Ecology Division - Landscape Ecology

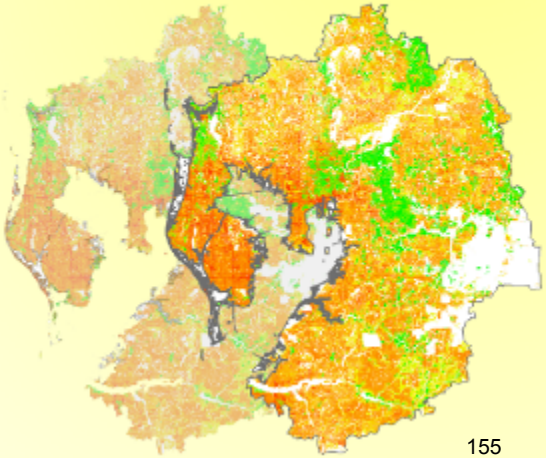
Tree Canopy Density | Percent Imperviousness | Soil Type | Land Cover / Land Use



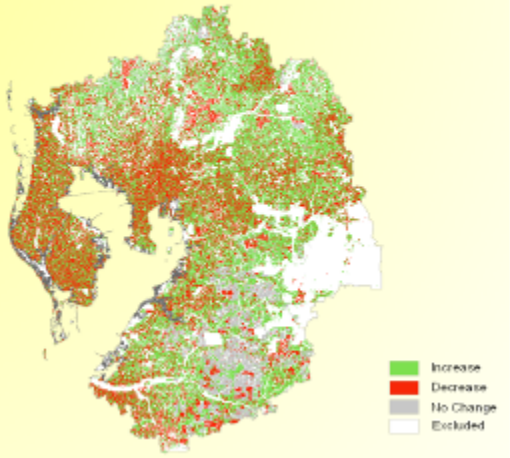
Estimated Stormwater Runoff
(Stormwater Mitigation Ecoservices)



Estimated Stormwater Mitigation Ecoservices
1995 2002

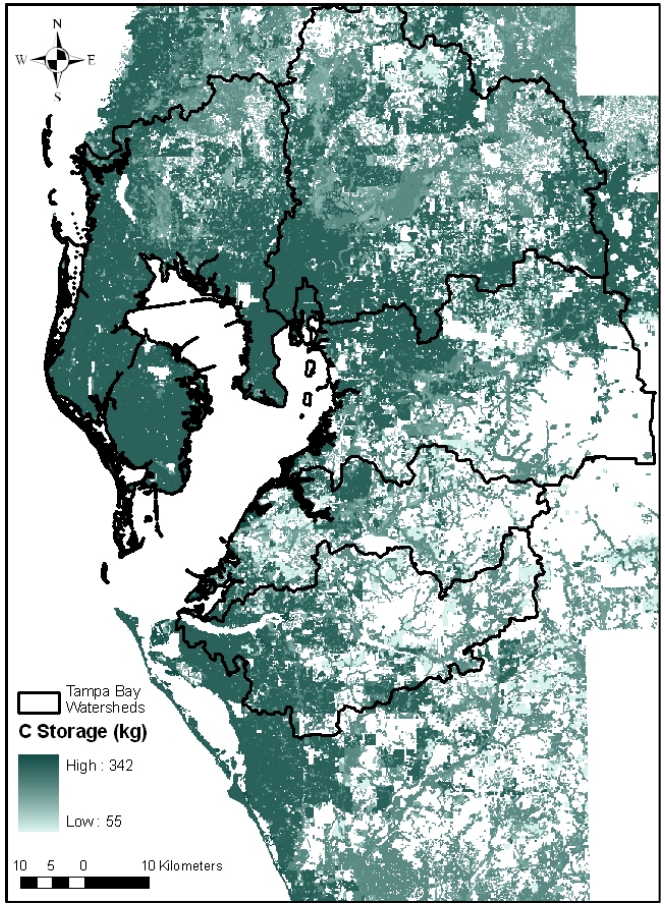


Change in Estimated Stormwater Mitigation Ecoservices



Study Area

Carbon Storage Bank



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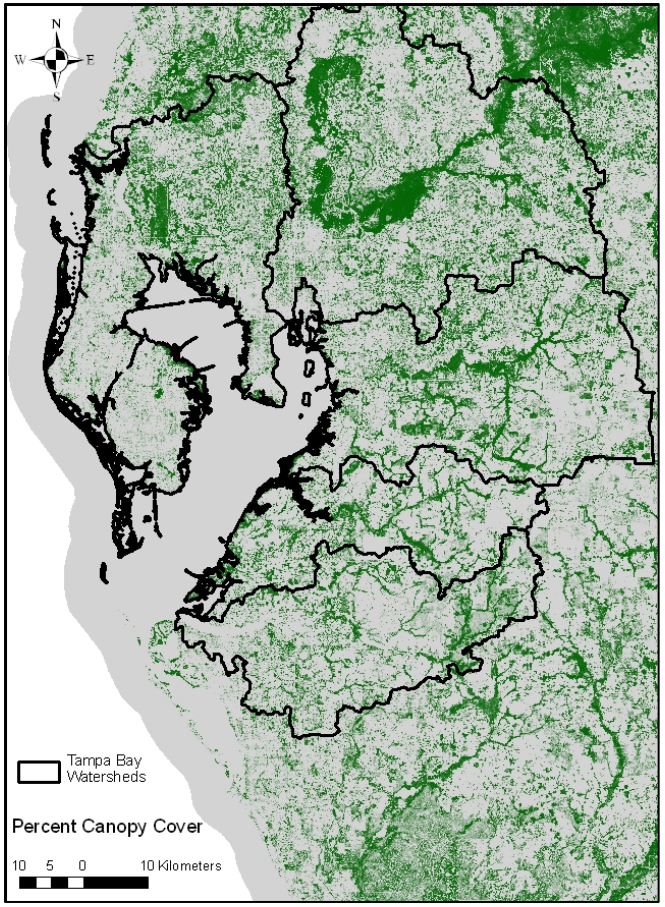
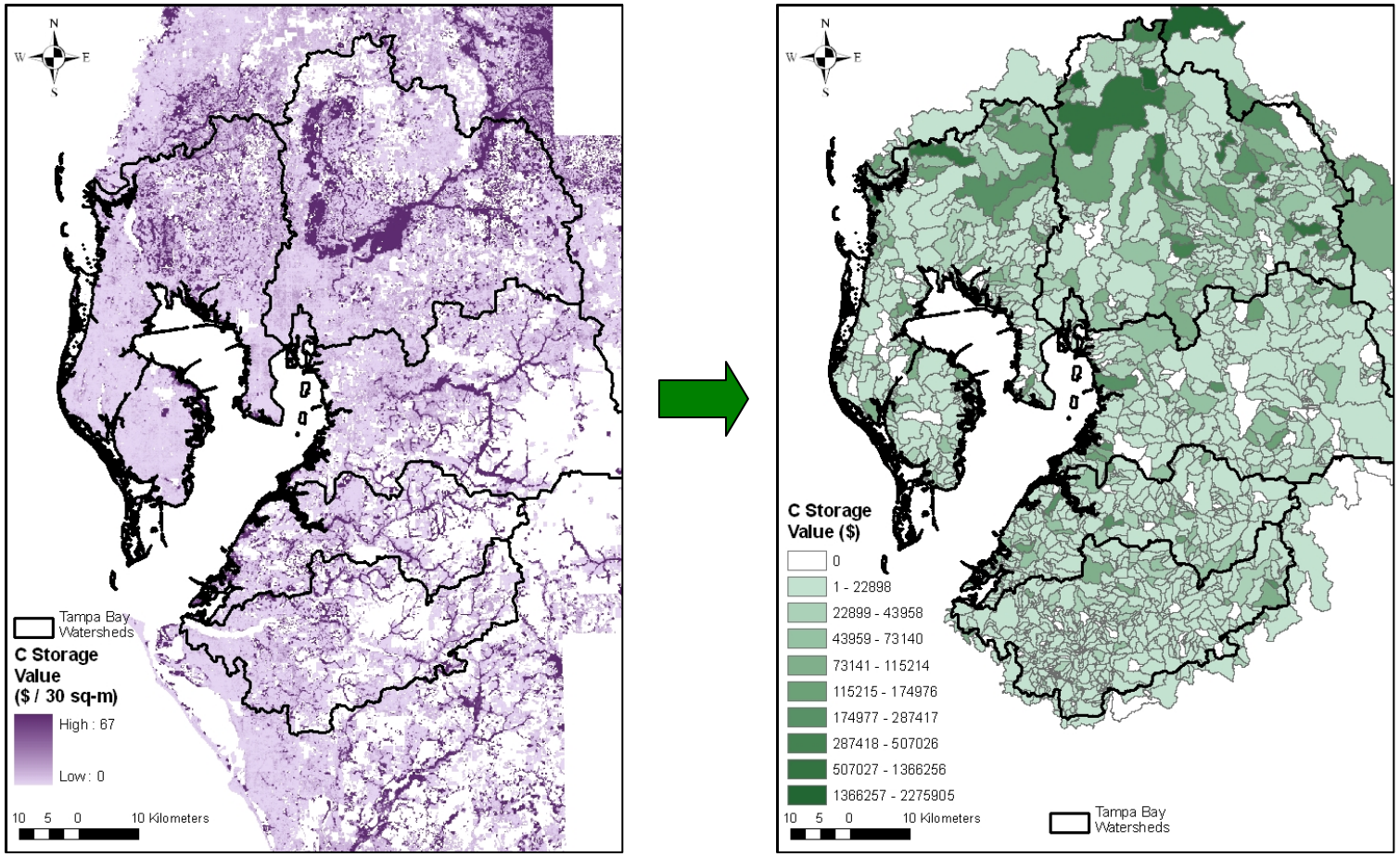
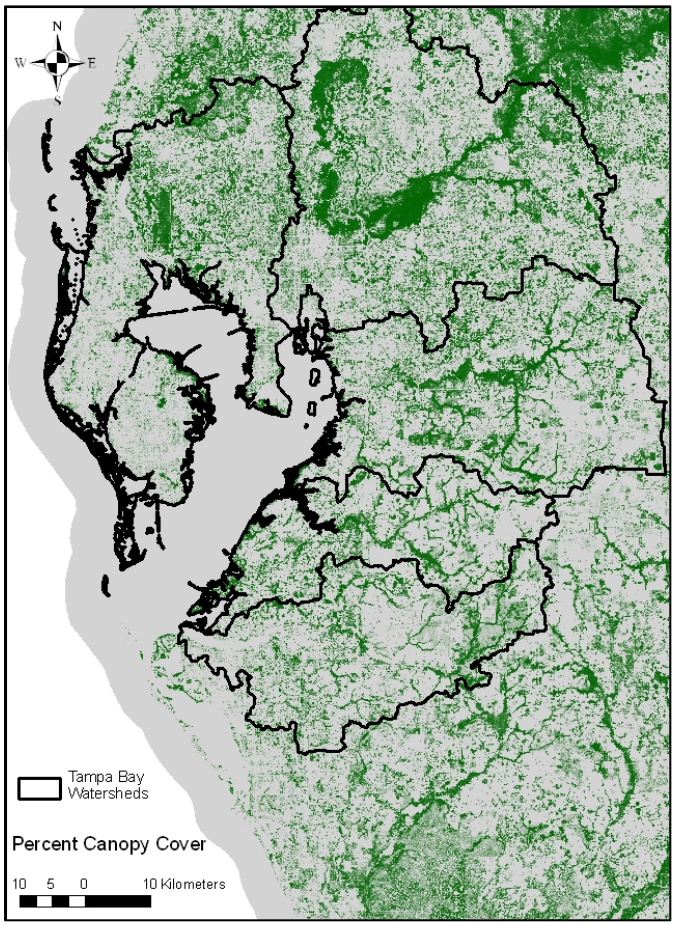


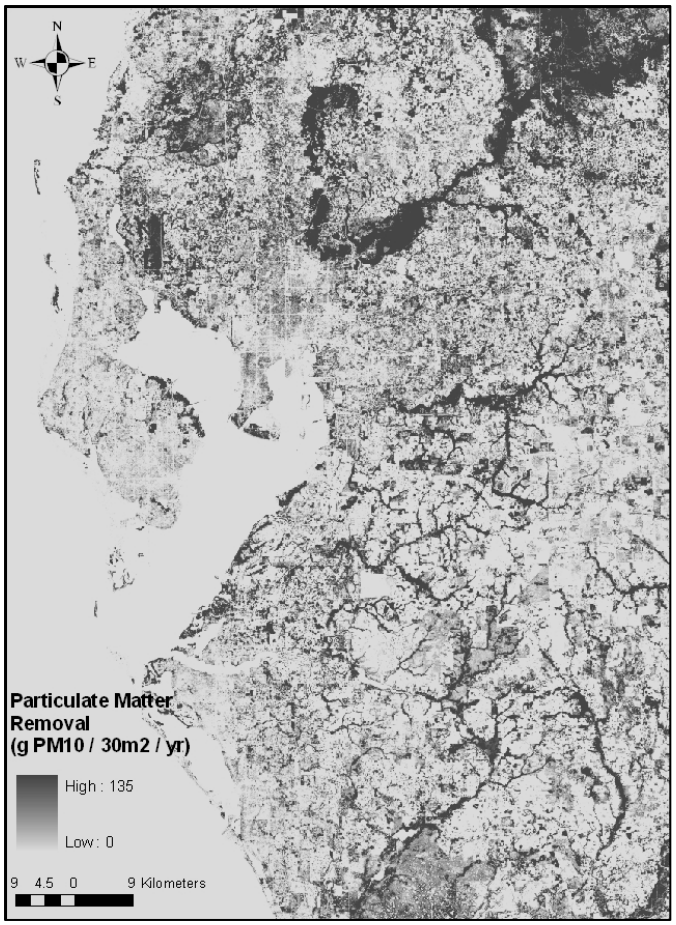
Reduce potential C storage using percent canopy cover



Apply value from Chicago Carbon Exchange ($15 / ton C) and apportion to NHD+ basins (Total = $1.8 billion)

Particulate Matter Removal



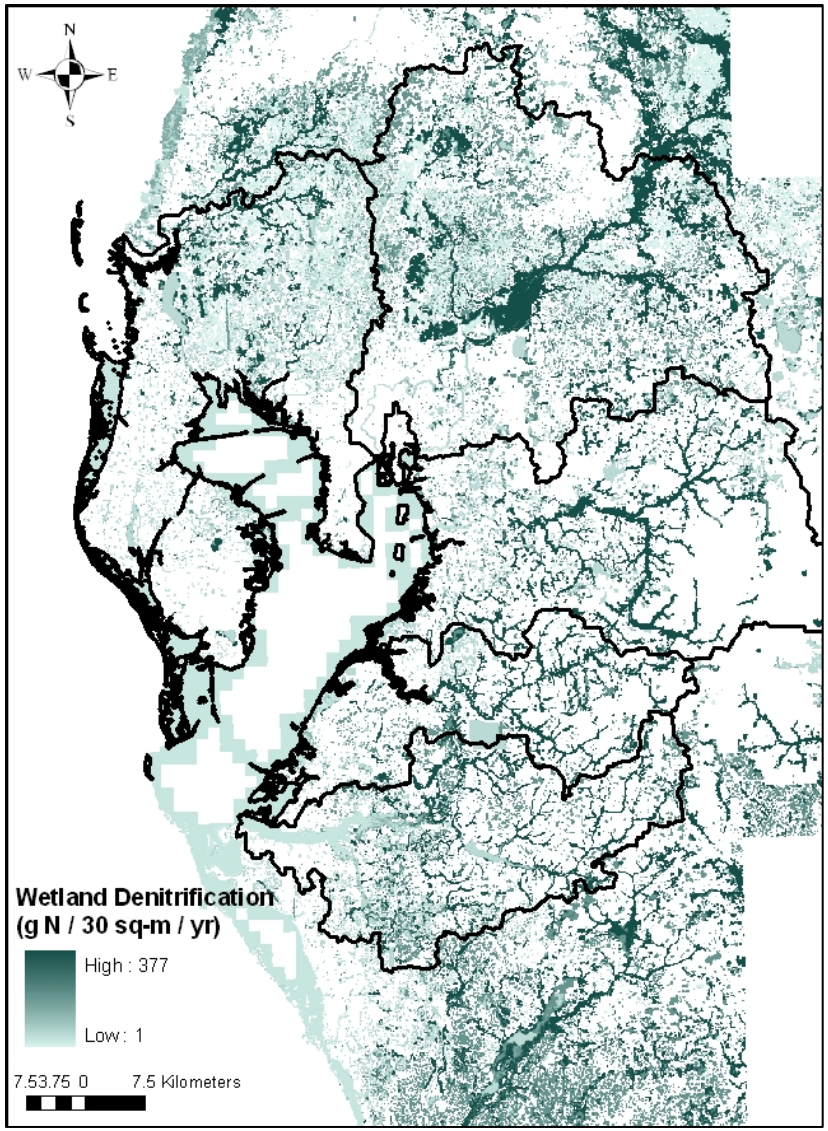


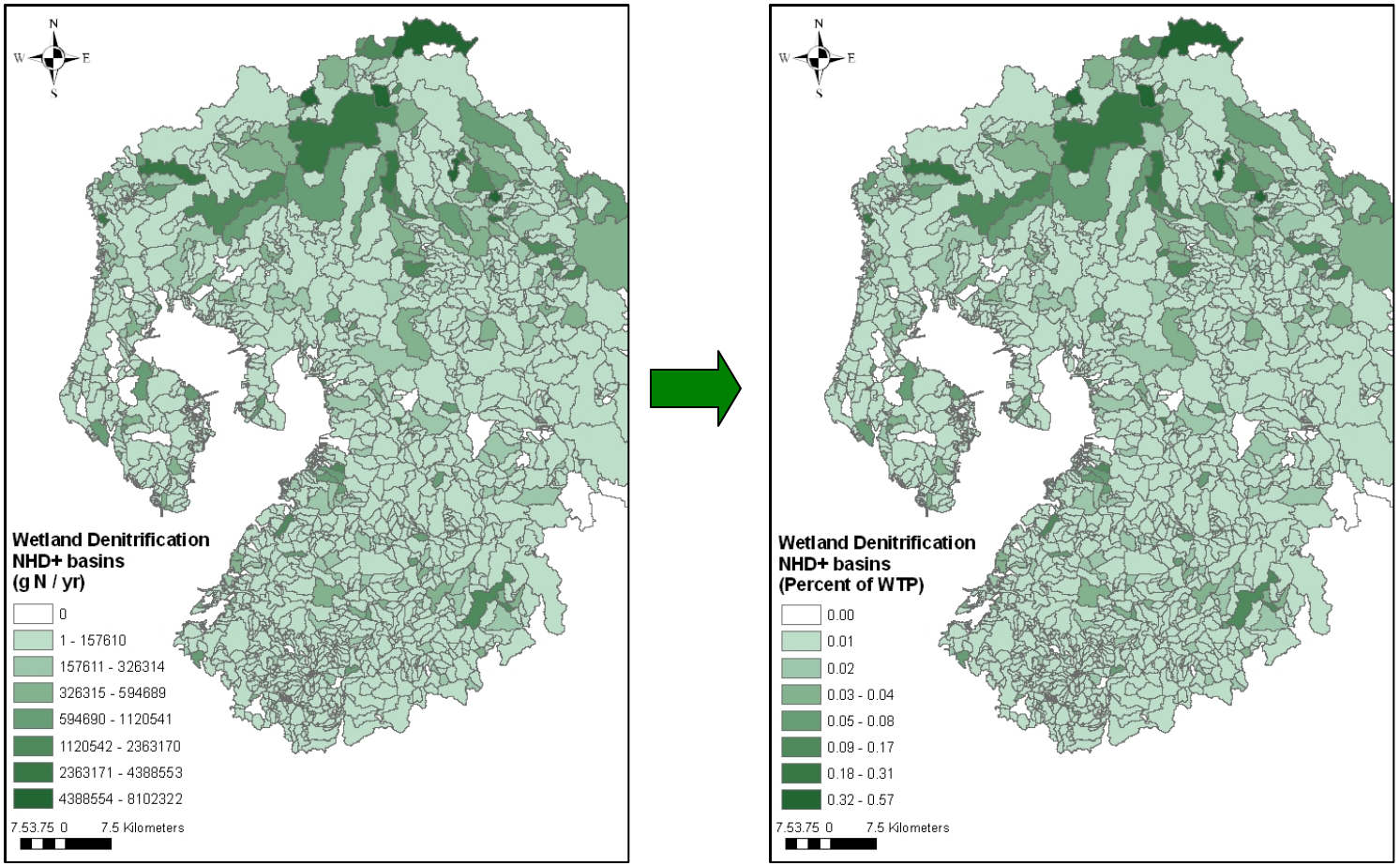
Improves human well-being: direct health benefit

Attainment of PM standards = $14-55 Billion worth of nationwide health benefits

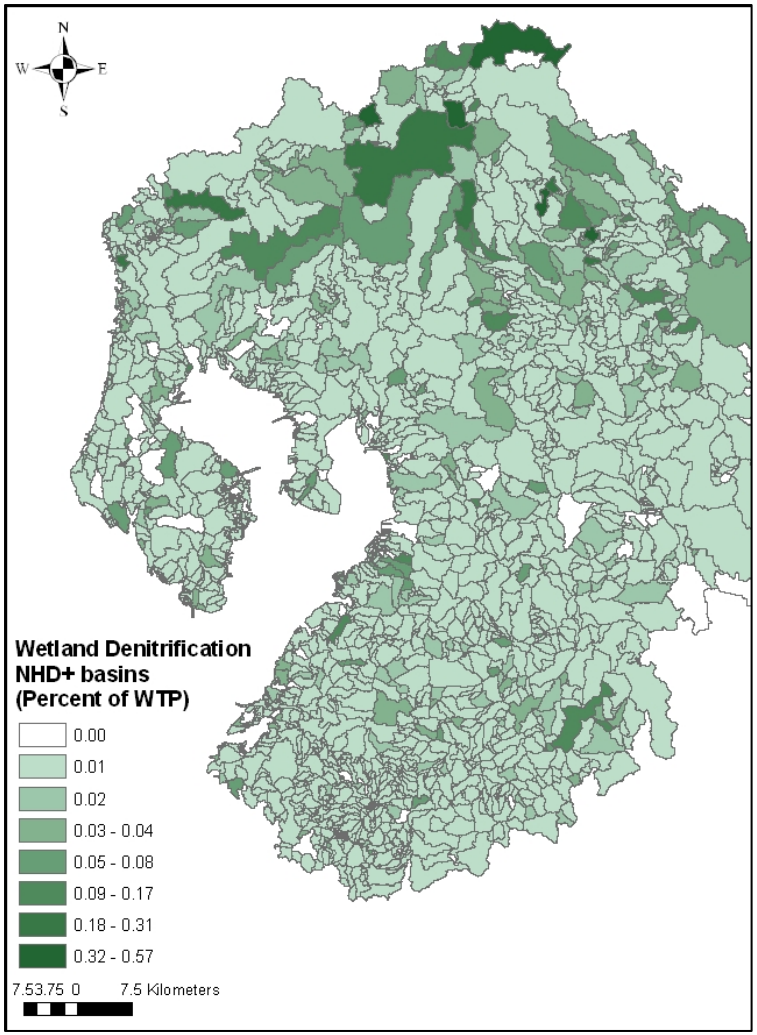
Denitrification

- Freshwater wetlands provide large potential for nitrogen removal.
- Mostly located upstream of urbanized areas near the coast.
- Future wetland losses may result in increased requirements for waste water treatment to maintain water quality criteria.



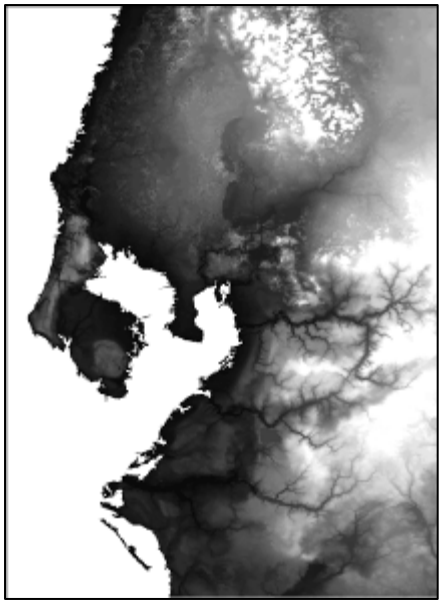


Hotspots of denitrification potential still exist in the Tampa Bay region, with some NHD basins providing more than half the removal capacity of an existing WTP.



NHD+ Denitrification

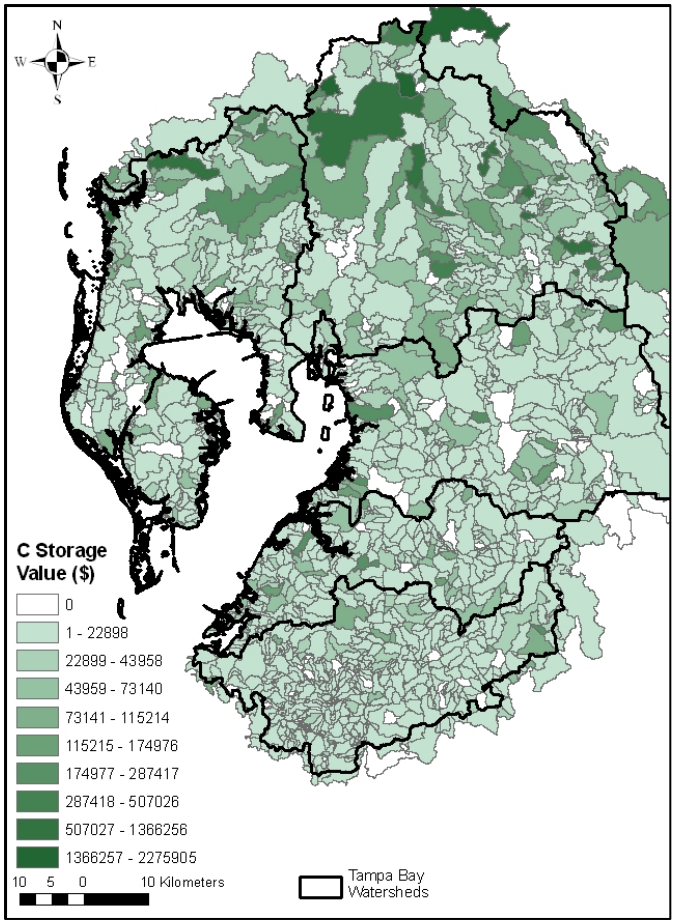
\+



Drainage Patterns

= Beneficiaries

Bundled Services Example



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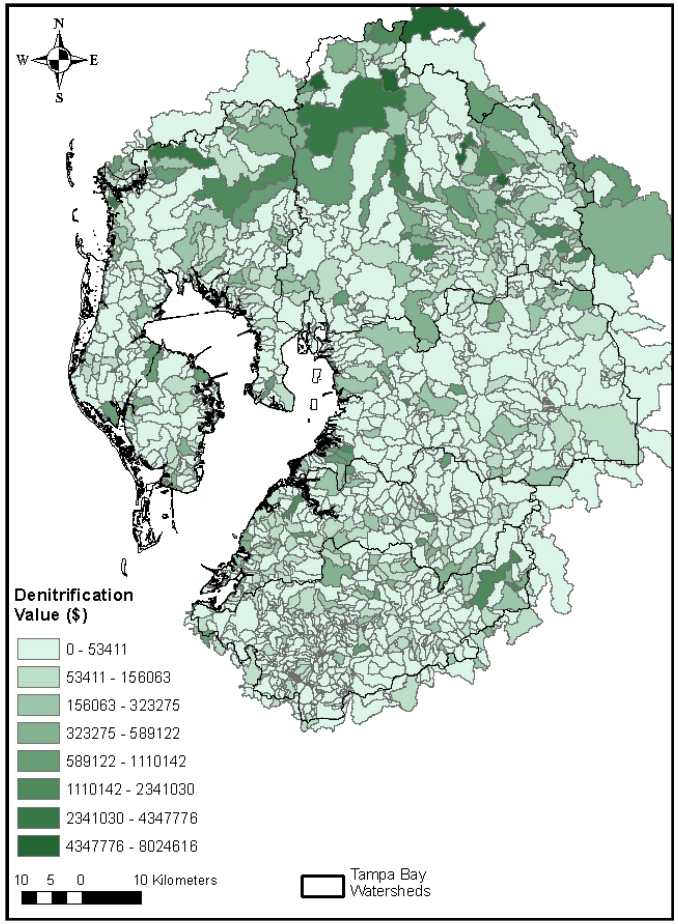
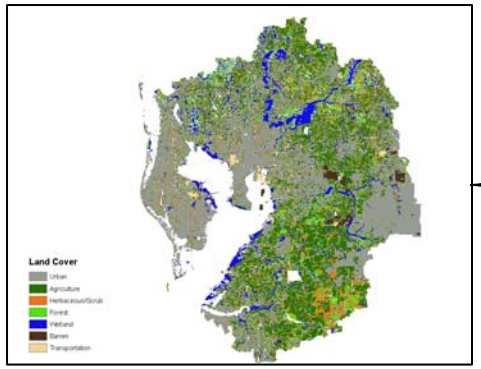
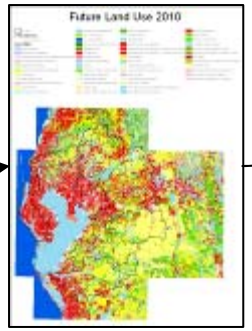


Scenarios – Land Cover/Use



2006

Modeled

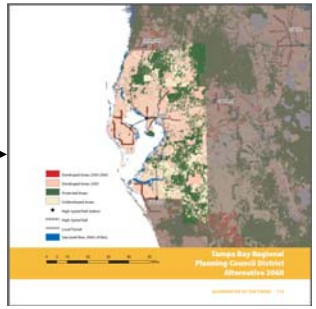


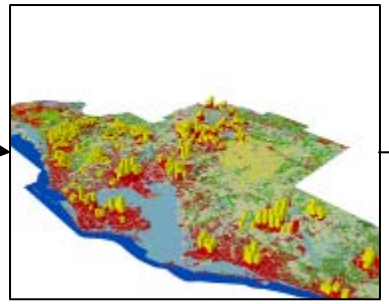
2010

2025

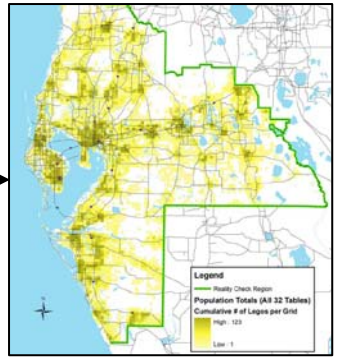
2060

Alternative

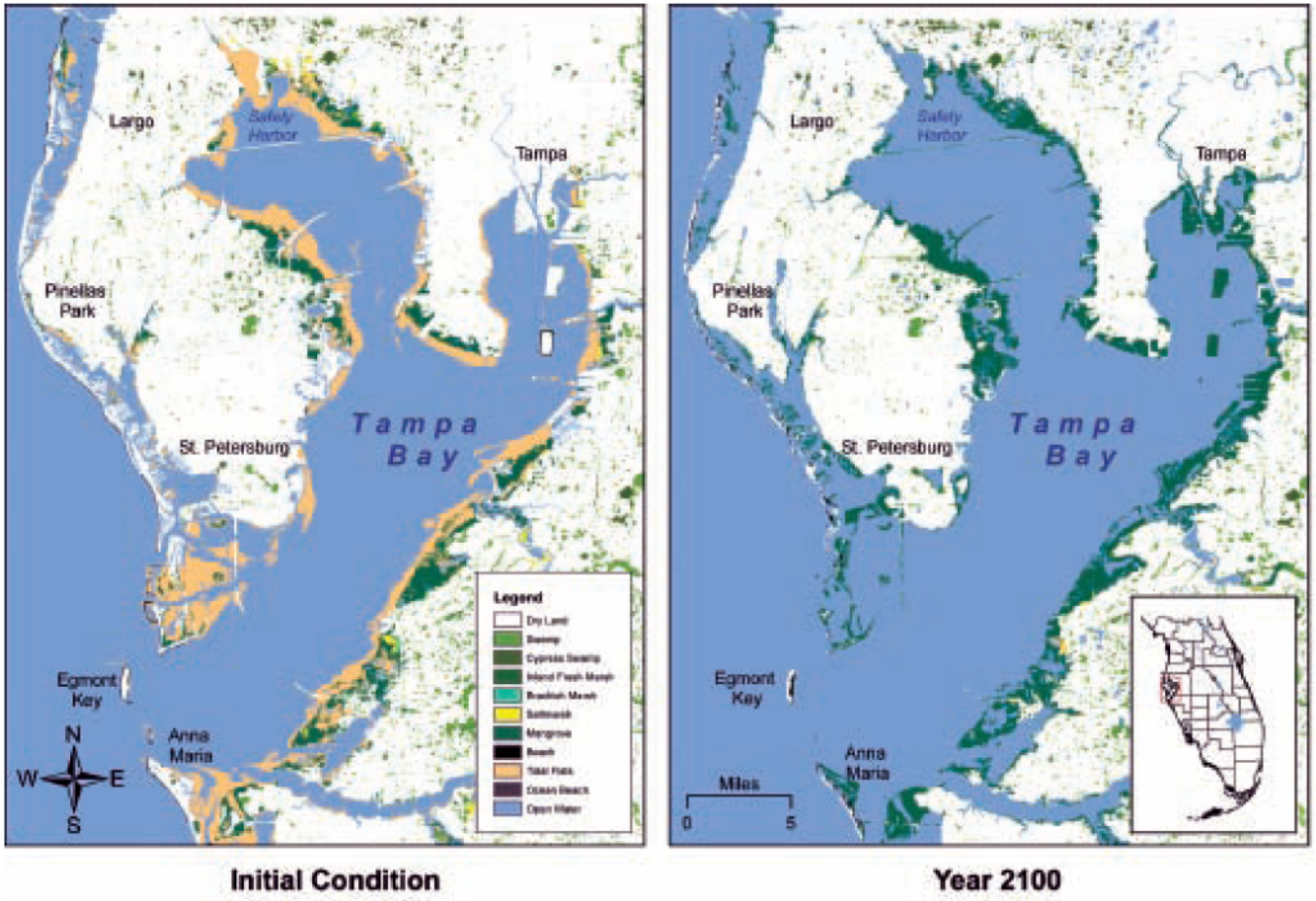




Public Process



2050



Projected Effects of 15-inch Sea-Level Rise

NWF Report 2006 “An Unfavorable Tide”

Questions?

Skyway bridge across bay

Hillsborough River Cypress

Downtown Tampa

Little Manatee River

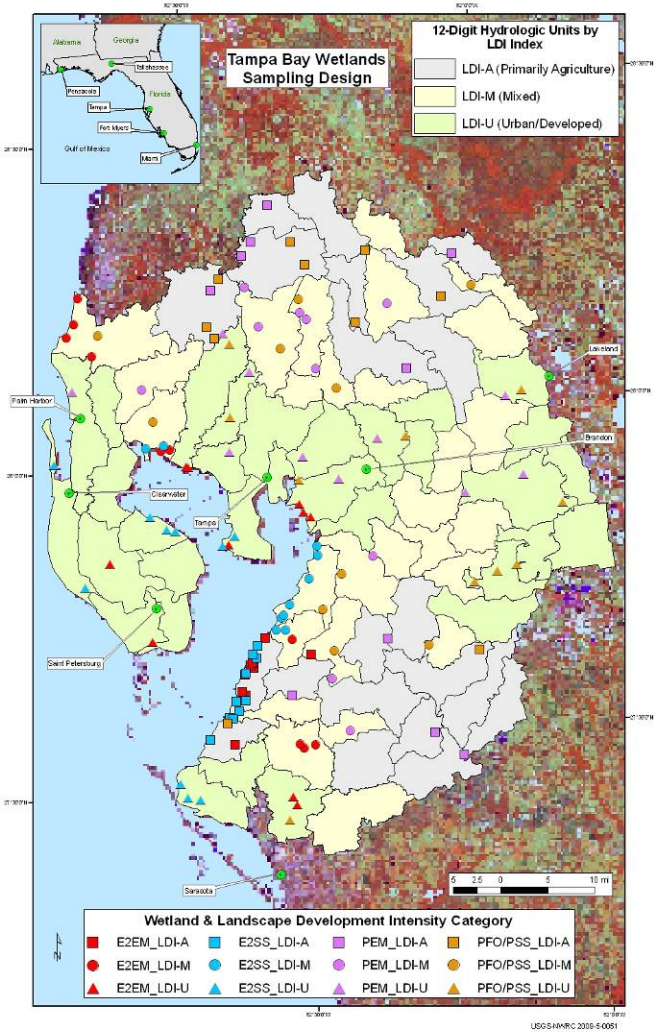
Alafia Banks Spoonbills

Knowledge gaps and research proposals.

1) USGS National Climate Change and Wildlife Science Center
   - Nitrogen removal process rates under stressor gradients.
     - Hydrology, redox potential of soils, and temperature
   - Habitat support for biodiversity/valued species.
2) Urban Long Term Research Area (ULTRA-EX) - NSF/USFS
   - Nitrogen removal in riparian and mangrove buffers under urban stressor gradients.
     - Impervious surface, nitrogen loading
   - Social behavior/values in managing private land riparian buffers.
3) Gulf of Mexico Alliance (GOMA)
   - Urban lawn N isotope tracking
   - Social behavior, fertilizer ordinances, and regional impacts
4) ESRP – Nitrogen
   - Coupled wetland rapid condition assessment methods with nitrogen removal rate measurements under stressor gradients.
     - Landscape Development Intensity index (LDI), nutrient loads
   - Ecosystem nitrogen connectivity (stable isotopes/hydrological modeling) from upland forest through wetlands and into seagrass beds.

Wetland Site Selection Database

- HUC12 sub-watersheds in the Tampa Bay watershed were mapped using the 2006 Florida Land Use, Land Cover Classification System (FLUCCS)
- 4 wetland classes (National Wetlands Inventory defined)
  - Estuarine emergent
  - Estuarine shrub-scrub
  - Palustrine emergent
  - Palustrine forested /shrub-scrub
- 3 landscape classes (Landscape Development Intensity index)
  - LDI < 3.5 = High agriculture land use
  - LDI 3.5 - 5 = Mixed land use
  - LDI > 5 = High urban / developed land use
- This stratified-random survey design provides 120 potential research sites



EPA's Future Midwestern Landscapes Study

Betsy Smith & Randy Bruins
Study Co-Leaders
Office of Research and Development
SAB Consultation, July 14, 2009

Photo: Iowa Pathways, Iowa Public Television

Study Contributors

- **Office of Research and Development**
  - Rob Wolcott
  - *National Exposure Research Laboratory*
    - Randy Bruins, Betsy Smith (Co-leaders)
    - Megan Mehaffey, Alex Macpherson, Ellen Cooter, Yongping Yuan, Jay Christensen, Charles Lane, Ken Fritz, Vasu Kilaru
  - *National Risk Management Research Laboratory*
    - Tim Johnson, Rebecca Dodder, Ozge Kaplan, Curtis Cooper
  - *National Health and Environmental Effects Research Laboratory*
    - Russell Kreis
- **Region 7 (Kansas City)**
  - Brenda Groskinsky, Walt Foster
- **Region 5 (Chicago)**
  - Mary White, Carole Braverman
- **Office of Policy, Economics and Innovation**
  - Andrew Manale

Outside Partners to date

- **Experts (Special EPA Employees)**
  - Lisa Wainger, U. of Maryland
  - Liem Tran, U. of Tennessee
  - Peter Woodbury, Cornell U.
- **Iowa State University/CARD**
  - Silvia Secchi (now at SIU-C)
  - Amani Elobeid
  - Simla Tokgoz
- **USDA Farm Service Agency**
  - Richard Iovanna

Presentation Outline

- Design decisions governing study structure and approach
  - Spatial & temporal scales, boundaries
  - Modeling approach
  - Future scenarios
  - Ecosystem services
- Progress to date
  - Efforts completed
  - Methodological issues addressed
  - Partnerships established
- Current efforts and challenges

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  - Partnerships established
- Current efforts and challenges

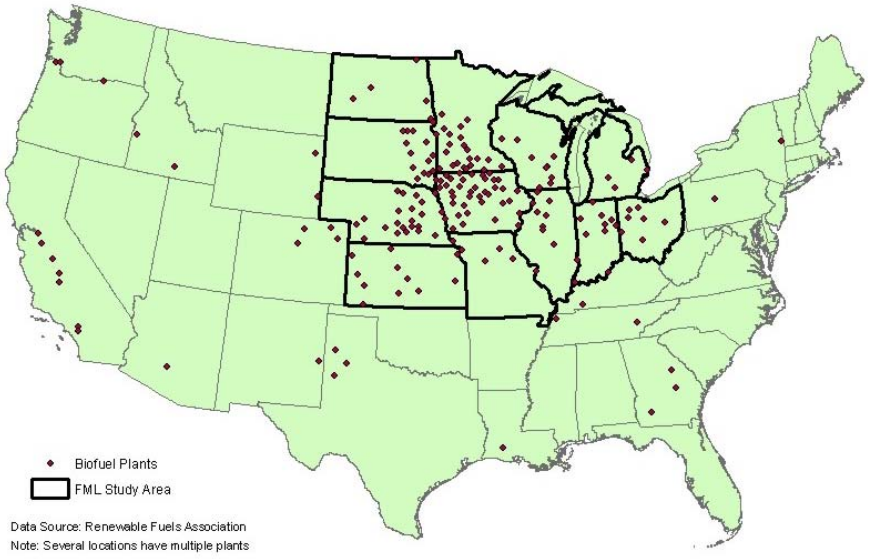
Decision-makers' needs

- How will today's land use decisions affect **trade-offs** of future ecosystem services?
- What land-use configurations afford the **best combinations** of ecosystem services?
- What **indicators** of ecosystem service changes communicate the vulnerabilities and opportunities?
- How can we **facilitate** conservation and restoration of ecosystem services?

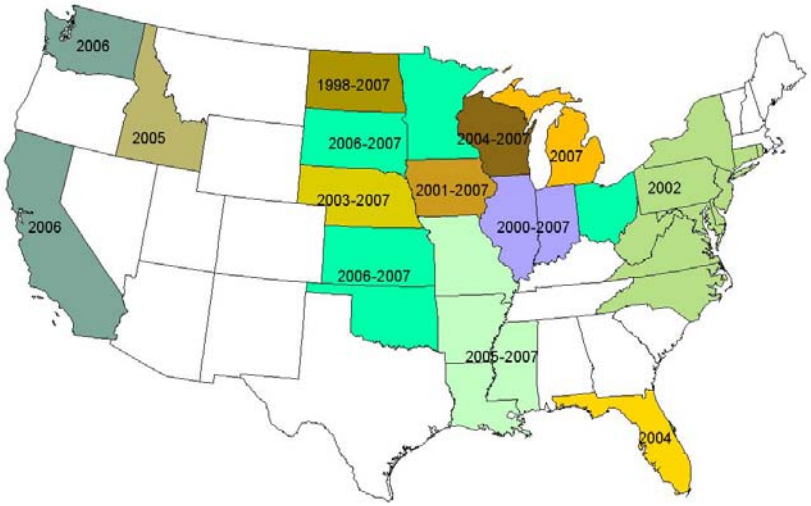
Change drivers of interest for Midwestern place-based study

- Biofuels
  - Potential for rapid, large-scale changes in land use or land management
  - Implicit trade-offs among ecosystem services
- Agricultural conservation practices
  - Existing area of large investment, uncertain benefit
  - Increasing interest in ecosystem service-based incentives and markets

FML Study Boundary

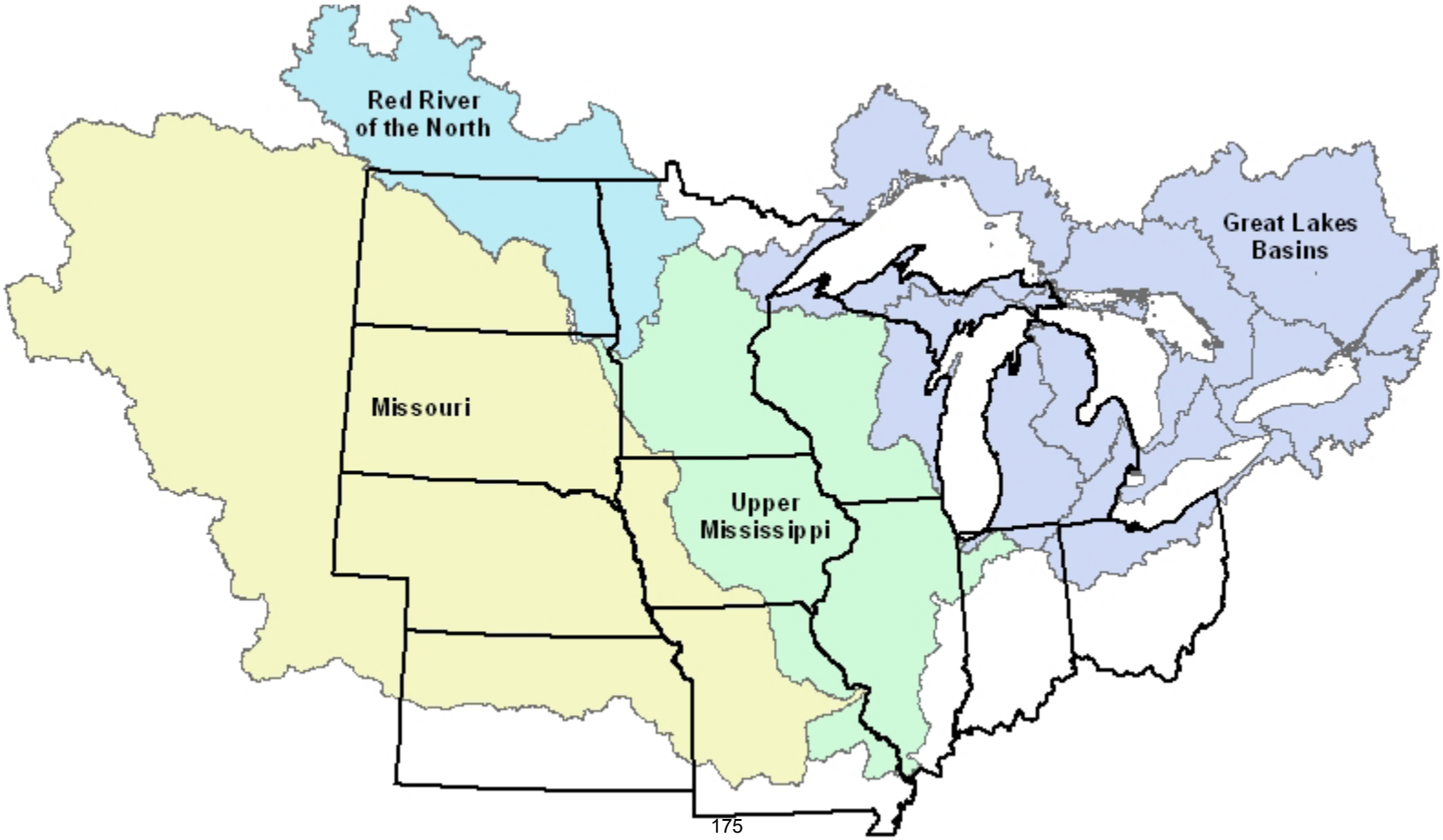


showing ethanol biorefineries



NASS Cropland Data Layers

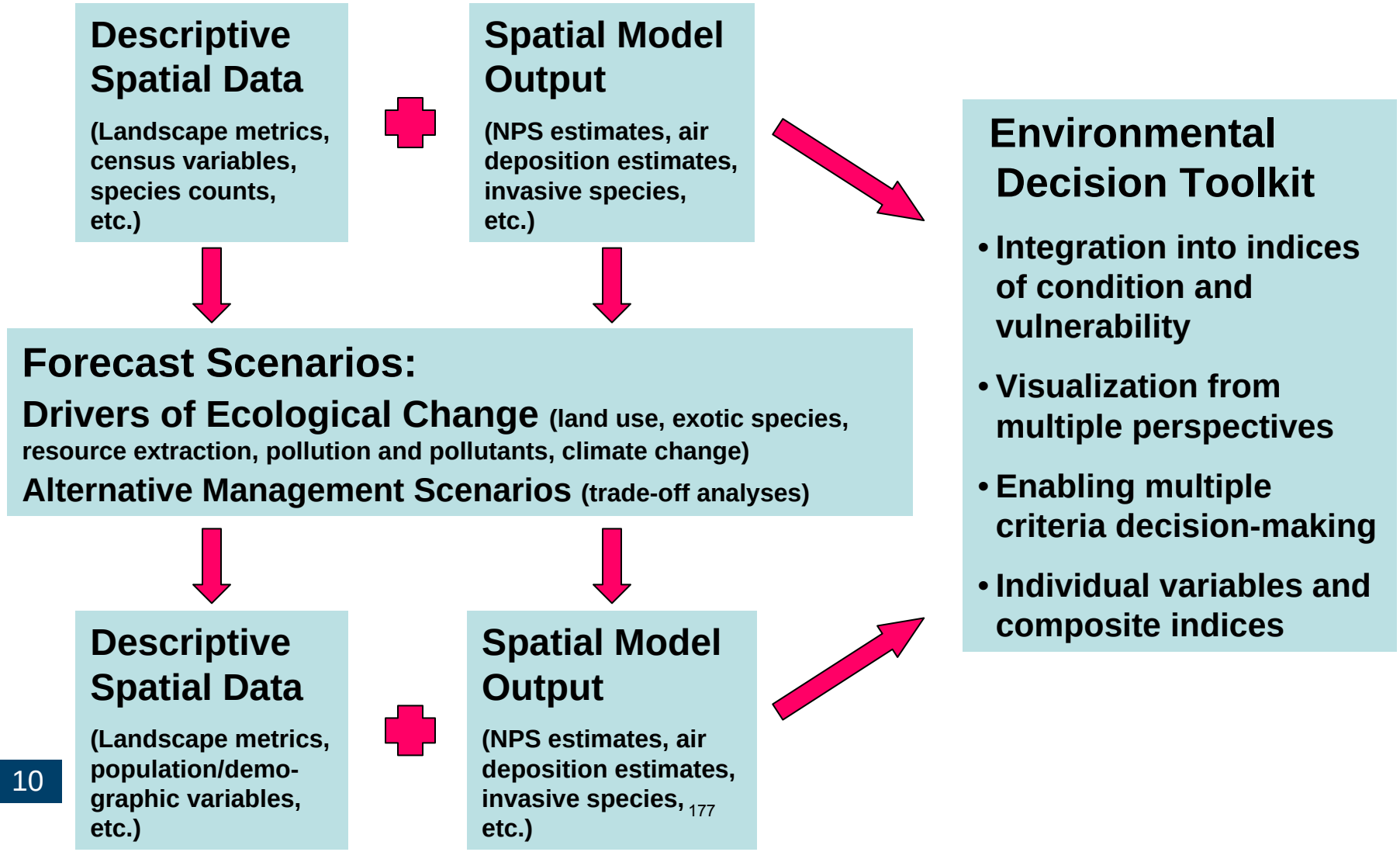
FML Study Area and Major Drainage Basins



Modeling approach options
(given unique spatial scale of FML Study)

- Unified simulation environment (implies use of generalized, representative landscapes)
- Realistic, detailed landscapes (implies coupling of existing models)
  - Disadvantages
    - cobbled modeling system, hard to build and run
    - hard to characterize sensitivity across whole system
    - limited to examining few scenarios
  - Advantages
    - decision-makers relate well to actual landscapes
    - decision-makers may be familiar with models
    - models (individually) have been validated
    - EPA success using a detailed landscape approach , Regional Vulnerability Assessment (ReVA), to inform at large scales

Regional Vulnerability Assessment (ReVA) Process



Uses of ReVA's EDT to support environmental decisions

- EPA Region 3 used EDT to **prioritize watershed projects**
- Charlotte, NC area planners used EDT to compare watershed impacts of **alternative regional development approaches**
- EPA air regulators are using EDT as framework for studying the **vulnerability of human populations and ecological systems** in the Southeast to toxic air pollutants from multiple sources.
- Great Lakes National Program Office used for **state-of-the-lakes reporting**, and to **prioritize efforts to reduce impacts** to lakes

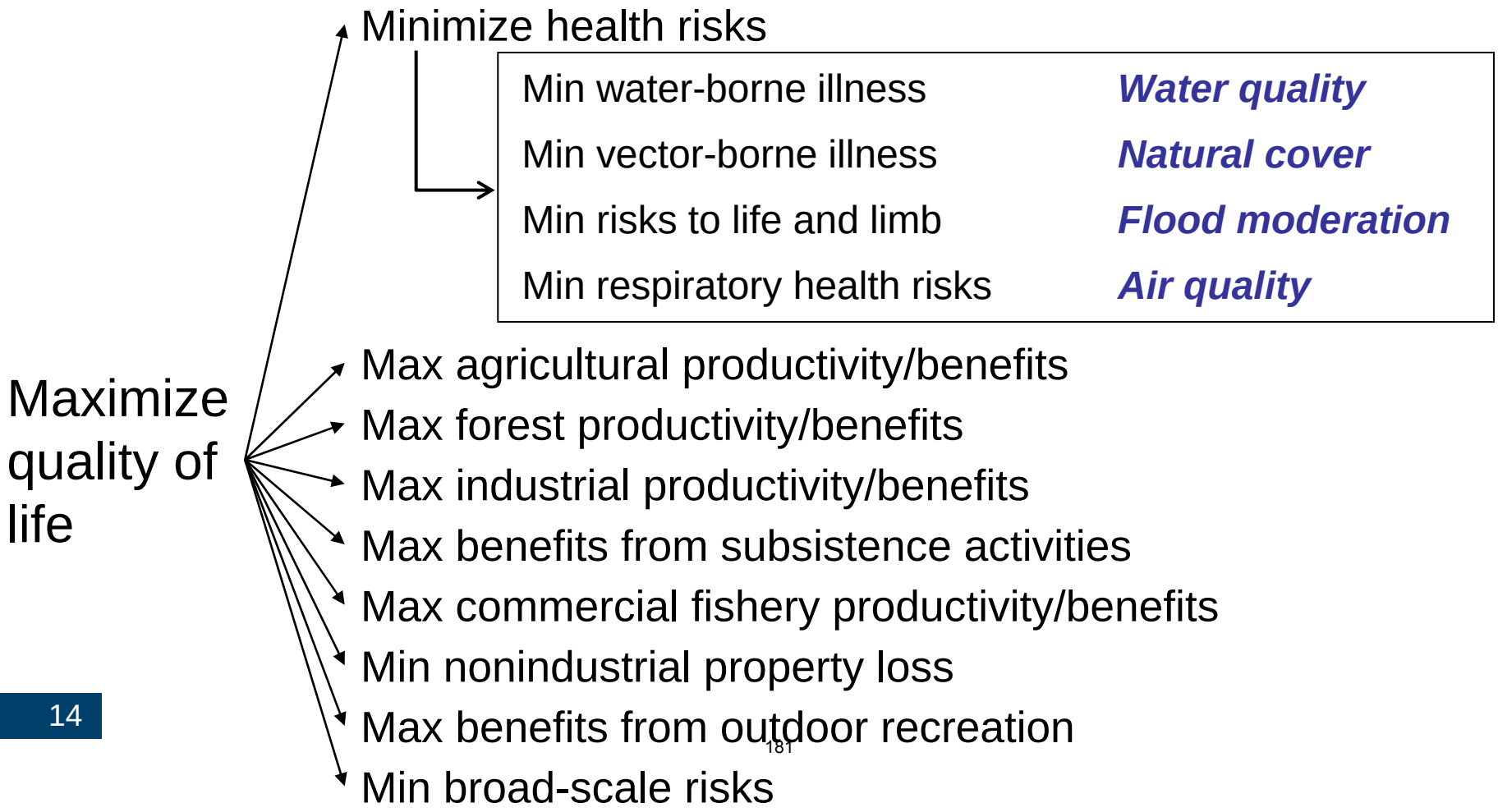
Decision: Use ReVA approach

- Combine existing data sets to produce detailed Base Year (BY) landscape …
  - Land uses, crop rotations and land management practices existing in 2001
- Economic modeling approaches to project landscapes ...
  - expected in 2022, given current biofuel incentives
    - Biofuel Targets (BT) Landscape
  - expected in 2022, absent US biofuel incentives, and given a hypothetical Multiple Services Incentive Program
    - Multiple Services (MS) Landscape

Decision: Use ReVA approach

- Apply/adapt existing models of…
  - Air emissions, air quality and deposition
  - Hydrology, water quality and aquatic biota
  - Wildlife habitat suitability
- Involve decision-makers in development of an on-line Environmental Decision Toolkit (FML-EDT)

Hierarchy of objectives and ***services***

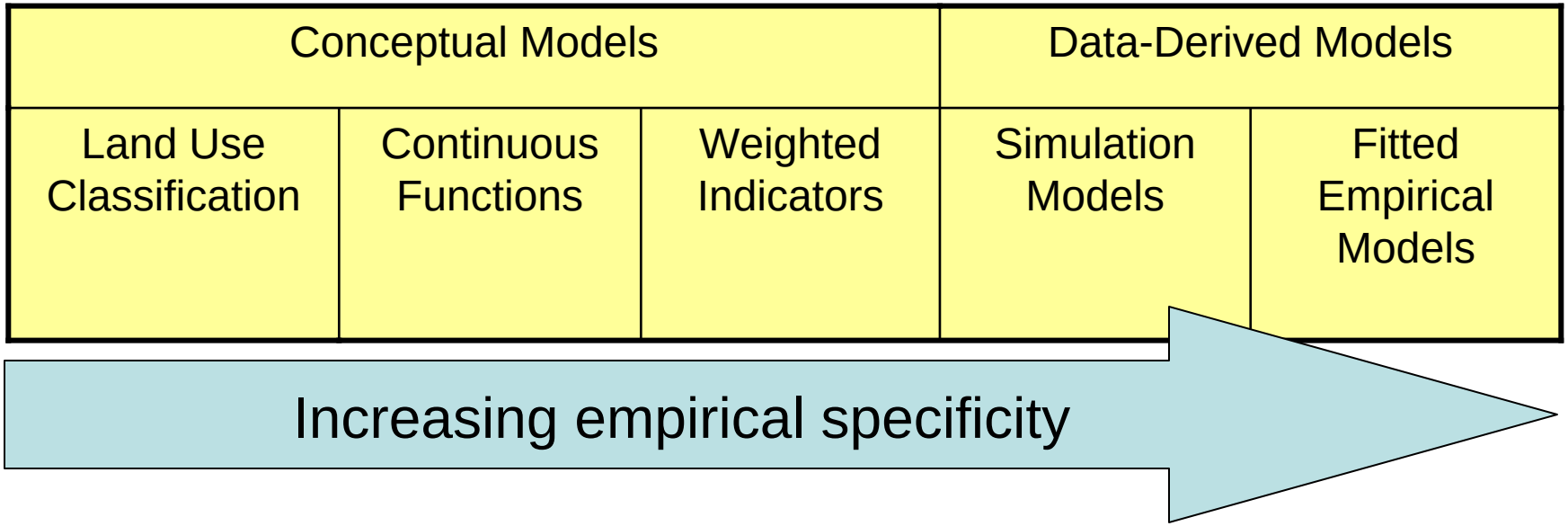


Services of interest in FML Study
(as defined within objectives hierarchy)

- ***Natural cover***
- ***Managed forest cover***
- ***Agricultural cover***
- ***Landscape heterogeneity***
- ***Soil quality***
- ***Carbon storage***
- ***Surface water storage***
- ***Groundwater storage***
- ***Flood moderation***
- ***Water quality***
- ***Biodiversity***
- ***Air quality***
- ***Food production***
- ***Biofuel feedstock production***

Production Function Methods Continuum

Lisa Wainger

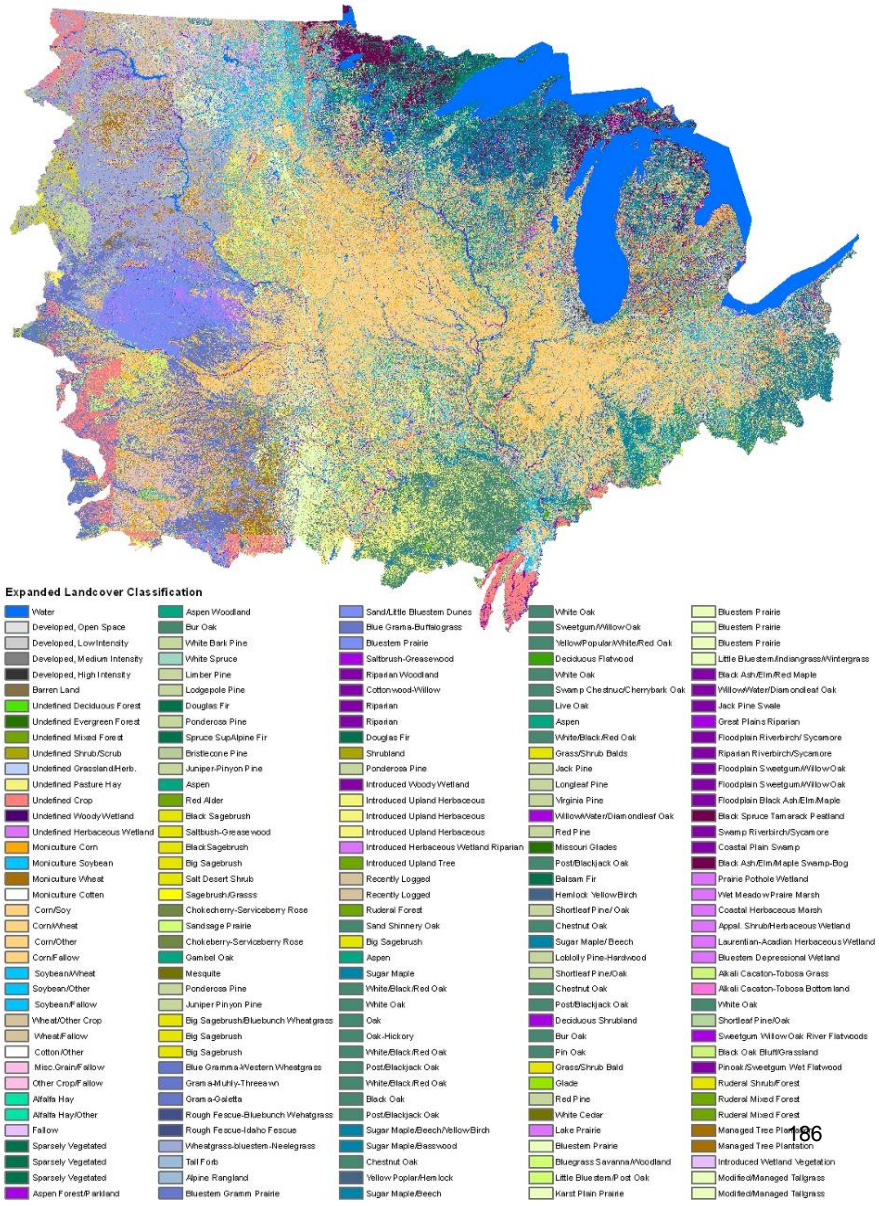


Presentation Outline

- Design decisions governing study structure and approach
  - Spatial & temporal scales, boundaries
  - Modeling approach
  - Future scenarios
  - Ecosystem services
- Progress to date
  - Efforts completed
  - Methodological issues addressed
  - Partnerships established
- Current efforts and challenges

Efforts completed

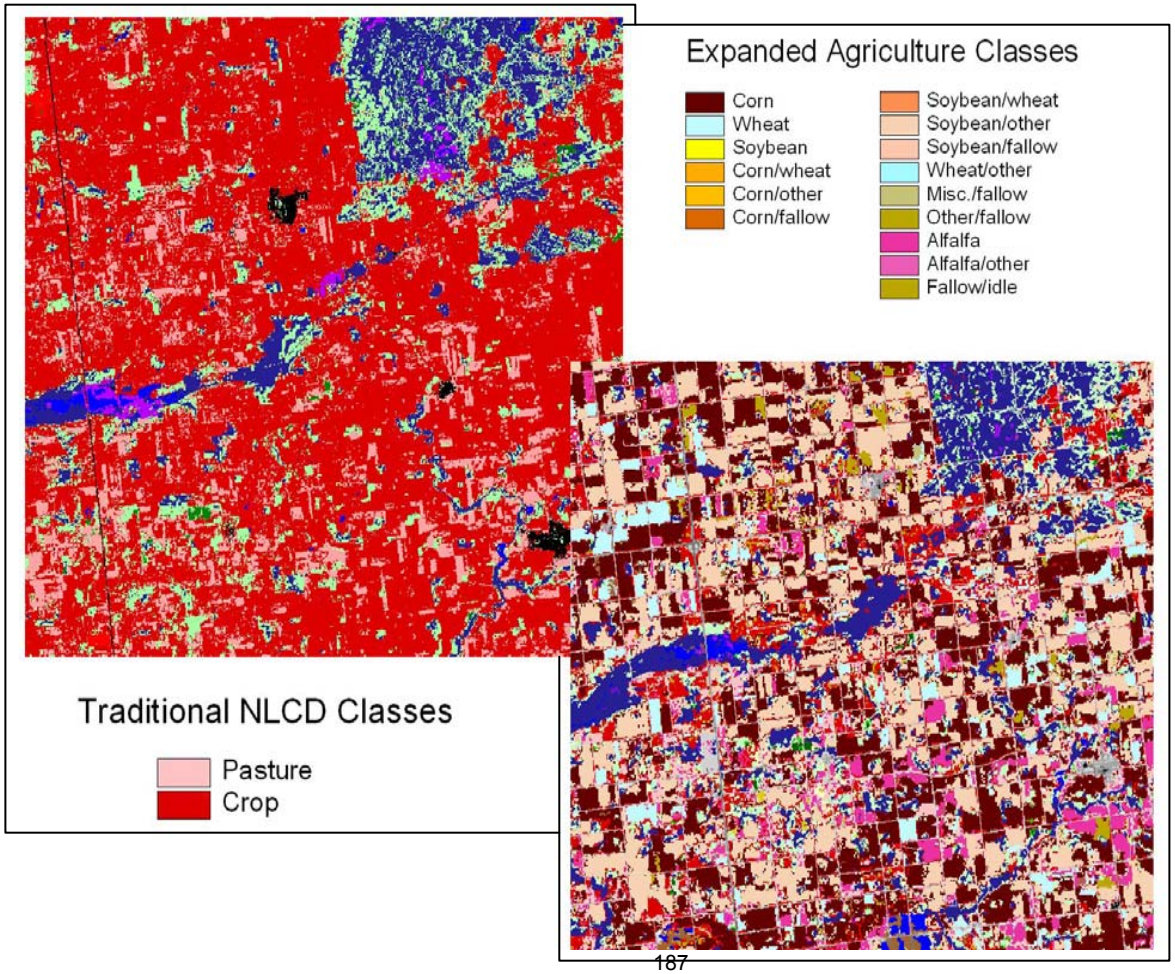
- Region 7 stakeholder workshop (Nov. 2007, Ames, Iowa)
- Pilot workshop for scientist and decision-maker values elicitation (Mar. 2009, RTP, NC)
- Base Year (2001) landscape coverage
- Biofuel Targets (2022) landscape coverage
- FML Environmental Decision Toolkit prototype online



FML Base Year Landscape

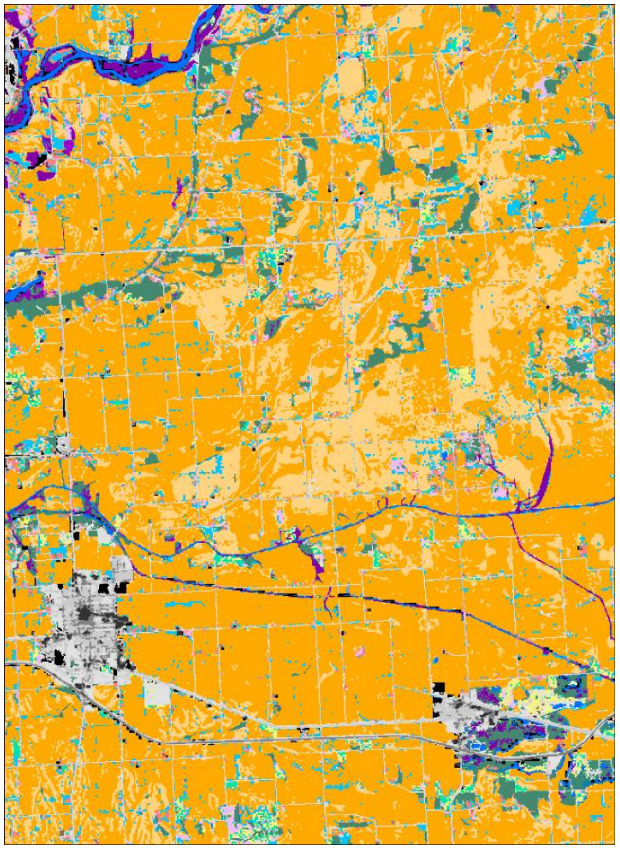
- Enhanced Land Cover Data for FML– Combines the best of NLCD, NASS Crop Data Layer, and LANDFIRE using a set of rules
- Includes crop type as well as rotation
- Implications for better estimation of nutrients and pesticides loads/export
- Better assessment of crop yields

Comparison of Traditional and Expanded NLCD Agriculture Classes for FML Base Year Landscape – Enhanced NLCD 2001/2002

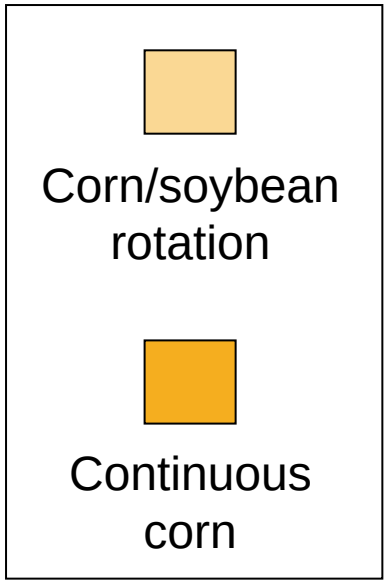


Detail comparison of Base Year (2001) and Biofuel Targets (2022) landscapes

Baseyear (2001)

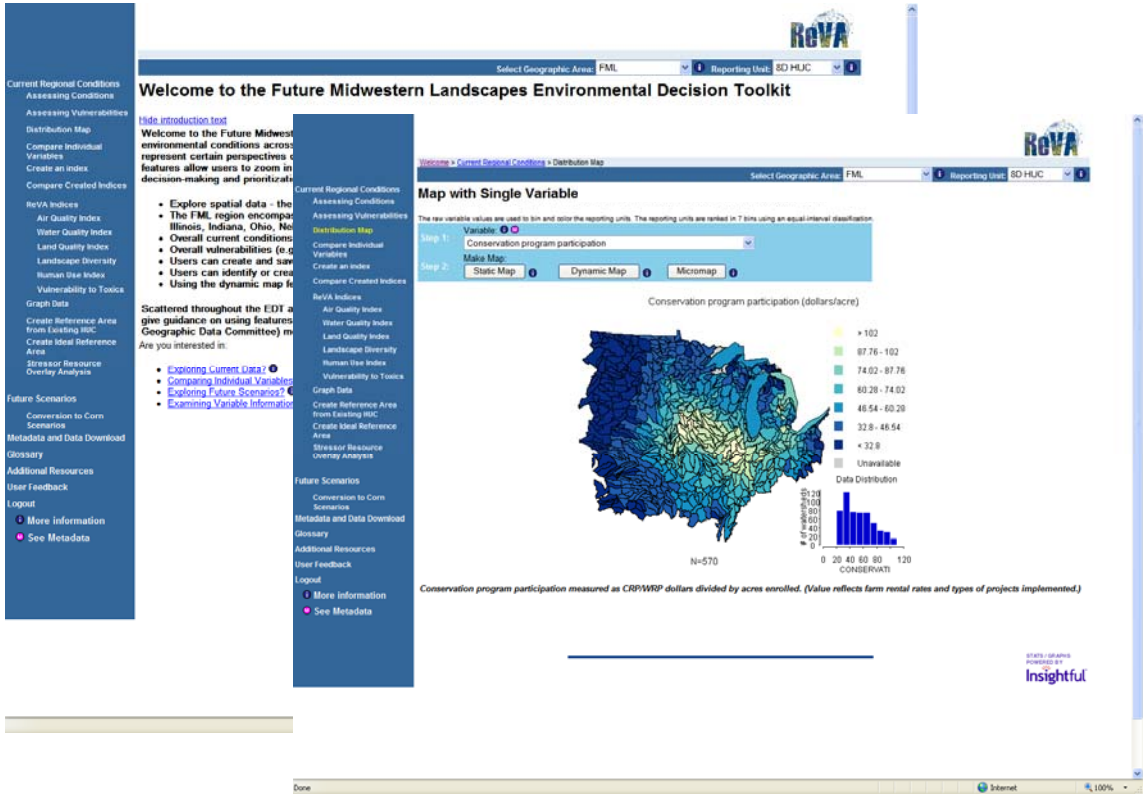


"Biofuel targets" (2022)



Detail for Corn Belt area in Illinois

The Future Midwestern Landscapes Environmental Decision Toolkit (FML-EDT)



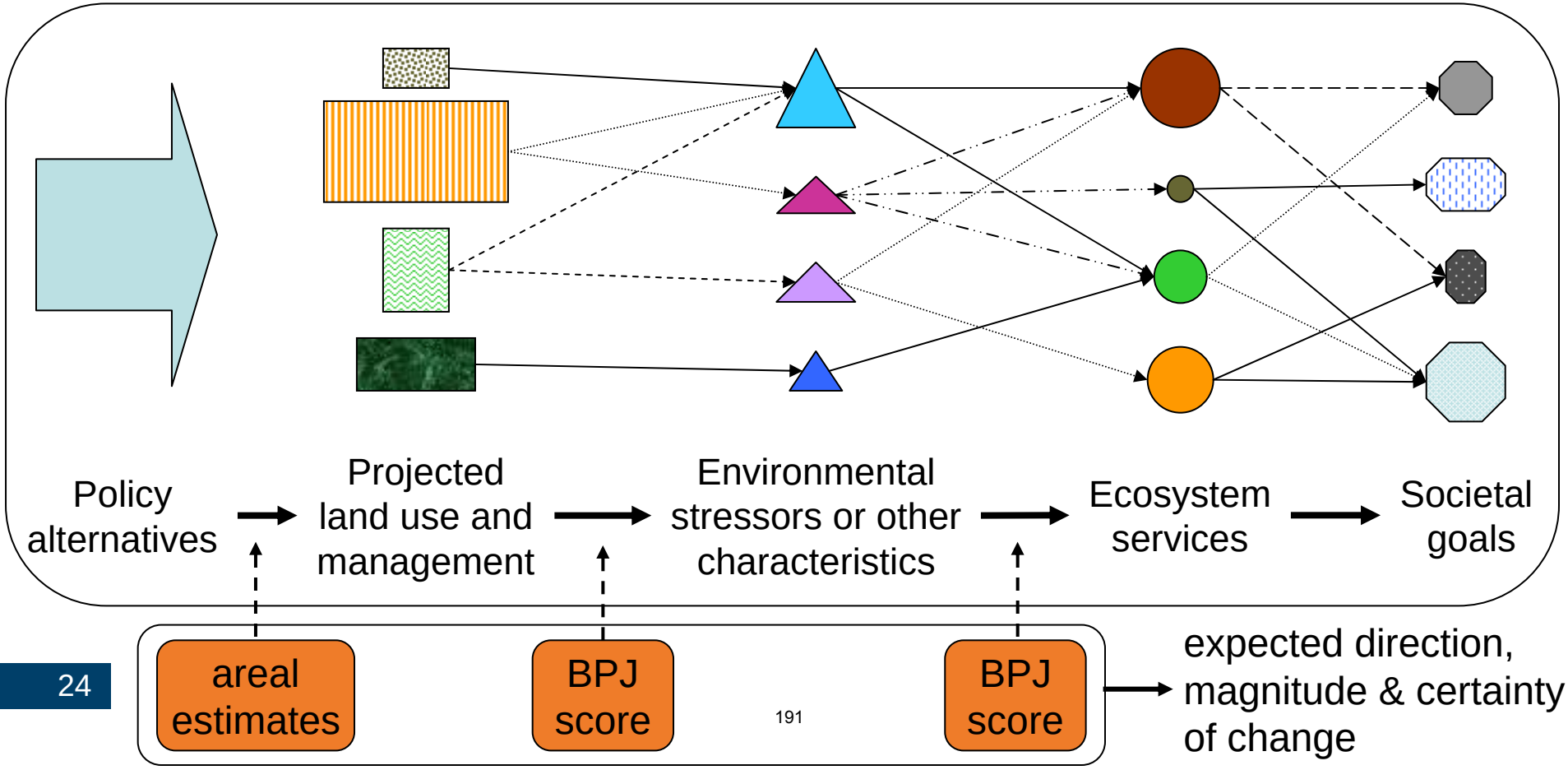
- **Prototype system currently on-line**
- **Landscape statistics from Base Year and Biofuel Targets scenarios now being summarized for inclusion**

http://www.waratah.com/fmledt revaguest/anonymous

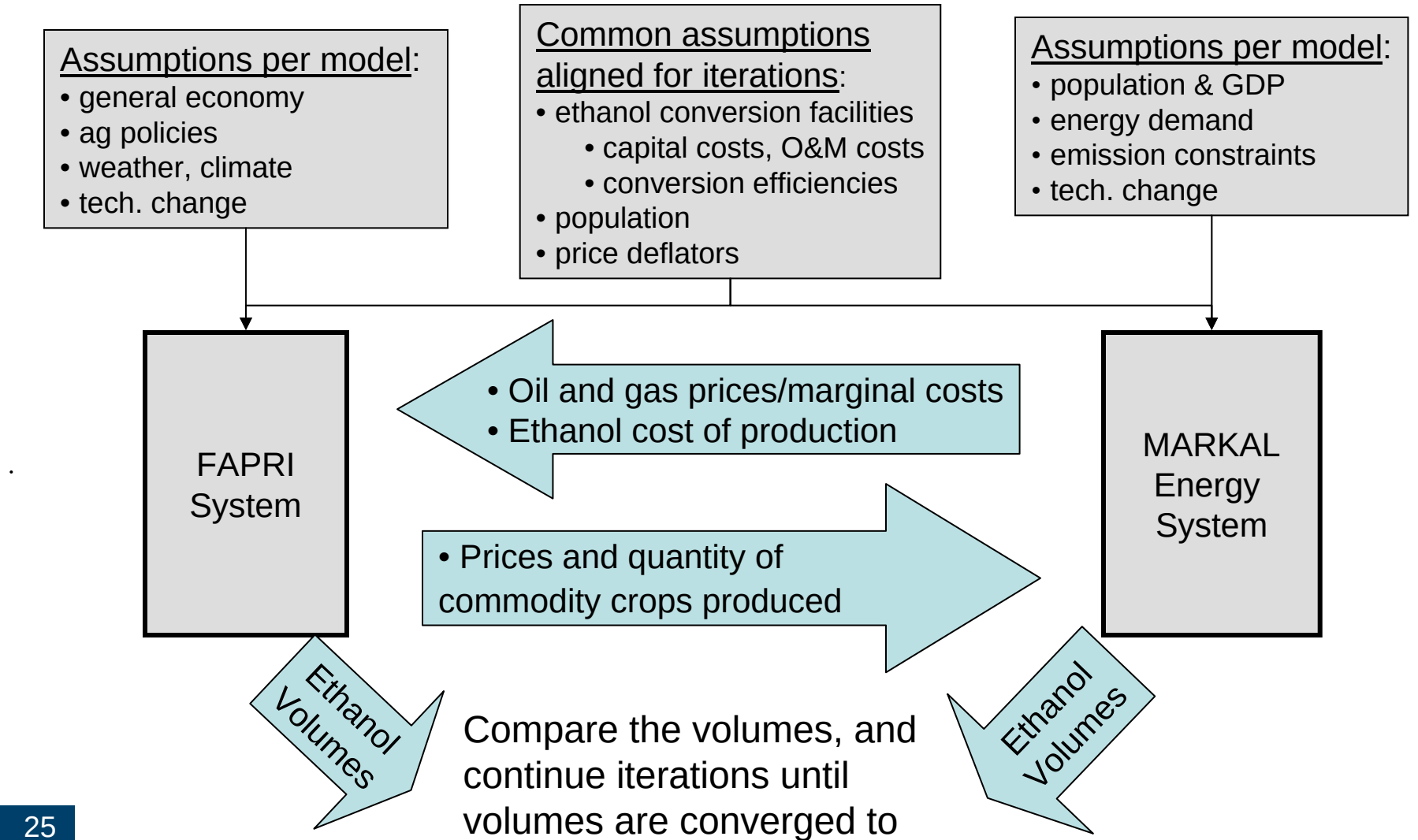
Methodological Progress (*partners*)

- Scoping analysis (*in-house*)
- Coupled analysis of US agricultural and energy systems (*Iowa State/CARD*)
- "Multiple Services" landscape design (*USDA Farm Service Agency*)
- Air quality response to land use & land cover change (*in-house*)
- Two-tier watershed modeling approach (*partners TBD*)

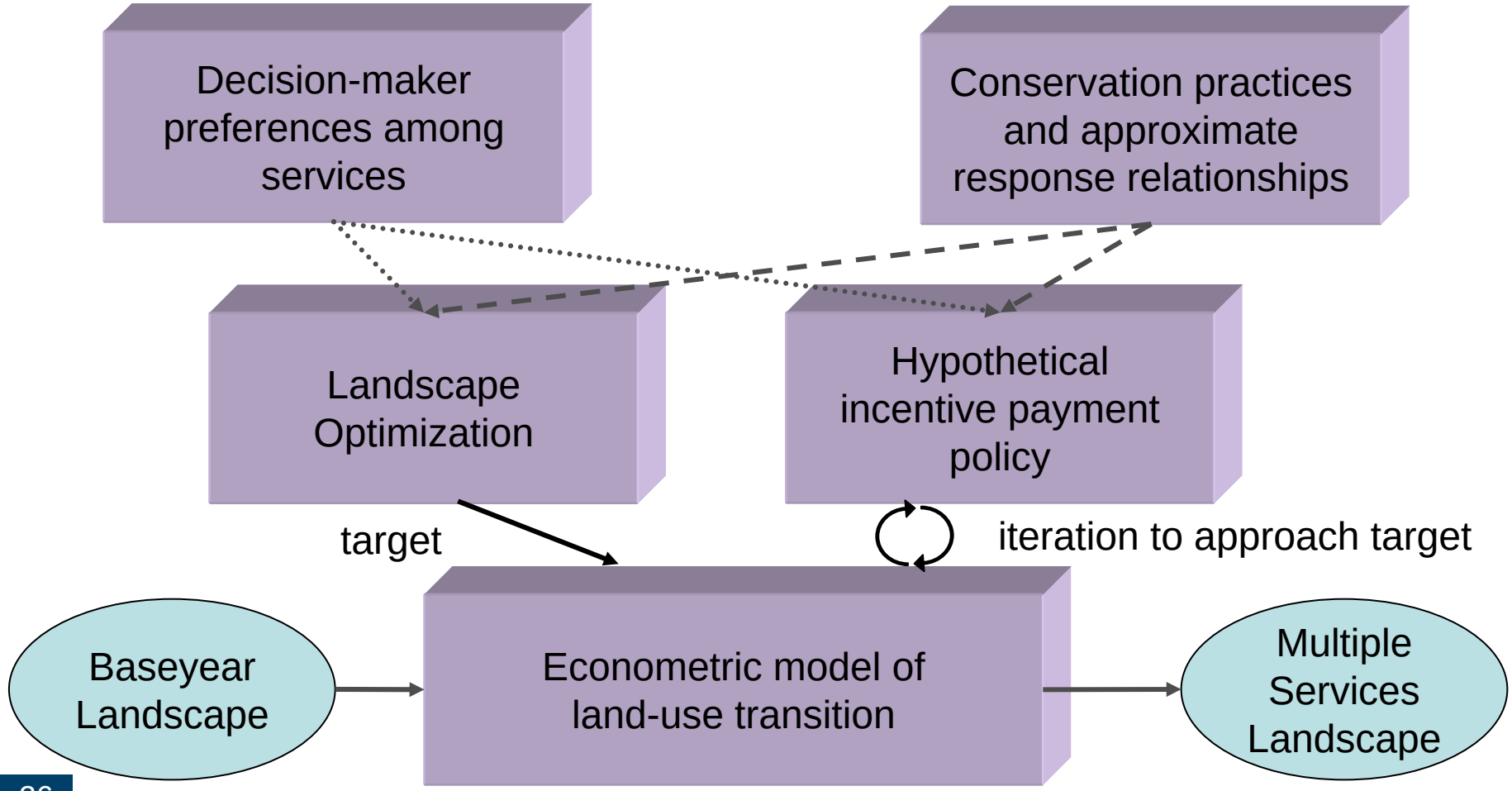
Forming hypotheses about scenario-driven changes in services



Capturing Energy and Agriculture Market Dynamics through EPA and Iowa State/CARD Interaction



2022 Multiple Services Landscape



Air Quality Response to Land Use Change

- Modifications to Community Multiscale Air Quality model (CMAQ) – underway or complete
  - Modifying meteorological model and emissions processing to accept land use/land cover (LULC) classes
  - Link LULC to biogenic emissions data base
  - Incorporate bidirectional ammonia flux
  - Develop fertilizer input scenarios

Two-tier watershed modeling approach under development

- SPARROW (SPAtially Referenced Regressions On Watershed attributes)
  - accuracy at large basin scale
  - statistical bounds
  - use to calibrate process-based models for existing conditions
- Process-based model(s)
  - SWAT, AnnAGNPS
  - able to simulate many land management changes
  - employ at HUC-8 and smaller scales
  - use to develop revised SPARROW models for future scenarios
- Partners yet to be identified

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- Current efforts and challenges

Current efforts and challenges

- Reaching out to additional ***partners***
  - Wildlife habitat modeling (***US Fish and Wildlife Service***)
  - Flood plain modeling (***Corps of Engineers Institute for Water Resources***)
  - Collaboration on modeling ecosystem services in the Midwest (***US Geological Survey***)
  - New STAR grantees?

ESRP-funded STAR grant solicitation:

"***Enhancing ecosystem services from agricultural lands***."

- Co-funded with USDA, total of $4.5 M ($1 M ESRP, $3.5 M USDA)
- Released Feb. 2009 (now closed, awards pending)
- Grants *may* complement in-house FML study, and potentially enable cooperation with in-house scientists, and with EPA Regional staff.

Details: http://www.epa.gov/ncer/rfa/2009/2009_star_ecosystem_services.html

Current efforts and challenges

- Expand FML approach in response to energy sustainability questions
  - include an additional region (e.g., Southeast)?
  - expand scenarios
    - examine other bioenergy/conservation policy combinations?
    - incorporate greater detail on bioenergy crops?

Contacts

Ecosystems Services Research Program

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Future Midwestern Landscapes Study

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Betsy Smith, Study Co-Leader

919-541-0620; smith.betsy@epa.gov

Appendix H – Wetland Ecosystem Services Program - ESRP
(Janet Keough)

EPA

www.epa.gov/ecology

ECOSYSTEM SERVICES RESEARCH PROGRAM

BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

Wetland Ecosystem Services Program (ESRP-Wetlands)

SAB EPEC

July, 2009

Why Wetland Eco Services? Why Now? Why ESRP?

- Located between land and water, wetlands are buffers for human impacts on receiving waters
- Wetlands provide so many services that are taken for granted
- Wetlands continue to be degraded and lost
- EPA and Army Corps protect wetlands through the Clean Water Act
- EPA – Army Corps Wetland Compensatory Mitigation Rule (2008) – avoid, minimize, and compensate – recognizes the ecosystem benefits of wetlands
- Wetland protection and restoration programs are active throughout the US, by public and private agencies and organizations – if only we could document the benefits!

Wetland Loss in the United States

Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004.

Intertidal Vegetated	Lost	32,400 acres
Intertidal non-vegetated	Gain	5,900 acres
Freshwater Emergent	Lost	142,600 acres
Freshwater Forest	Gain	548,200 acres
Freshwater Shrub	Lost	900,800 acres
Ponds / nonvegetated	Gain	715,300 acres

Both Estuarine and Freshwater Wetland Losses were to Open Water types (open salt water and ponds)

"No Net Loss" policies obscure potential losses in services (e.g. as open water ponds replace vegetated wetlands

Overview of presentation:

Conceptual Framework for ESRP-Wetlands

Will highlight intersections of wetlands with:

- Mapping theme
- Place-based studies
- Reactive nitrogen theme
- Links to Office of Water assessments of wetland conditions (via probabilistic monitoring)

Uncertainties and challenges

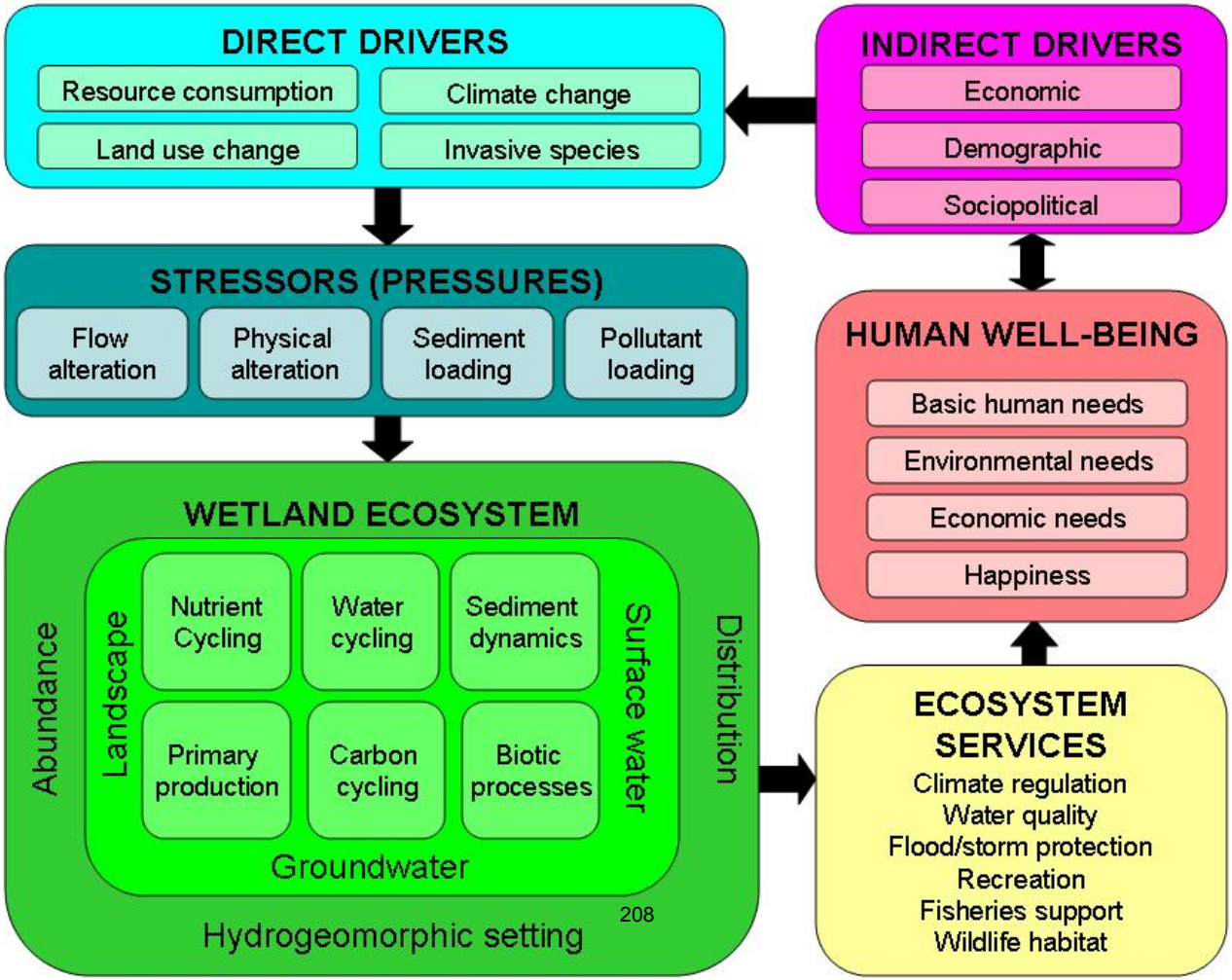
ESRP Organizational Matrix

Projects and Long term Goals →		LTG 3 Pollutant-Specific Studies: 6%	LTG 4 Ecosystem Specific Studies: 23%		LTG 5: Community Based Demonstration Projects: For National, Regional, State and Local Decisions 28%					Theme Leads
	Cross Program Themes and Research Objectives	Nitrogen (6%)	Wetlands (22%)	Coral Reefs (5%)	Willamette (11%)	Tampa Bay (4%)	Mid-West (4%)	Coastal Carolinas (8%)	Southwest (1%)	
Integration, Well-Being, Valuation, Decision Support, Outreach and Education LTG 1 9%	Ecosystem Services and Human Well-Being (3%)		*							Laura Jackson
	Valuation of Ecosystem Services		✓							Wayne Munns--Consultation Committee
	Decision Support (6%)		*							Ann Vega
	Outreach & Education to		*							Open
Inventory, Map, and Forecast Ecosystem Services at multiple scales LTG 2 31%	Landscape Characterization and Mapping (12%)		✓							Anne Neale
	Inventory and Monitoring of Services (14%)		✓							Mike McDonald
	Modeling (5%)		✓							Tom Fontaine--Consultation Committee
Pollutant Specific Studies LTG 3	Nitrogen (6%)		✓							Jana Compton
Eco-system Specific Studies LTG 4	Wetlands (22%)	✓	✓		✓	✓	✓	✓	*	Janet Keough
Project Area Leads	Rick Linthurst and Iris Goodman	Jana Compton	Janet Keough	Bill Fisher	David Hammer	Marc Russell	Randy Bruins/ Betsy Smith	Deborah Mangis	Nita Tallent-Halsell	Rick Linthurst and Iris Goodman
					Hal Walker: Place Based Coordinator					

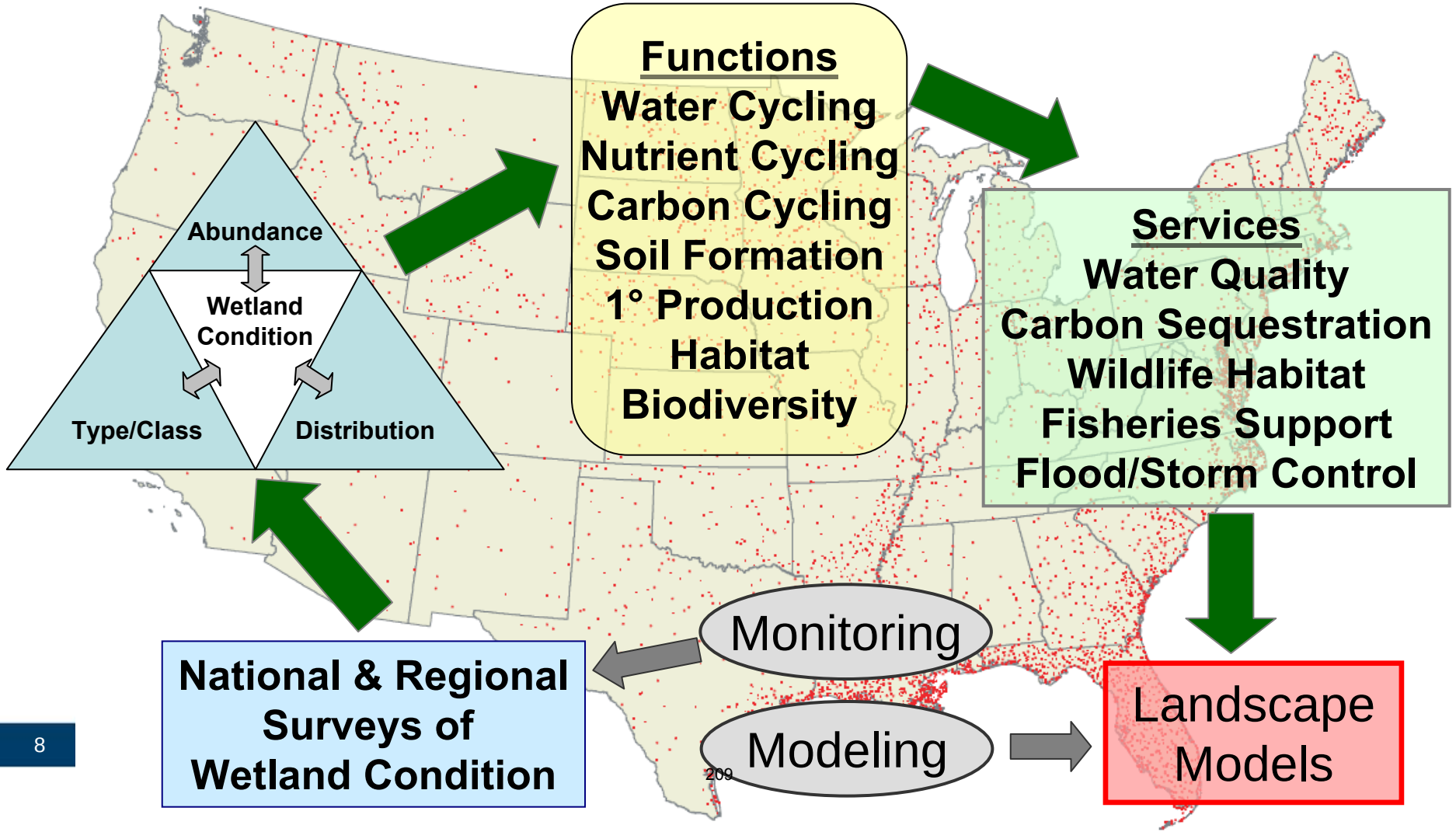
ESRP Wetland Team – ORD scientists and partners

- ORD Divisions – Duluth, Narragansett, Cincinnati, Las Vegas, Gulf Breeze, Corvallis, Ada, Athens
- STAR Grants
  - 2 new grants on relating wetland condition to ecosystem services
  - 1 new grant on relating the National Wetland Condition Assessment approach to eco services
- Special Governmental Employees – Dr. Marisa Mazzotta, Dr. Charles Vorosmarty
- OW Partners – OWOW Wetland Division (NWCA)

Conceptual Model for Wetland Services
Relationships with Drivers, Stressors, and Human Well-Being



Wetland Ecosystem Service Roadmap



Examples of Eco Services Metrics

Ecosystem Service	Wetland Metrics
Carbon Storage	Carbon stocks in plants and soil / Carbon accretion to wetland soil; flux of GHG
Fisheries Support	Commercial / Recreational Fish or Shellfish Quantity / Fish – Shellfish Habitat Quality; Feedstock for C/R fisheries
Flood Control/Storm Surge Protection / Water Storage	Extent of Wetland Attenuation of Storm Surge or Flood, Water Volume Capacity of Wetlands
Water Quality Improvement	Reactive Nitrogen / Phosphorus Removal / Water Clarification; Pesticide Trapping
Wildlife Support	Birdwatching (Biodiversity) Opportunities / Wildlife Prey Abundance / Breeding Bird Community

General Categories of Wetlands in the ESRP Research Program

▪ Estuarine Intertidal Emergent	salt marsh
▪ Estuarine Intertidal Forested/Shrub	mangrove
▪ Estuarine Aquatic Bed	seagrass
▪ Estuarine Unconsolidated Shore	beaches/bars/tidal flats
▪ Palustrine Forested	forested swamp
▪ Palustrine Shrub	shrub swamp
▪ Palustrine Emergent	inland marsh/wet meadow
▪ Palustrine Aquatic Bed	floating/submerged vegetation

From Dahl, 2006. Status and Trends of Wetlands in the Conterminous United States 1998-2004

Consistent with the EPA OW National Wetland Condition Assessment Categories

These types comprise 98% of marine/estuarine wetlands and 94% of freshwater wetlands. Types not included Are marine intertidal and freshwater ponds.

THESE GENERAL TYPES VARY ACROSS ECOREGION, HYDROGEOMORPHIC SETTING, AREA, SALINITY-CONDUCTIVITY GRADIENT, SUCCESSIONAL STAGE

Wetland Categories x Services

Wetland Classes	Estuar Emerg	Estuar Shrub	Estuar Aquat	Estuar flat	Palust Forest	Palust Shrub	Palust Emerg	Palust Aq Bed
Carbon Storage	✓	✓			✓	✓	✓	✓
Fish Support	✓		✓	✓	✓	✓	✓	✓
Storm-Flood - Storage	✓	✓			✓	✓	✓	✓
Water Quality	✓	✓	✓	✓	✓	✓	✓	✓
Wildlife Support	✓	✓	✓	✓	✓	✓	✓	✓

✓ Regional and/or National Case Studies

We ultimately want to demonstrate:

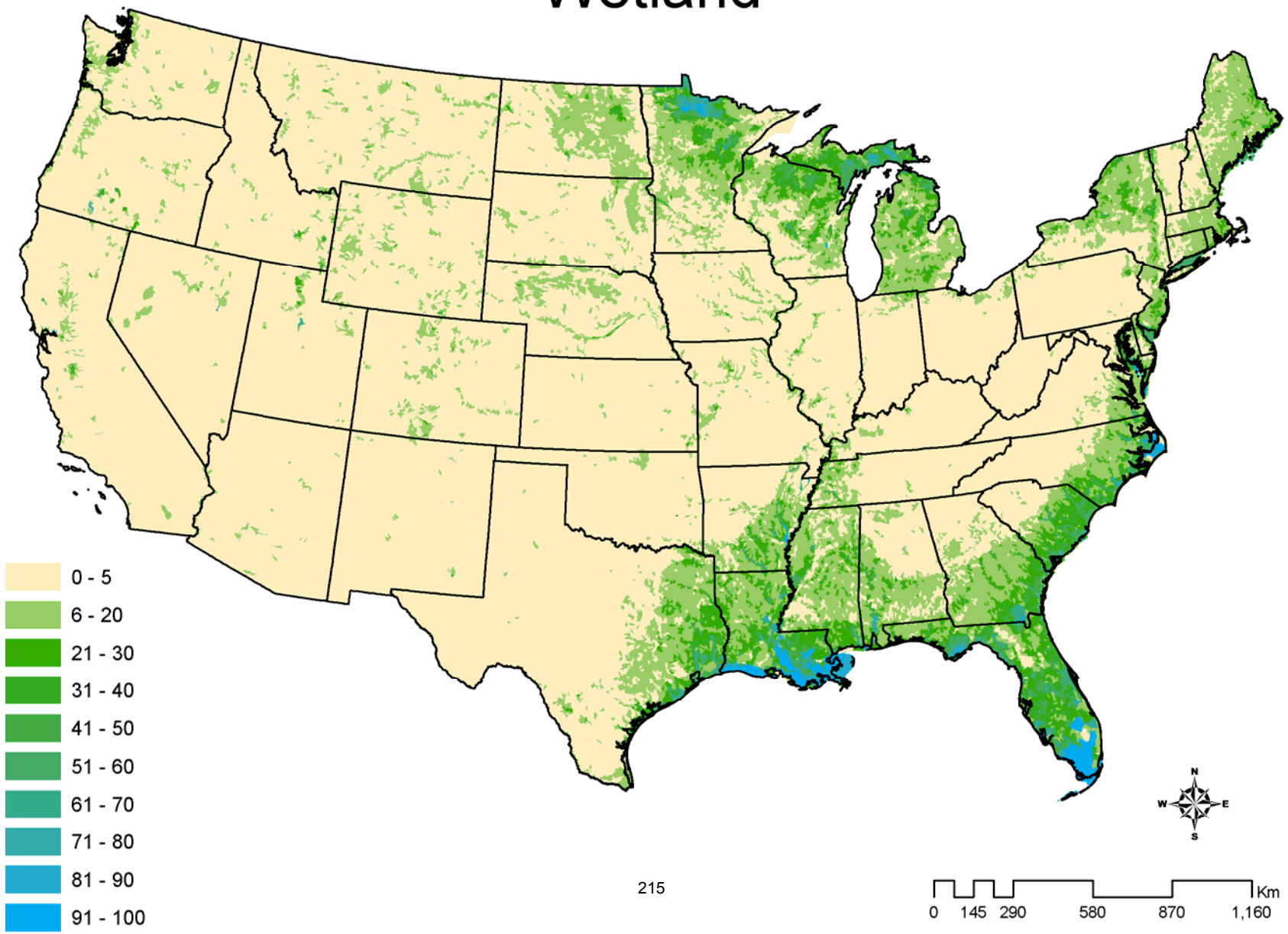
- The ability to use wetland condition indices (as monitored in the field) to estimate ecosystem service production functions
- The roles of location, pattern and connectivity of wetlands in delivery of multiple services
- Creation of wetland landscape profiles of services for most major classes of wetlands, over most of the conterminous U.S.
- Testing wetland landscape profiles for usefulness in predicting suites of wetland services at scales appropriate for decision-making

Status of ESRP Wetlands

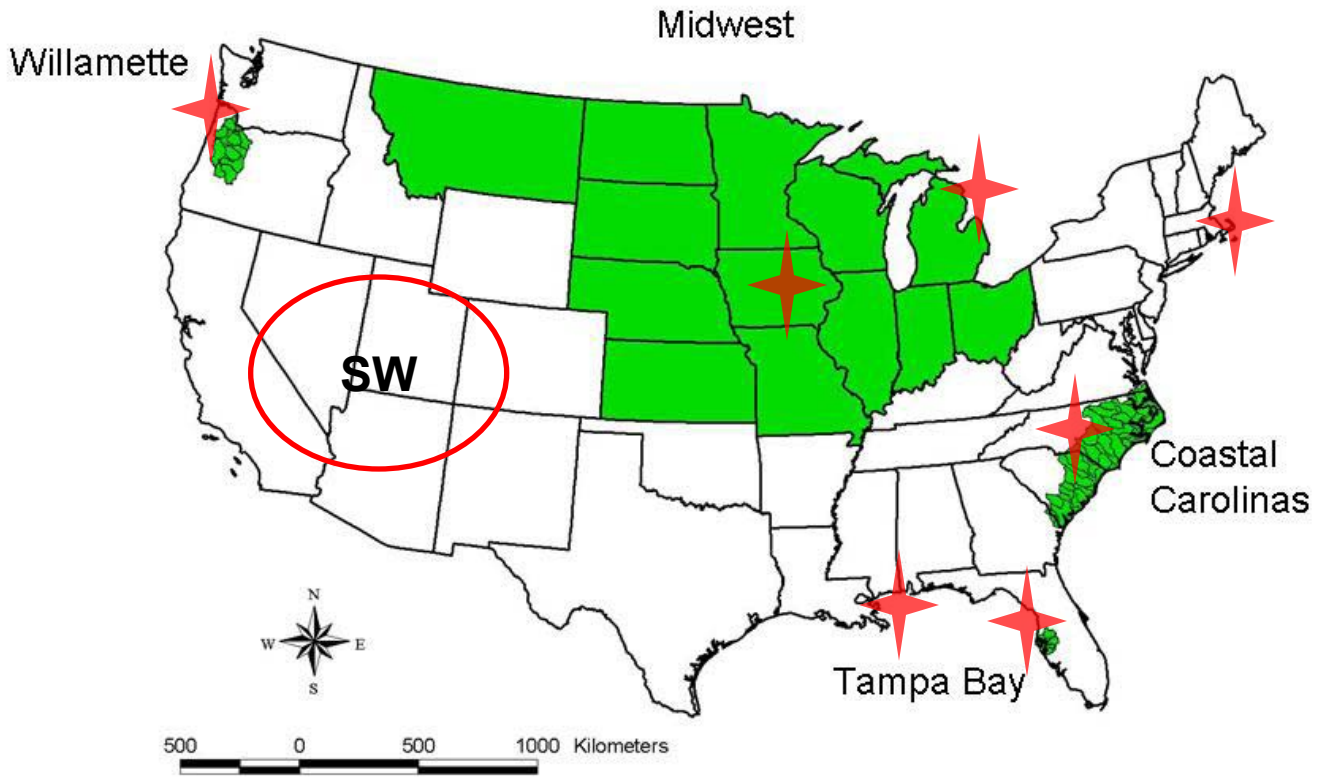
National Implementation Plan has been written, received peer review, now in revision

ORD Staff are gaining experience with ecosystem services science through literature reviews, seminars, and exploring existing data through meta analysis

Percentage WBD 12 Digit Hydrologic Units Wetland

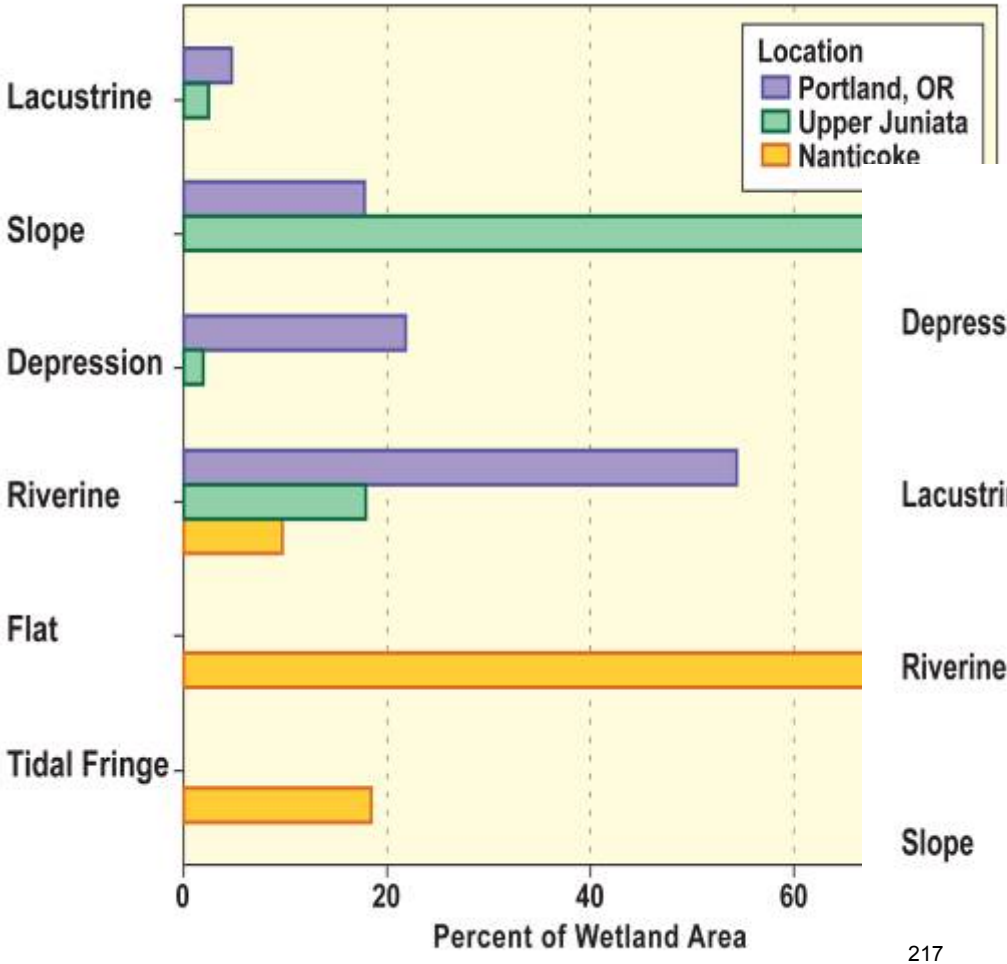


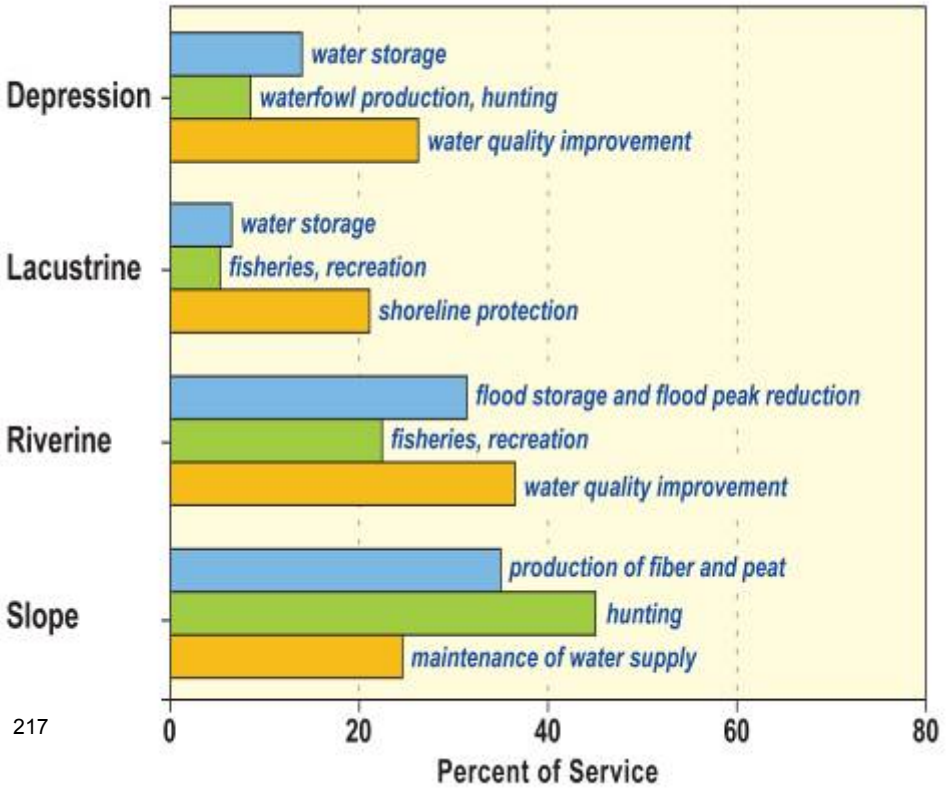
Place Based Studies – Wetland Efforts



Opportunity for coordinated site work: Standardization, Scaling, Applicability Testing, Collective Strength,….

Landscape Profiles





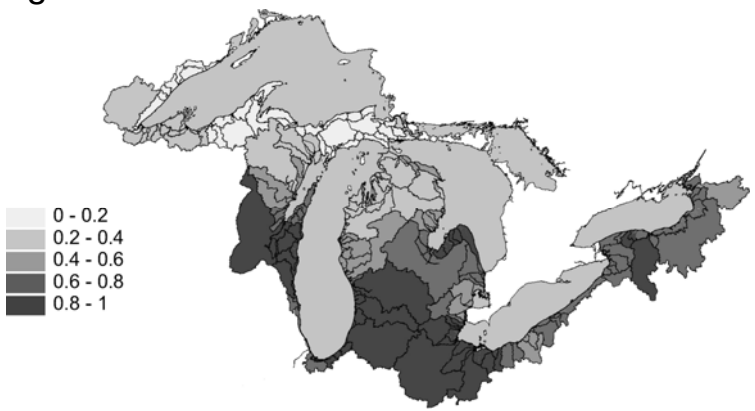
Modeling Services by Landscapes – Examples

Research Task	Methods (the "how")
Flood & Storm Surge Protection	Model storm surge vulnerability of coastal Louisiana & Carolinas from coastal wetland extent, tropical storm probabilities, and storm surge reduction coefficients. Develop models of wetland volume to determine capacity of wetlands to store water
Carbon sequestration	Apply soil organic carbon accumulation rates to wetlands in agricultural landscapes in the upper Midwest.
Water Quality & Nitrogen Cycling	Develop spatially-explicit nitrogen removal model for wetlands based on intensive datasets in specific places and literature.
Bundled wetland services	Develop landscape models of bundled wetland services (waterfowl production, carbon storage, water quality, habitat, recreation) in Mississippi River basin (or other basins)

Factors that regulate delivery of nutrients to Great Lakes Coastal wetlands

Anthropogenic activities in the Great Lakes basin

Agriculture

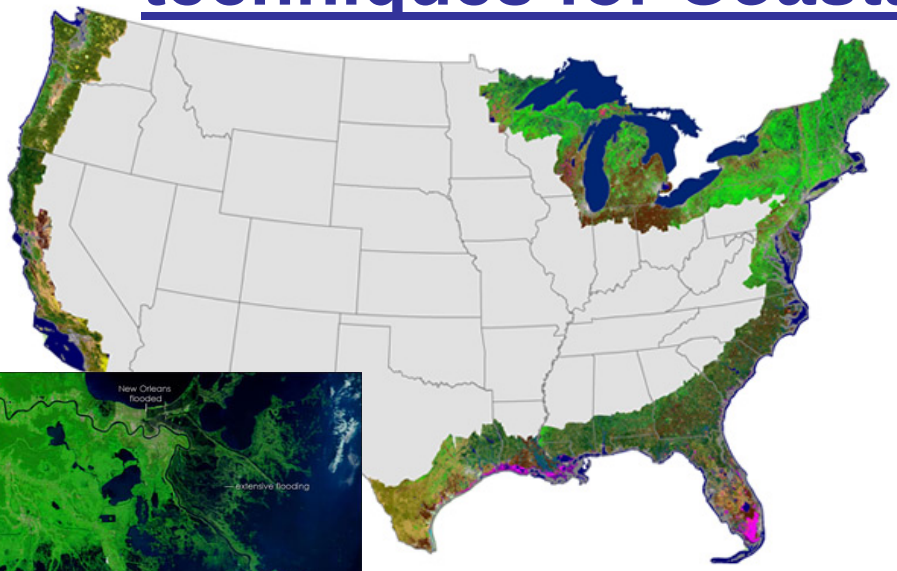


Human population

Point source pollution

Atmospheric deposition

Application of 'modified-traditional' mapping techniques for *Coastal Wetlands*



Sea Level Rise

Mapping/modeling of:

- (Presence/Extent/Condition)

  Coastal wetland change using multi-spectral satellite data (in addition to soil moisture indices, NWI, presence of hydric soils, and other variables)

- (Ecosystem Services, including change)
  - Storm surge protection (SSP)
  - Wave energy and tidal energy attenuation, including analyses of sea level rise (SLR)
  - Production of commercially and recreationally important fish and birds
  - Pollutant accumulation/transformation
  - Provisioning of human recreational benefits and human aesthetic benefits

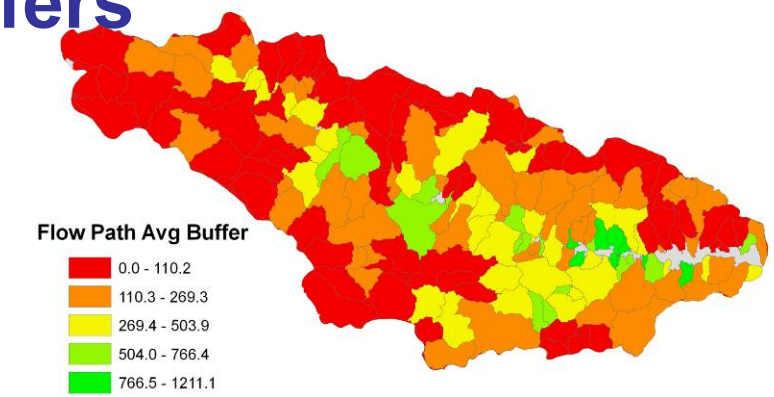
Storm Surge Protection

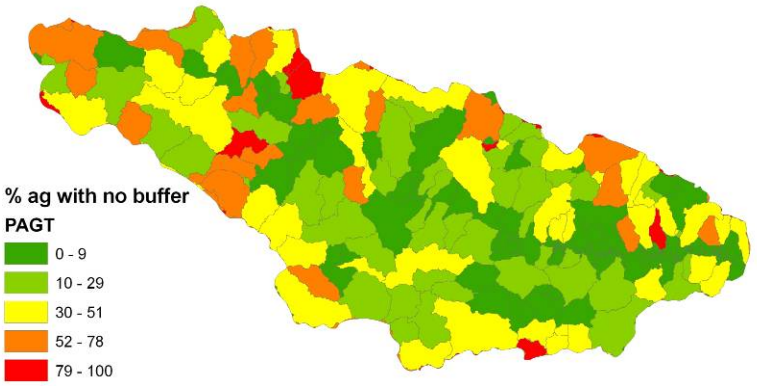
Ric Lopez

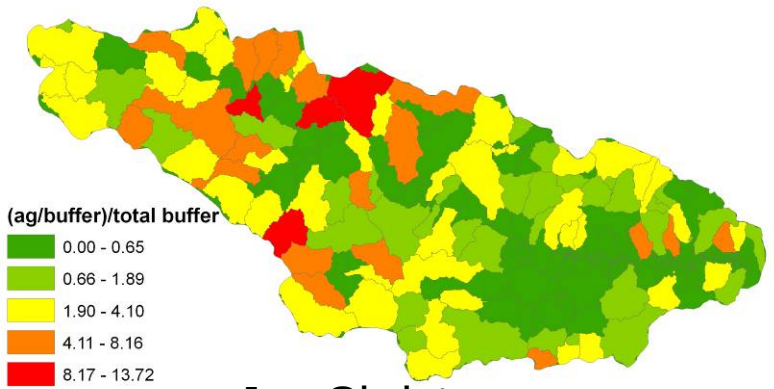
Water Quality -- Nutrient Attenuation/Removal by Riparian Buffers

Riparian metrics being tested

- Average Flow Path Buffer Width from Ag Cells (m)
  Based on Baker et al 2006
- % Ag draining to stream without passing through naturally vegetated buffer
- Sum of Ag/Buffer Ratio / total buffer length







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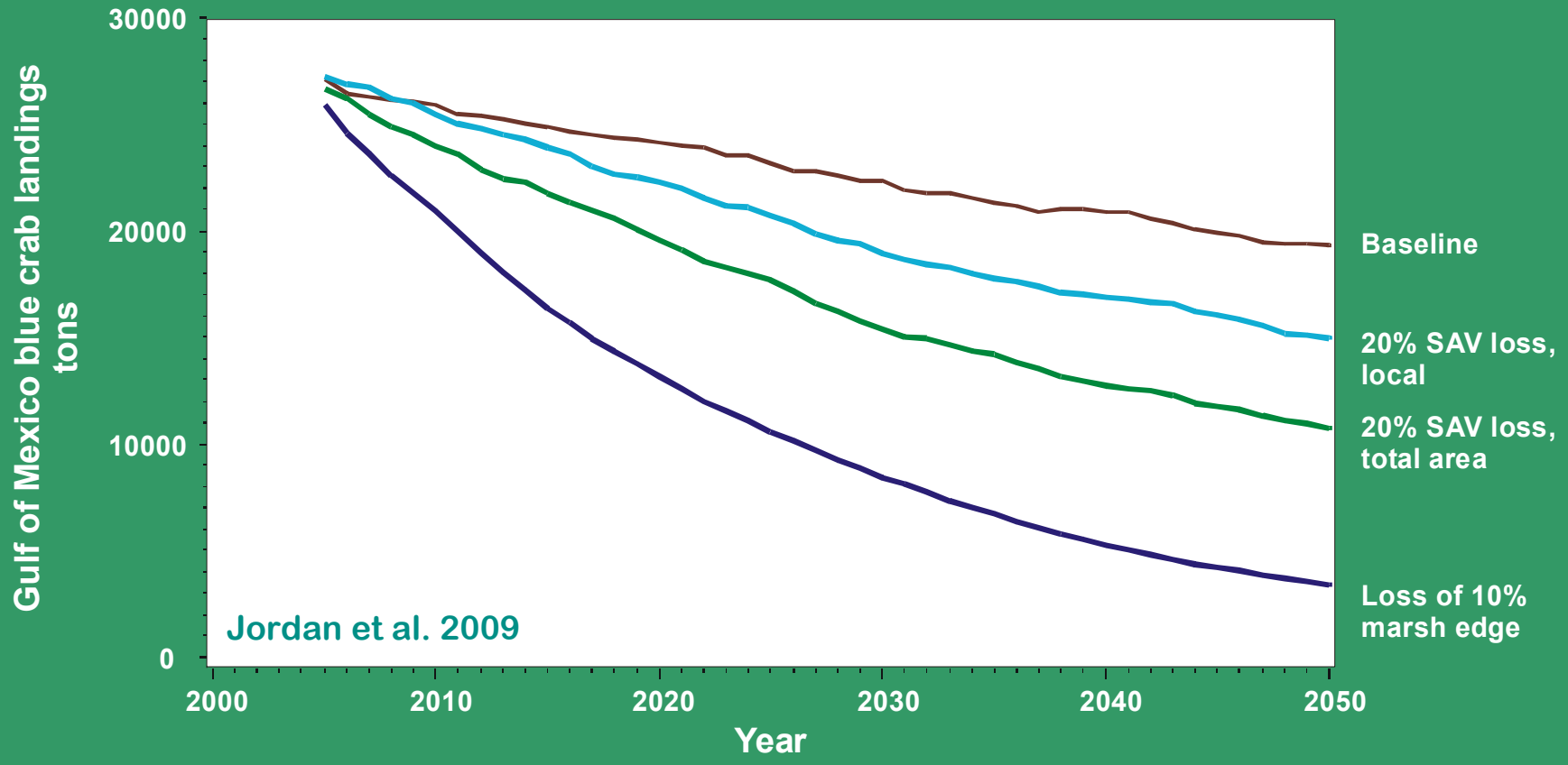
Jay Christensen

Candidate conservation practices for FML "Multiple Services" scenario

- Land retirement for conservation
- **Wetland restoration (interrupt tiles)**
- **Wetland creation (for water treatment)**
- Nutrient management (amount, timing)
- Reduced tillage (includes no-till)
- Winter cover
- Contouring and terracing
- **Riparian forest buffer**
- Grassed waterway
- Drainage water management (timing)
- **Flood-plain grassland**

Simulated effects of wetlands loss on fisheries

scaling from patch to estuary to region

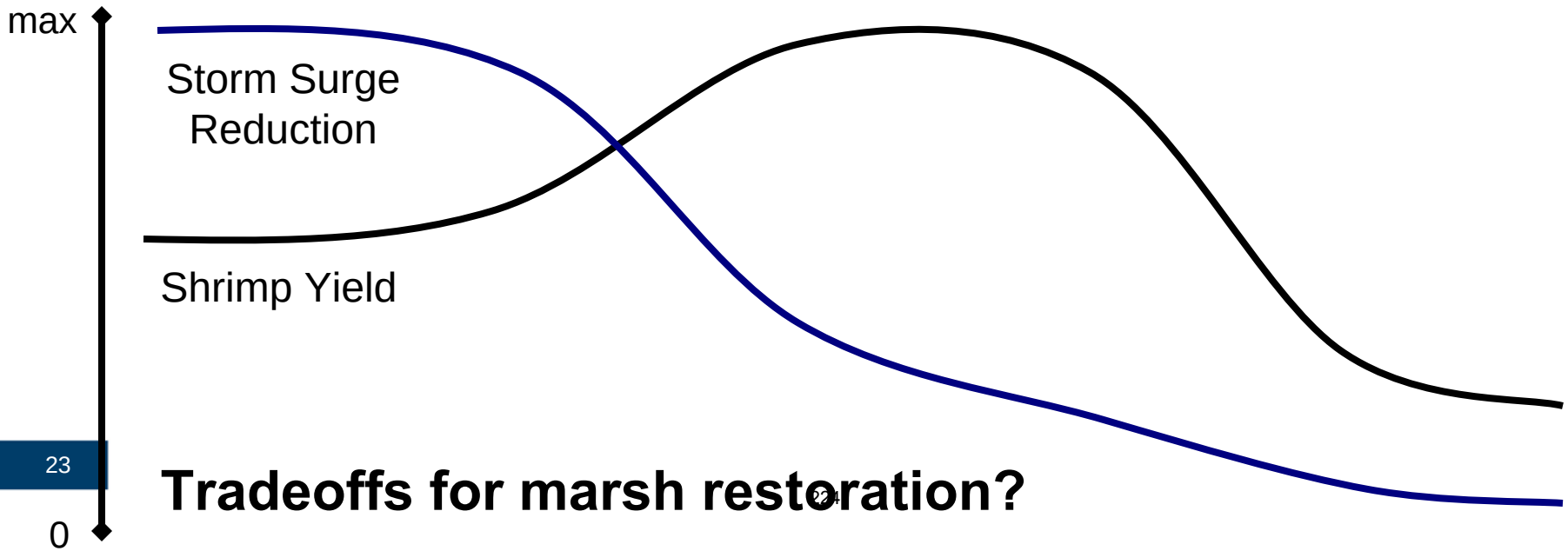


From S Jordan, ORD GED

Intact Marsh

Fragmented Marsh

Marsh Loss

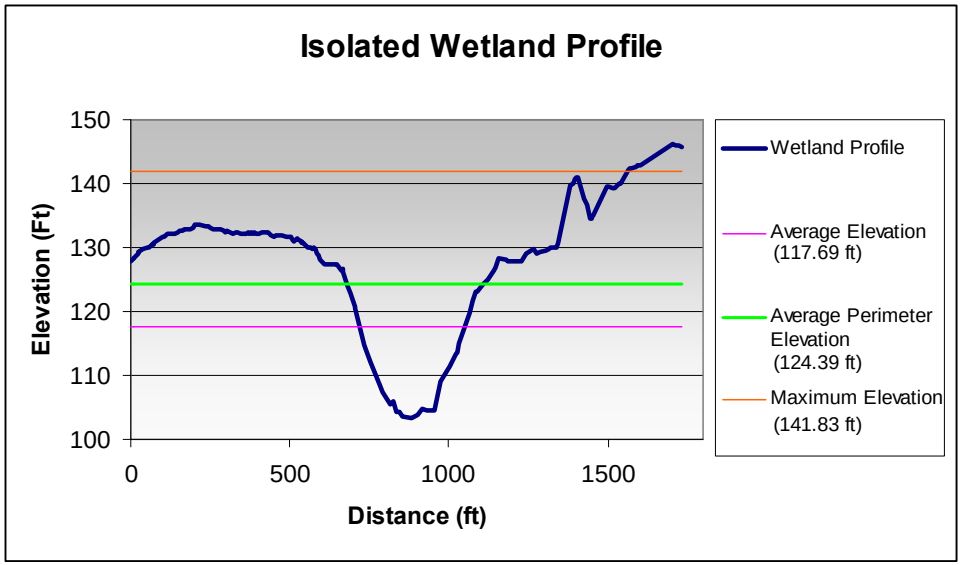


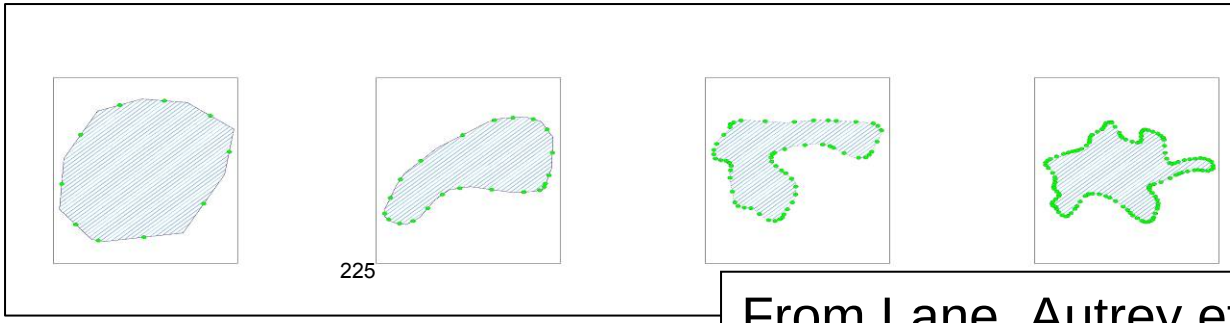
Tradeoffs for marsh restoration?

Isolated Wetland Water Storage Capacity

Identified 12,519 isolated wetlands in 2600 km^2 study area

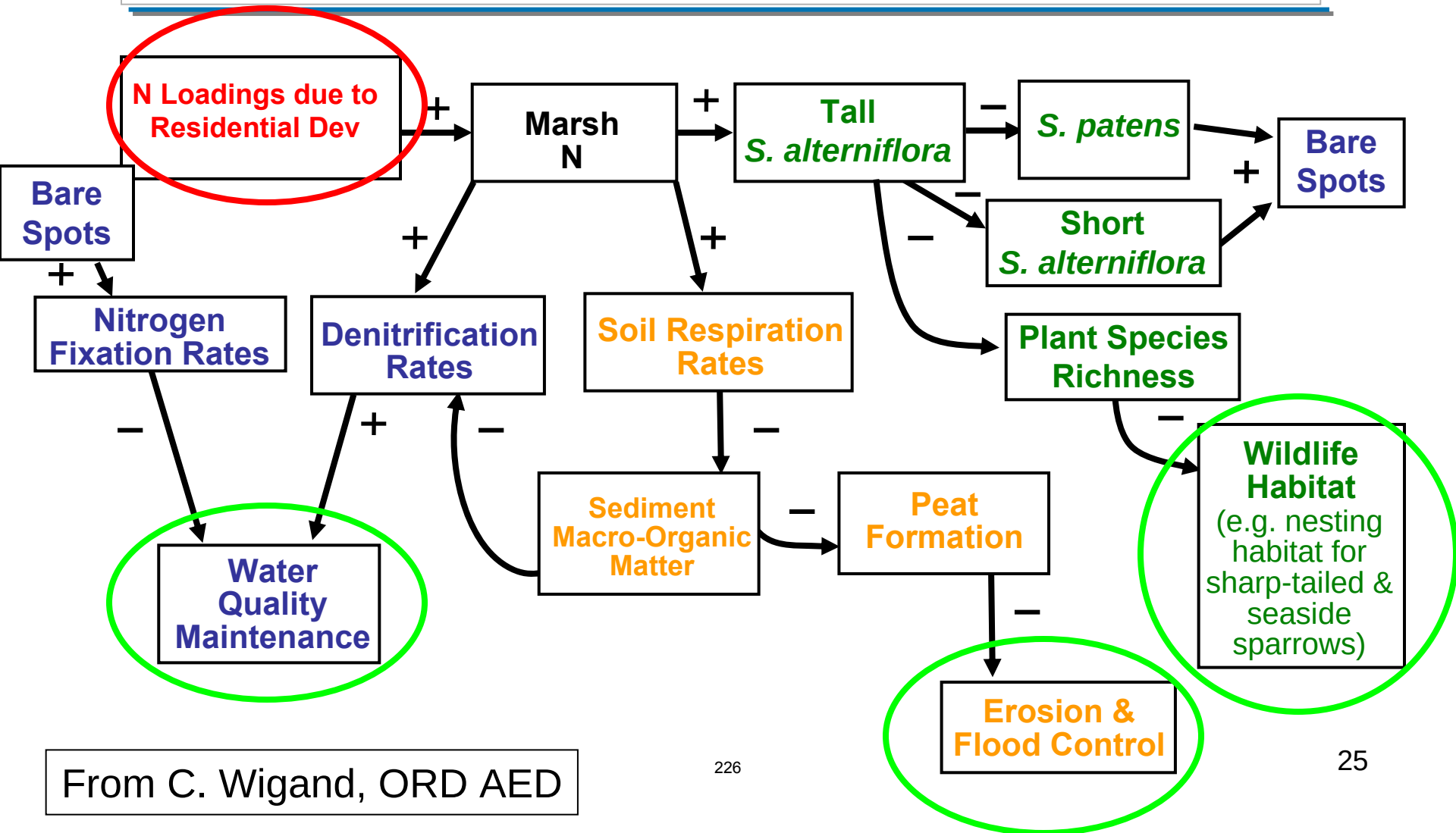
- Used LiDAR to ID bathymetric profile
- Isolated wetlands storage capacity of 43,000,000 m^3 of water





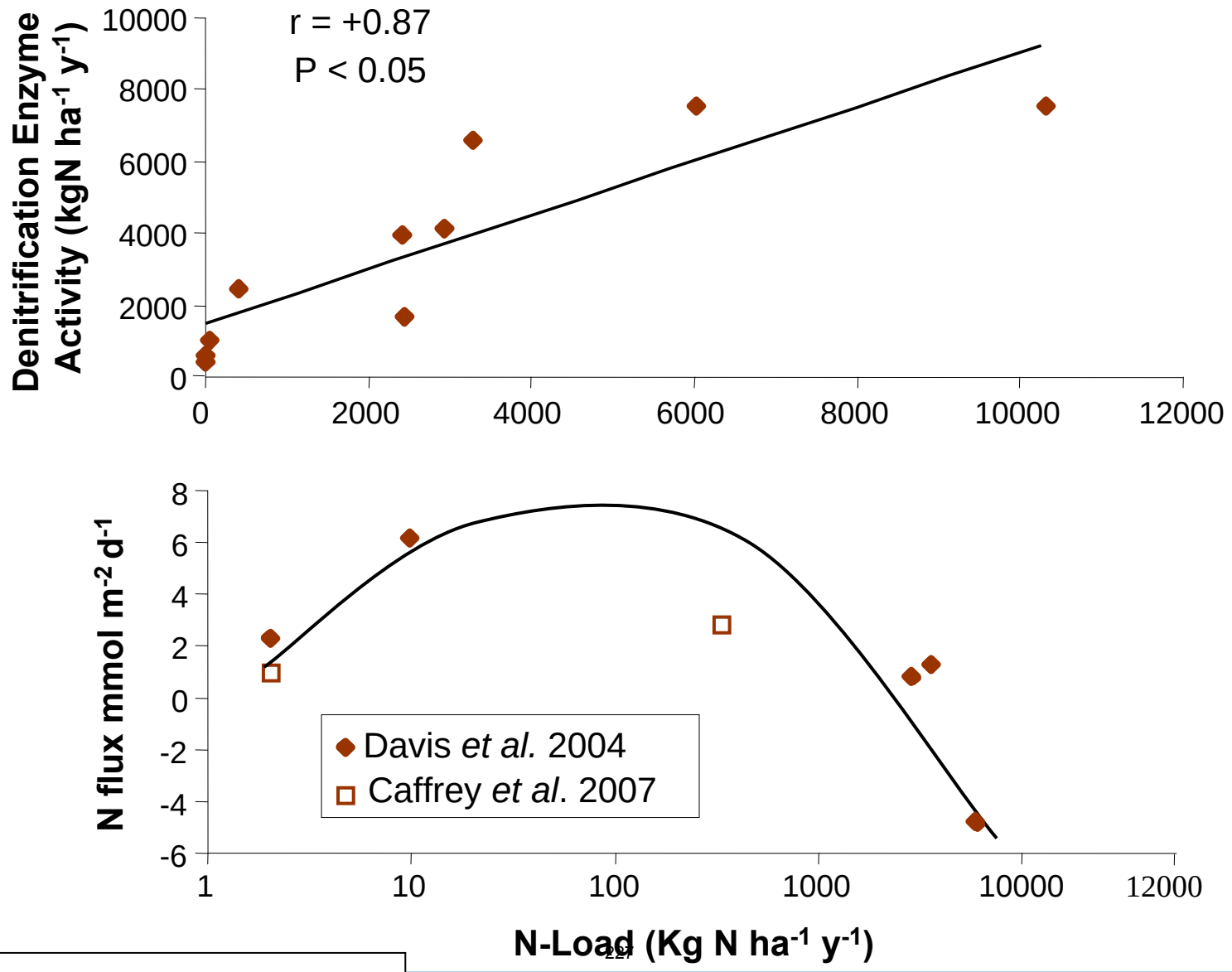
From Lane, Autrey et al

Mechanisms of Nitrogen Loading Effects on Marsh Structure, Function, and Delivery of Services in the Urbanized Northeast



From C. Wigand, ORD AED

High Marsh Denitrification Potential & Nitrogen Flux



From C. Wigand, ORD AED

Monitoring Ecosystem Services at a National Scale

- Using the EPA National Wetlands Condition Assessment (OW-ORD Partnership) data to attempt estimates of services at a national scale
- National ES assessment would provide:
  - a baseline assessment of current services
  - unbiased and representative regional/national inventories
  - all vegetated wetlands of the U. S.
  - immediate link to Wetland Status and Trends efforts and associated policy and management

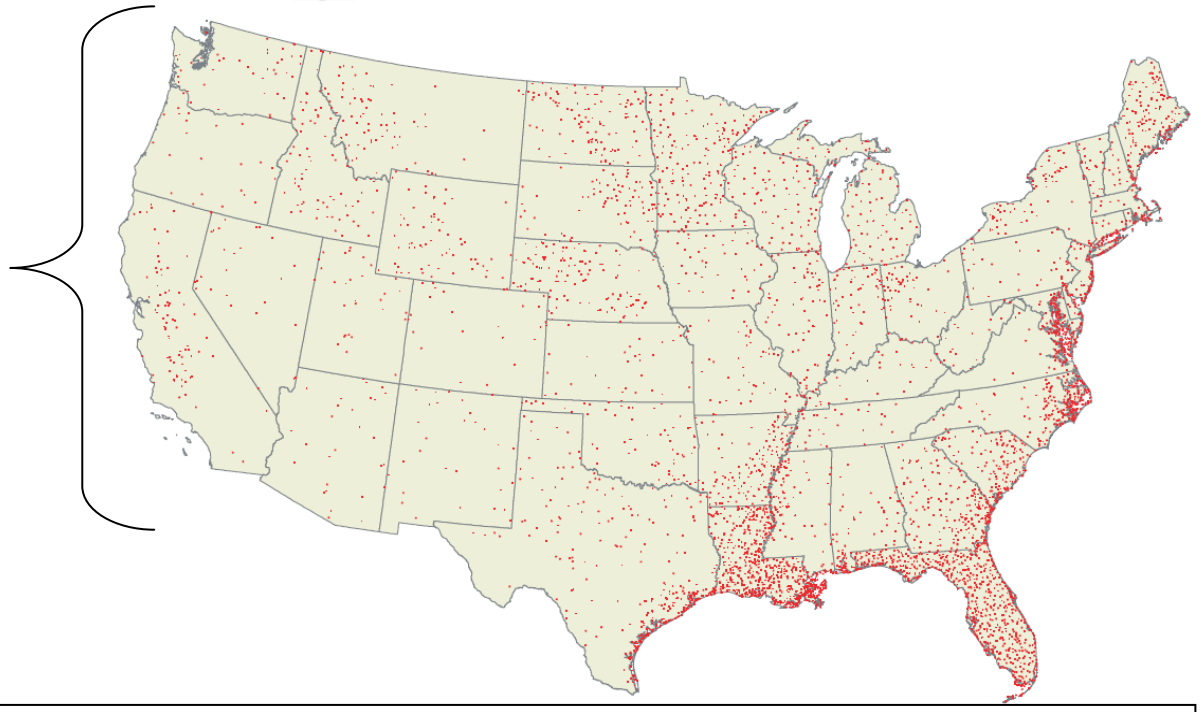
Sampling Frame
(Map for Selecting Sample Sites)

EPA is working in partnership with the U.S. Fish & Wildlife Service

Status and Trends Enhancements

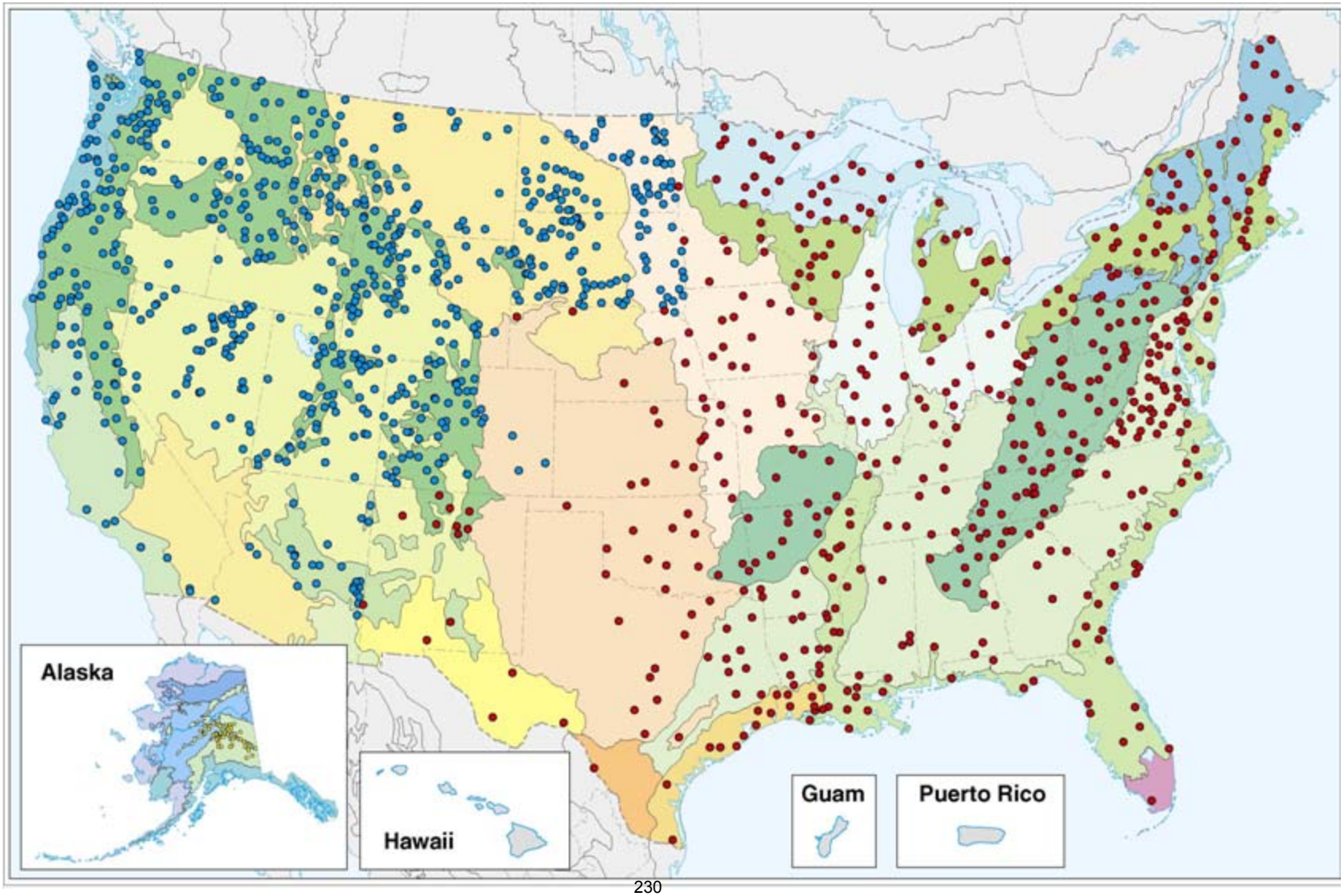
New Pacific Coast Plots

Status and Trends 2005 Plot Locations

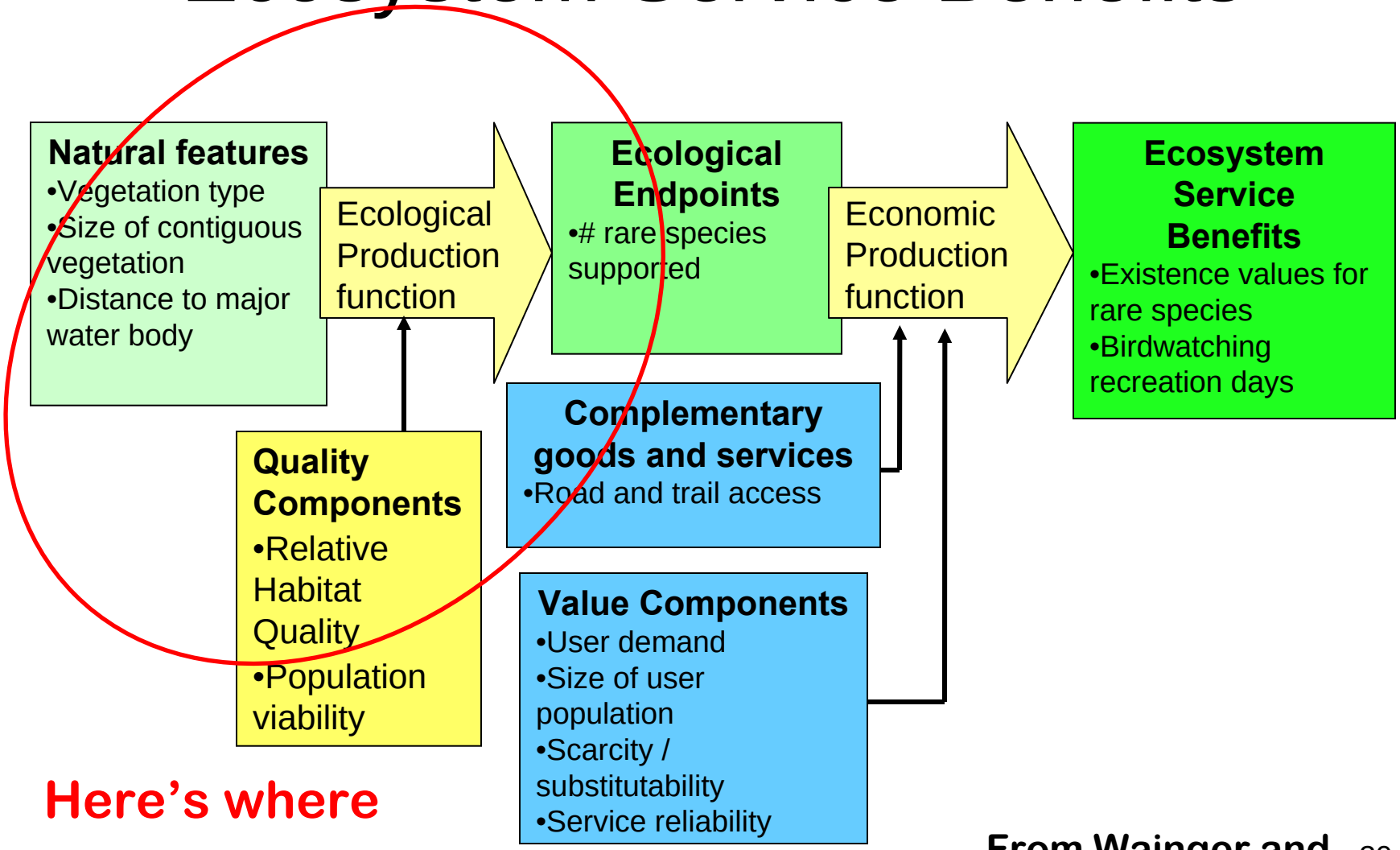


*** Each red dot is a 4 square mile plot that includes mapped wetlands, deepwater, and uplands.**

The Wetland Assessment Distribution
Will look a lot like Wadeable Streams Assessment



Example: Measurement of Ecosystem Service Benefits



Here's where

We are at this point

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From Wainger and Boyd

Central Scientific Uncertainties

Wetland Class → Function → Service Relationships

- Can ecosystem function/service be inferred from wetland type?
  - What are the natural moderating factors?
  - How does the magnitude of functions/services scale with
    - wetland size or shape?
    - location within a watershed or larger landscape / connectivity?
    - proximity to other habitat types?
  - What is the accuracy of estimating function/service at unmeasured sites?

Condition → Function → Service Relationships

- How does wetland condition affect ecosystem function/service?
  - Does the condition function/service relationship differ among wetland types?
  - What are the condition-response functions for key stressors?

Scientific Uncertainties

Nutrient, Sediment, Toxic Removal / Transformation

- **What types of mapped or monitored features can be used to estimate pollutant removal? For instance, Nitrogen removal, sediment trapping, etc.**
- **What are the most informative units of pollutant removal?**
- **(Net mT/ha/year? % loading removal/ha/year? Or?)**
- **What scale of estimation / mapping is feasible and appropriate for decision-making?**
- **Can we estimate these services for sites that are not measured?**

Challenges

- Demonstrating relationships between ecosystem services, ecosystem benefits and human values / well-being – do we have the capacity to make the translation of ecological data to social or economic information?
- Demonstrating the uncertainty associated with estimating wetland services at larger scales and translating these into estimates of benefits at those larger scales

Appendix I – Decision Support Framework - DSF
(Ann Vega)

DECISION SUPPORT FRAMEWORK (DSF)

(Formerly Decision Support Platform)

Ecosystem Services Research Program (ESRP)

Presented by Ann Vega (EPA/ORD)

To:
Science Advisory Board
Ecological Processes and Effects Committee
July 15, 2009 – Washington, DC

Outline

- SAB Comments/Quality Reviewer Comments
- In Response:
  - Management Action
  - Workshops
- Major Lessons Learned So Far
- Emerging Vision
- On-going work
  - Database
- Proposed Next Steps
- Proposed Revised Goals
- Challenges

Summary of SAB Comments (EPEC Advisory)

- Lack of in-house expertise
- Combine the DSP with Outreach and Education (OE)
- Adequately describe how the DSP would work
- Concerns about feasibility of developing the DSP
- Develop connections and utilize outside partners
- Define potential clients

SAB Quality Reviewer (summary)

- **Don't assume a DSP is what is needed**
  - **Understand decision-maker needs before determining what to do to improve ESRP-related decision-making**
- **Focus on creating deliberative processes**
  - **To help decision-makers understand impacts of their decisions on ecosystem services**
  - **Requires active, continuous engagement with stakeholders and decision-makers**

SAB Report (2000) "Toward Integrated Environmental Decision-Making"

- Need "to assess cumulative, aggregate risks; to consider a **broader range of options** for managing or preventing risks; to make clear the **role of societal (public) values** in deciding what to protect; to **clarify the trade-offs** (including costs and benefits) associated with choosing some management scenarios and not others; and to evaluate progress toward desired environmental outcomes."
- The SAB suggested a Framework for Integrated Environmental Decision-Making that "adopts an **interdisciplinary approach** that **combines deep understanding of environmental science with theory and empirical methods in behavioral and decision science**."

240 **SAB Comments/Quality Reviewer Comments**

Management Action - Increase R&D Capability

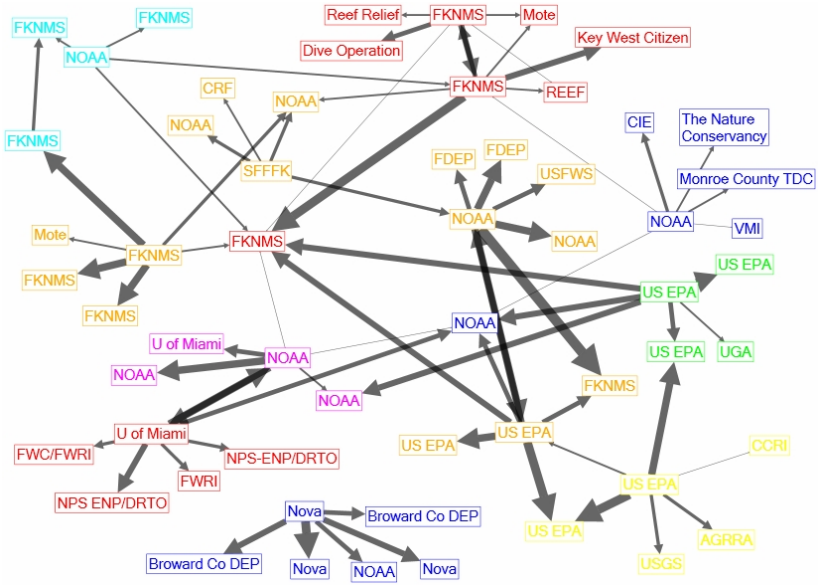
- NRMRL New Hires: Decision Analysis/Probabilistic Modeling; Macro Economist
- Cross-ORD Post-Docs: Valuation/Decision Support; Decision Analyst (DA)
- NRMRL/BOSC DA Workshop
- ESRP Experts
  - Mitch Small (DS/DA expert)
  - Amanda Rehr (DS/DA expert)
  - Peter Shuba (Stakeholder Involvement expert – Coral Reefs)
  - John Bolte (DS/Modeler expert - Willamette)
  - Allyson Beall (Stella Model/Stakeholder Involvement expert – O&E)
  - Ken Reckhow (DA expert; water quality - Modeling)
  - Neptune and Company; Shaw (DA/DS/Modeling contractors)

Management Action - Increase R&D Capability

- **Current DSF Partners**
  - **Mark Judson (IT expertise – Tampa Bay partner)**
  - **EBM Tools Network**
  - **MIT-USGS Science Impact Collaborative (MUSIC)**
  - **NOAA (via Coral Reefs team)**
- **"On-the-job training"**
- **Expertise Yet to be Tapped:**
  - **Ralph Keeney (DA expert; risk analysis expert)**
  - **Helmholtz Centre for Environmental Research (Germany)**
  - **NCER grants**
  - **OPEI expertise**

Workshop – Coastal Carolinas

- **DSF team members participated**
- **Decision-makers need:**
  - **A way to show how XYZ development will impact ecosystem services and evaluate other options**
  - **To know who to talk to and where data are (social networking analysis)**



Preliminary SNA from Coral Reefs Workshop

Workshop – Coral Reefs/DSF

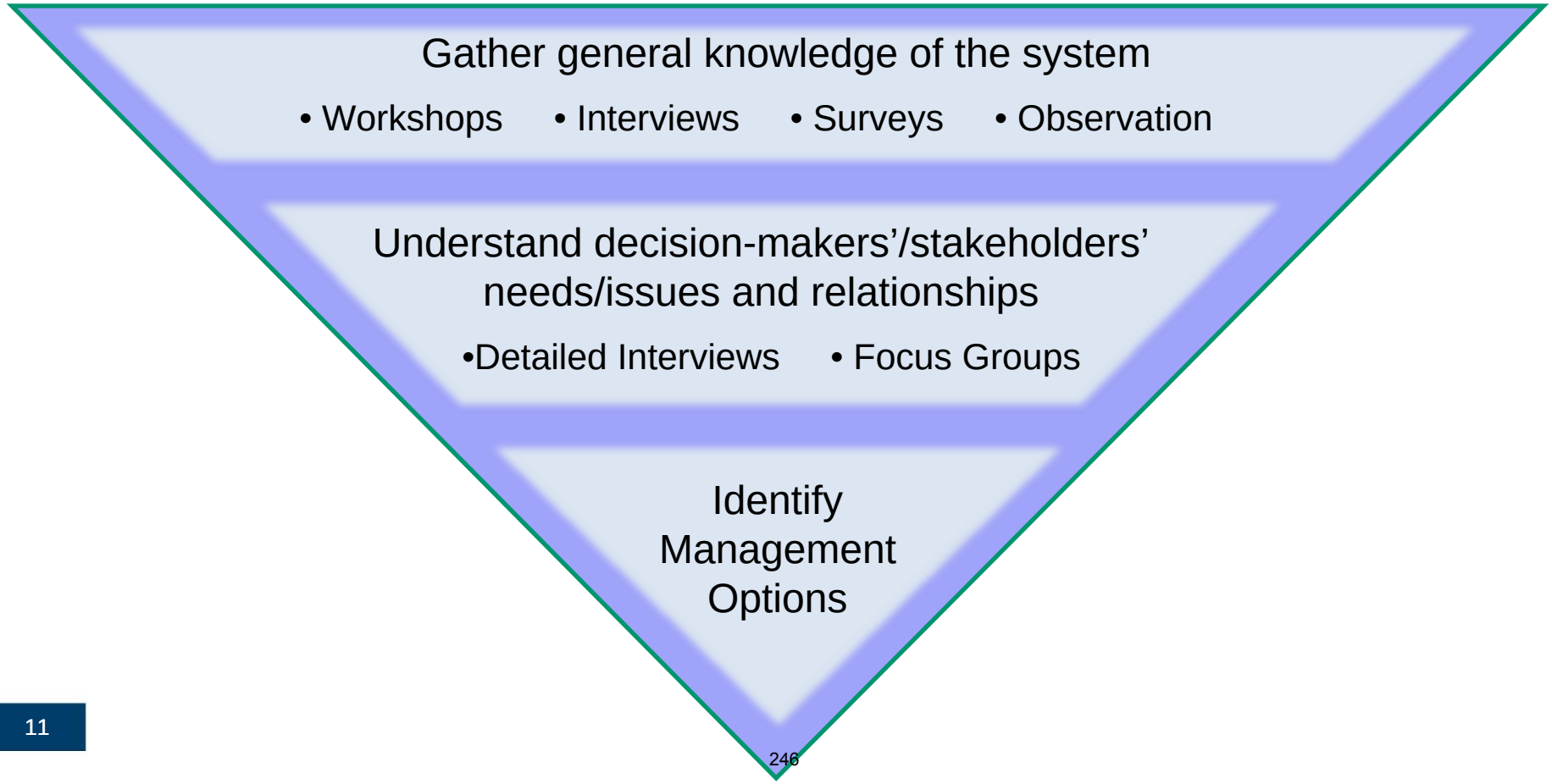
- Co-led workshop with Coral Reefs team at the Florida Keys National Marine Sanctuary
- Main concerns: climate change, land use change, overfishing
- Decision-makers need an integrated approach to coral reef system management – this includes (but is not limited to):
  - Educating people about the condition of the coral reef ecosystem
  - Understanding effects of land use on coral reef ecosystem and informing these decisions (e.g., road widening)
  - Addressing impacts such as extracting resources and damage to reefs caused by anchors, touch, physical/chemical changes, etc
  - Management based science and science based management

Major Lessons Learned So Far…

- DSP for all of ESRP – unrealistic – focus on DSF
- Need to use participatory decision-making to develop and evaluate a variety of potential management options for specific problems
  - Use an integrated, multi-disciplinary team including social scientists and economists
- Determine if we can identify "common" decisions and potentially develop a more broadly applicable DSF
- Social networking tools and analysis seem promising for bringing concerned groups of people together around a problem

Emerging Vision - DSF

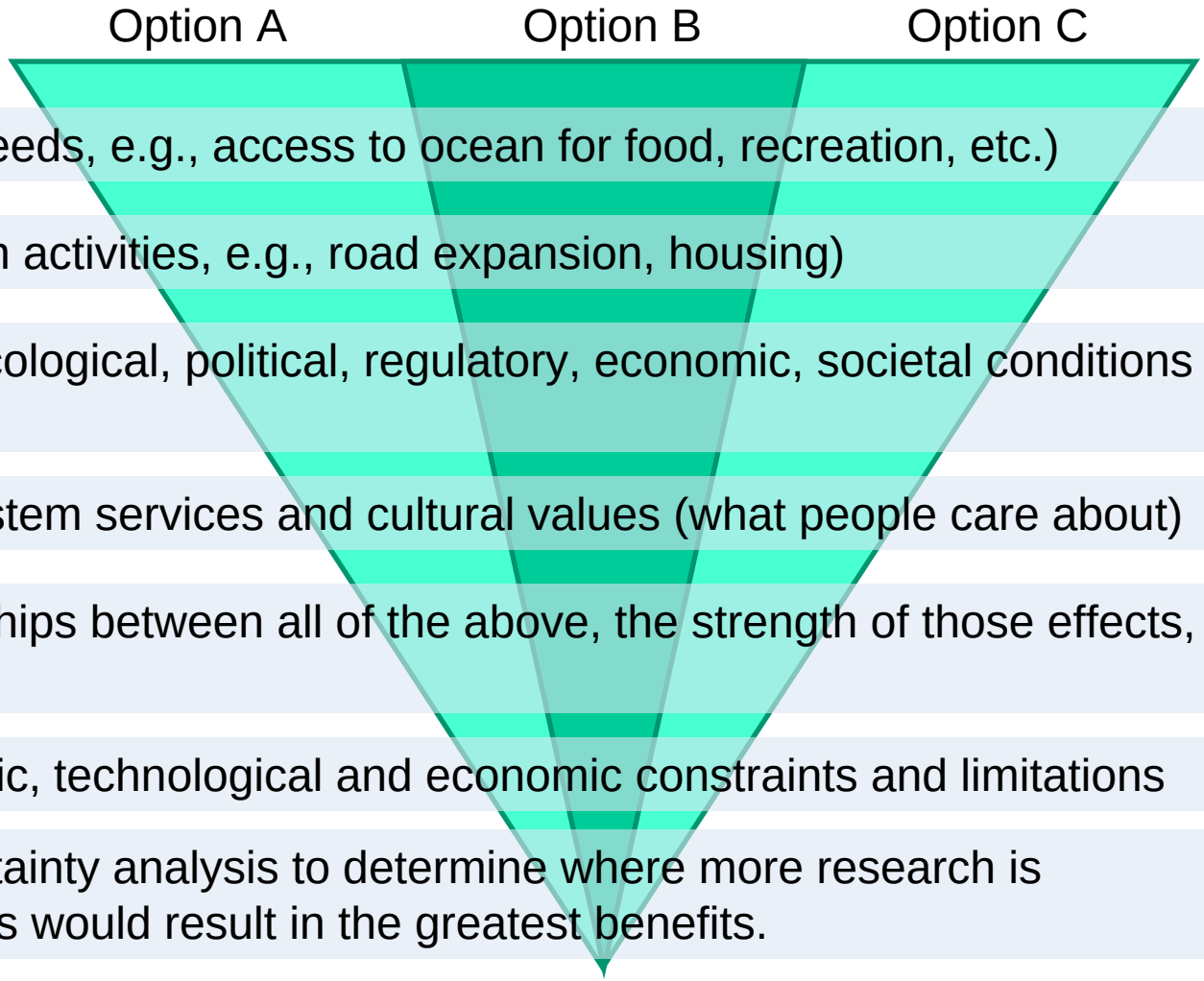
From the Big Picture to Specific Decision Alternatives (Management Options)



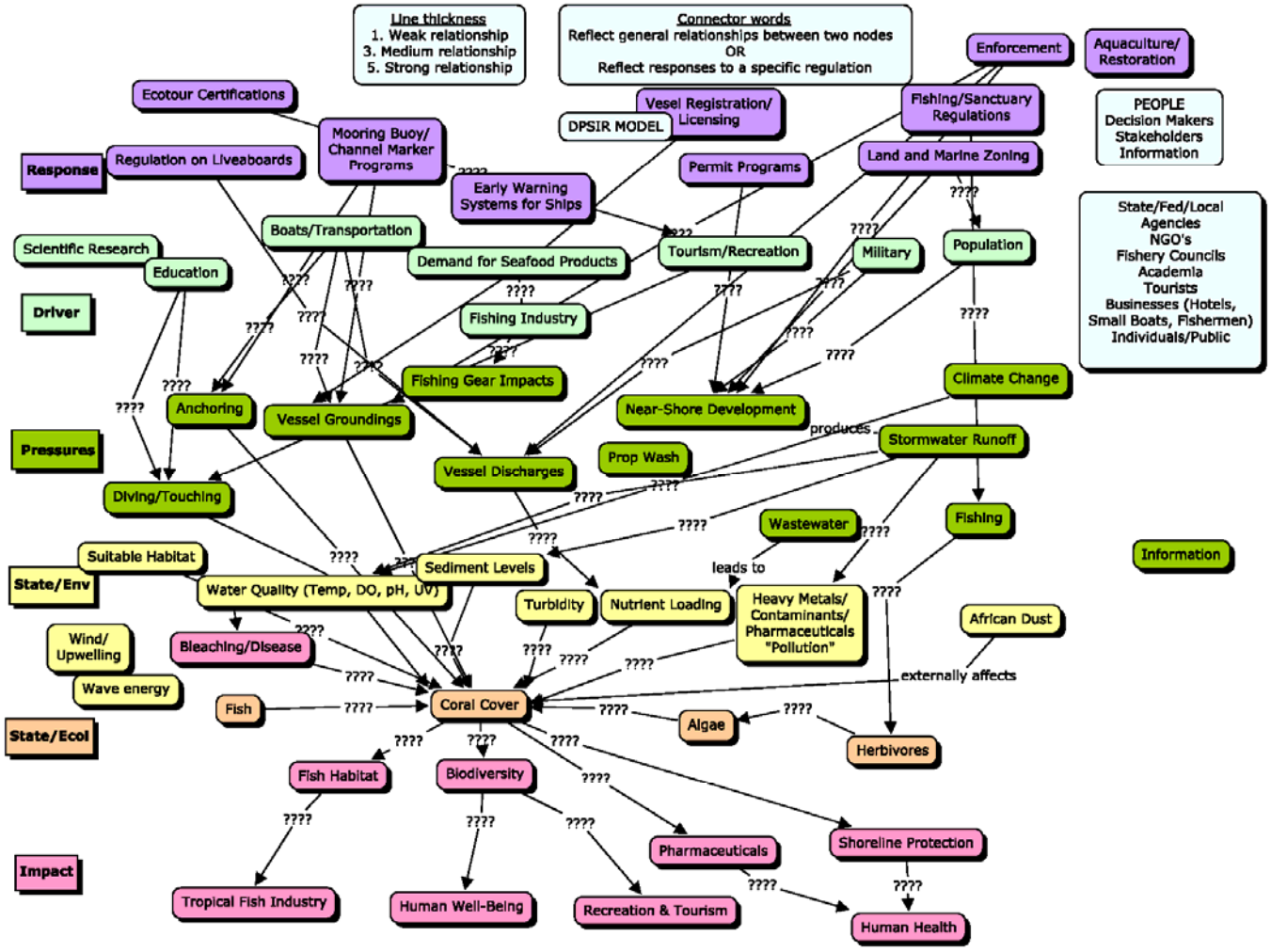
Evaluate Management Options

For each option:

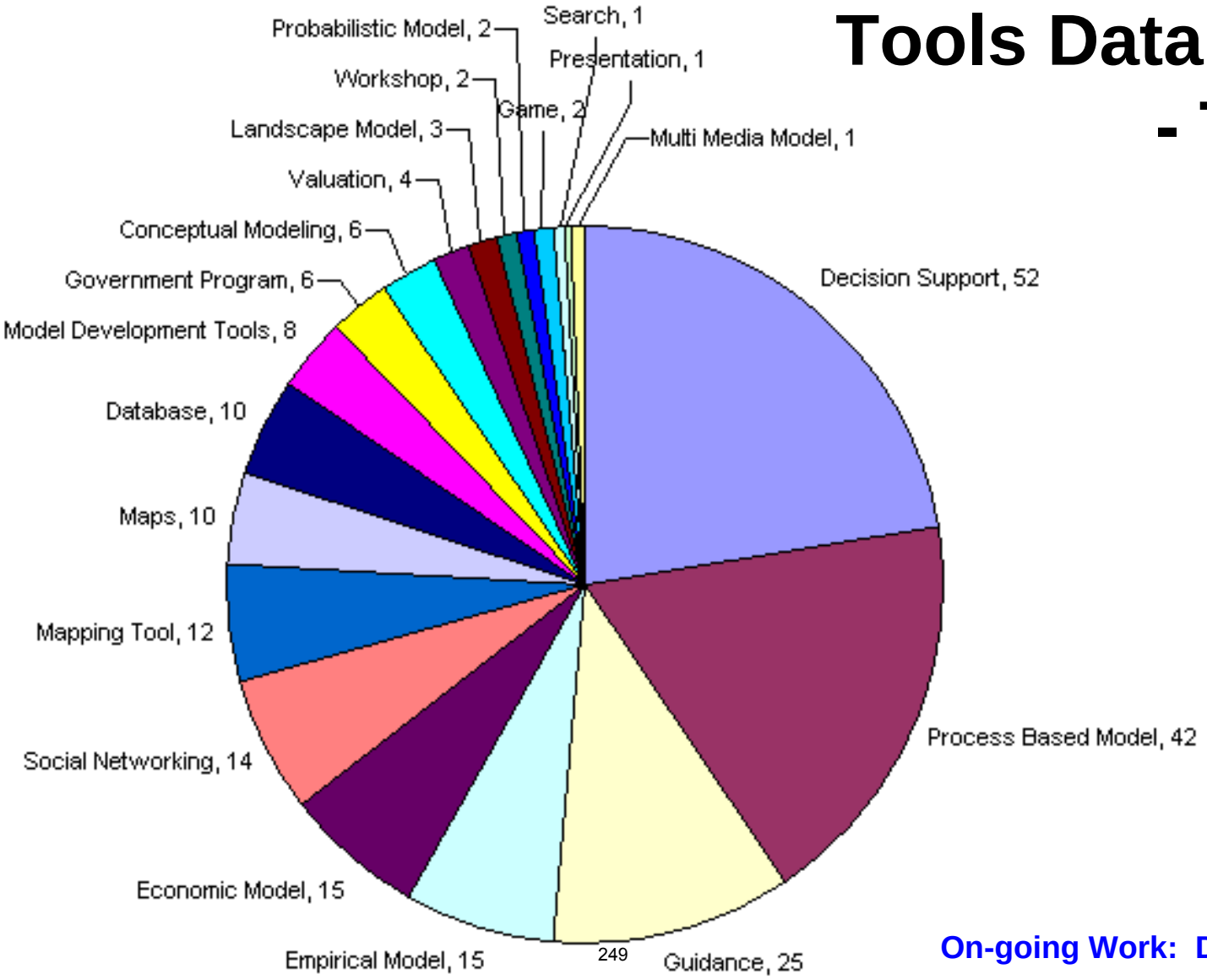
- Identify drivers (human needs, e.g., access to ocean for food, recreation, etc.)
- Identify pressures (human activities, e.g., road expansion, housing)
- Identify environmental, ecological, political, regulatory, economic, societal conditions (state)
- Identify impacts to ecosystem services and cultural values (what people care about)
- Understand interrelationships between all of the above, the strength of those effects, and uncertainty
- Understand legal, scientific, technological and economic constraints and limitations
- Use sensitivity and uncertainty analysis to determine where more research is needed and where actions would result in the greatest benefits.



DPSIR for Coral Cover



Tools Database - Type



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On-going Work: Database

Proposed Next Steps

- Continue to work directly with Coral Reef decision-makers
  - Multiple locations with similar concerns but different political climates, stakeholders, decision-makers, levels of expertise/experience
- Review and evaluate participatory decision-making processes used in other ESRP projects
- Co-Develop (with Nitrogen Lead) decision support product(s) for the management of Nitrogen
- Identify a sociologist (expert?) willing to work directly with us
- Increase focus on developments in the areas of participatory decision-making within the U.S.
- Continue to investigate social networking sites and analysis
- Continue to refine and improve the database (with outside partners from coral reef teams and others)

Proposed Revised Goals

- Continue to populate the database; improve it based on feedback; and develop a user interface allowing access to both our database and the EBM Tools Network database
- Test the emerging vision in a real-world situation using an integrated, multi-disciplinary team
- Identify “common” decisions, if possible
- Enhance our knowledge and use of participatory decision making processes and social networking tools and analysis

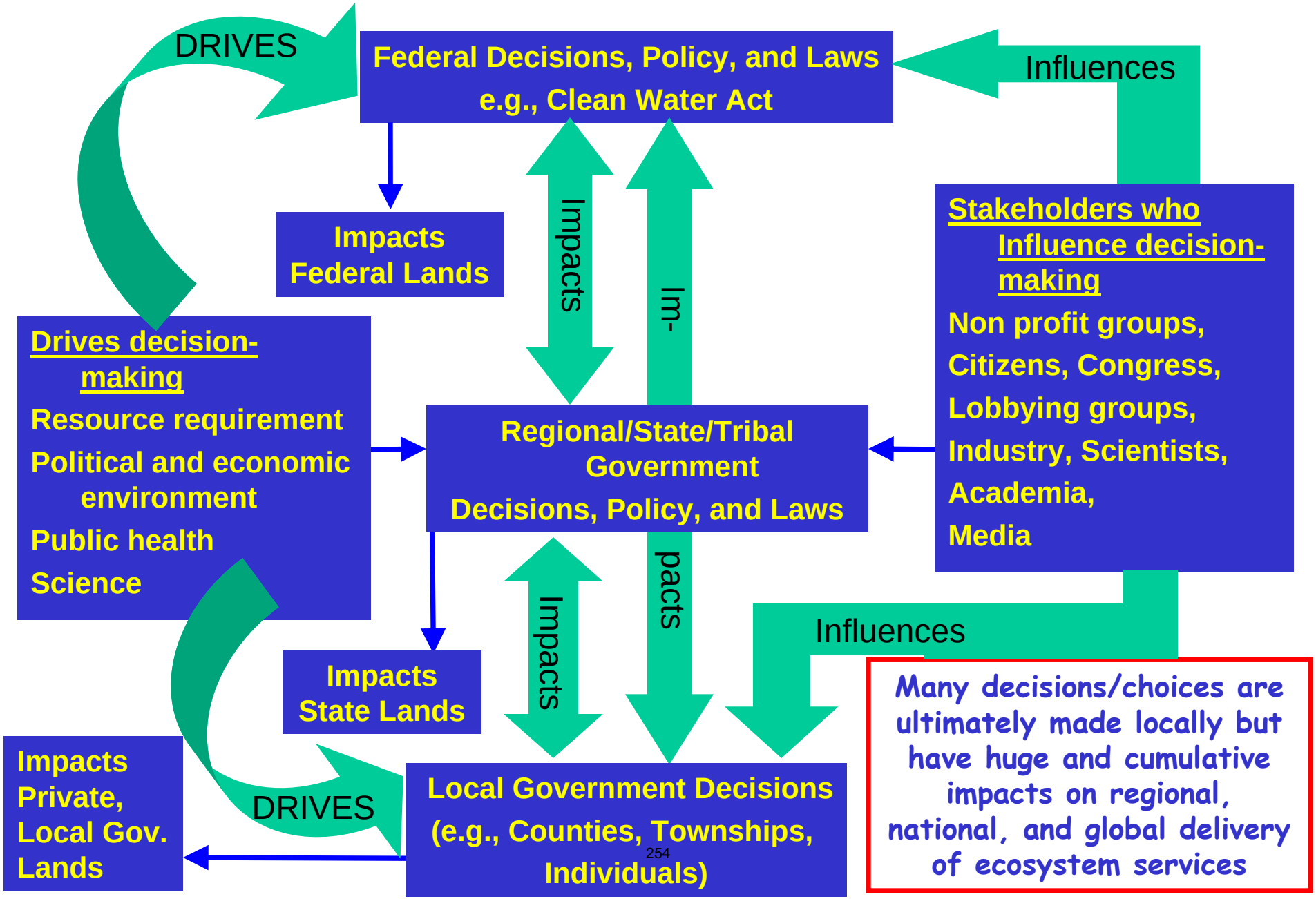
Challenges

- Decision-makers' responsibilities and authorities are often narrowly defined
- A huge potential exists for cumulative and incremental impacts of multiple local decisions on larger scales and local consequences of region/national/global environmental policy
- Current regulations don't always allow regulators to look at cumulative impacts

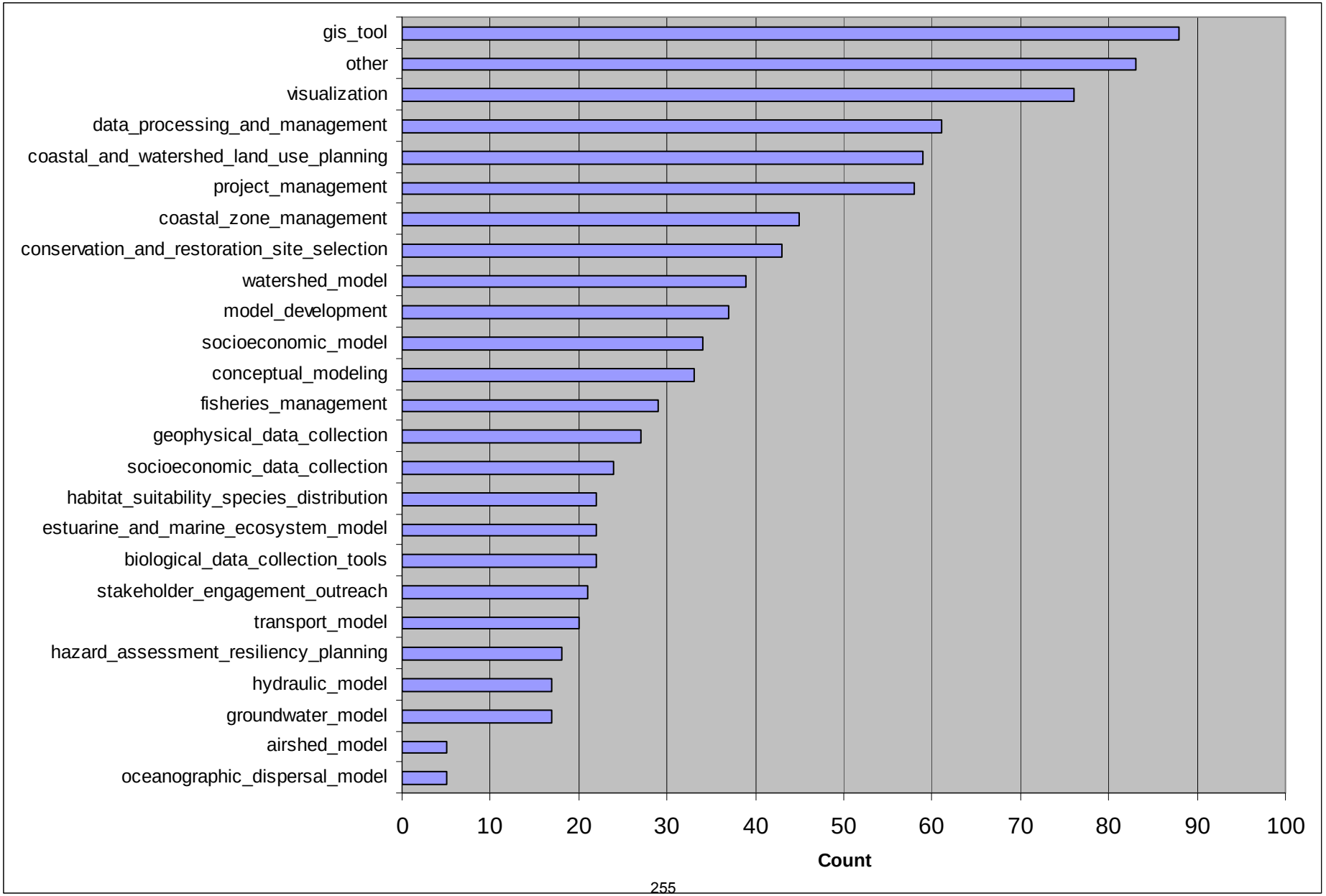
- Does our emerging vision serve as a way to address these challenges?

Open Discussion

Decision-Making Occurs at Multiple Levels



What does the tool do…



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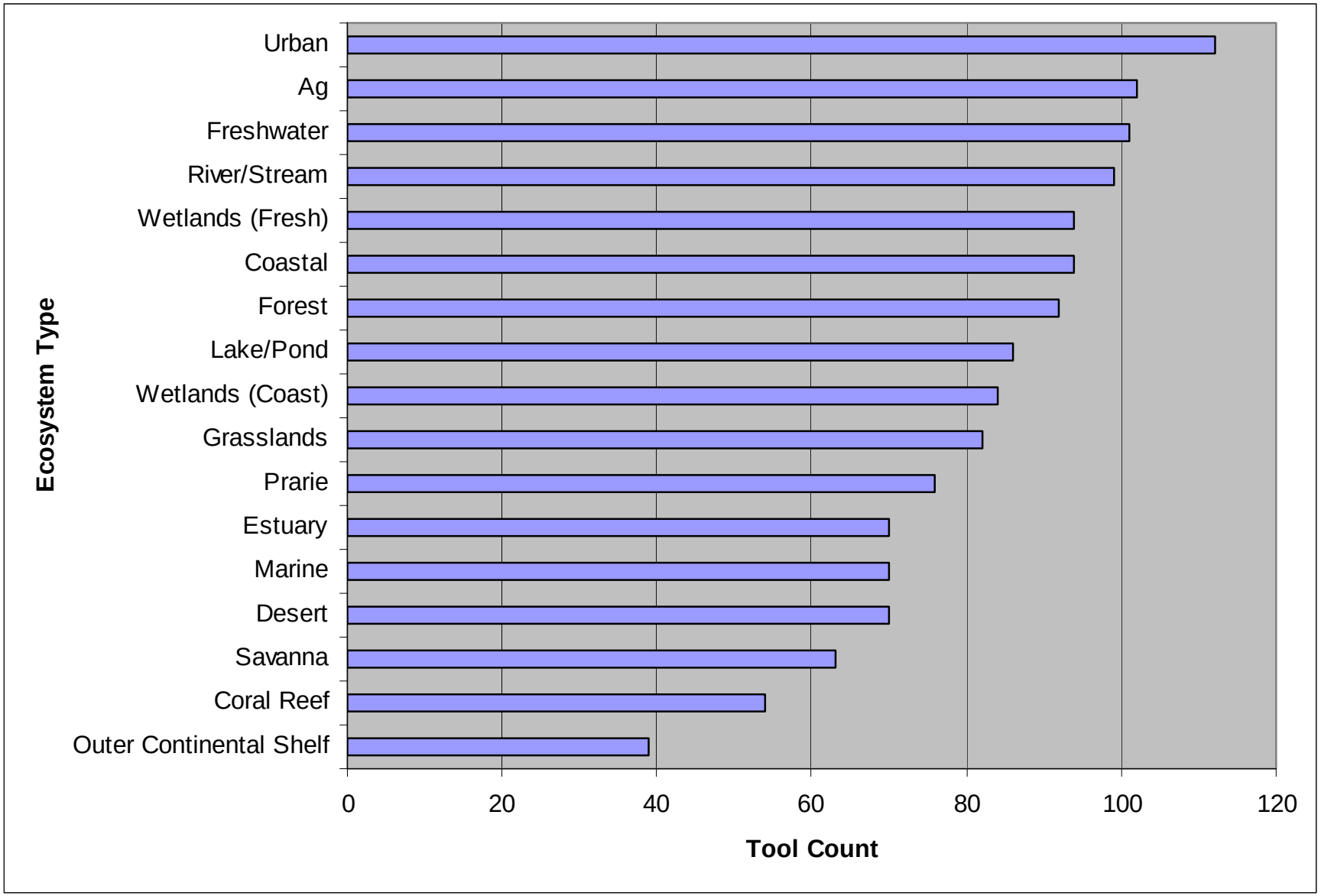
On-going Work: Database

Ecosystem Type



On-going Work: Database

Documents that Influenced Directions

- U.S. Environmental Protection Agency. 2000. Toward Integrated Environmental Decision-Making. (EPA-SAB-EC-00-011). Office of Research and Development, Washington, DC
- National Research Council. 2005. G.D. Brewer and P.C. Stern (eds.) Decision Making for the Environment, Social and Behavioral Science Research Priorities. National Academy Press, Washington, DC
- Fischhoff, B. (2008) "Nonpersuasive Communication about Matters of Greatest Urgency: Climate Change." Environmental Science & Technology 41(21), 7204-7208.
- Fischhoff, B. (2005) "Cognitive Processes in Stated Preference Methods." In Mäler, K.-G., Vincent, J. (Eds). Handbook or Environmental Economics. Elsevier, Amsterdam. pp.937-968.
- Renn, O. (1999) "A Model for an Analytic-Deliberative Process in Risk Management." Environmental Science and Technology 33 (18), 3049-3055.
- Gregory, R. and Keeney, R. (2002) "Making Smarter Environmental Management Decisions." Journal of the American Water Resources Association 38 (6), 1601-1612.

Appendix J – Summary of Key Points Discussed

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.