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## ECOLOGICAL RESEARCH PROGRAM

BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

# Ecosystem services as a new strategic focus for U.S. EPA's Ecological Research Program

**Presentation for the SAB  
December 17, 2007**

**by  
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## ECOLOGICAL RESEARCH PROGRAM

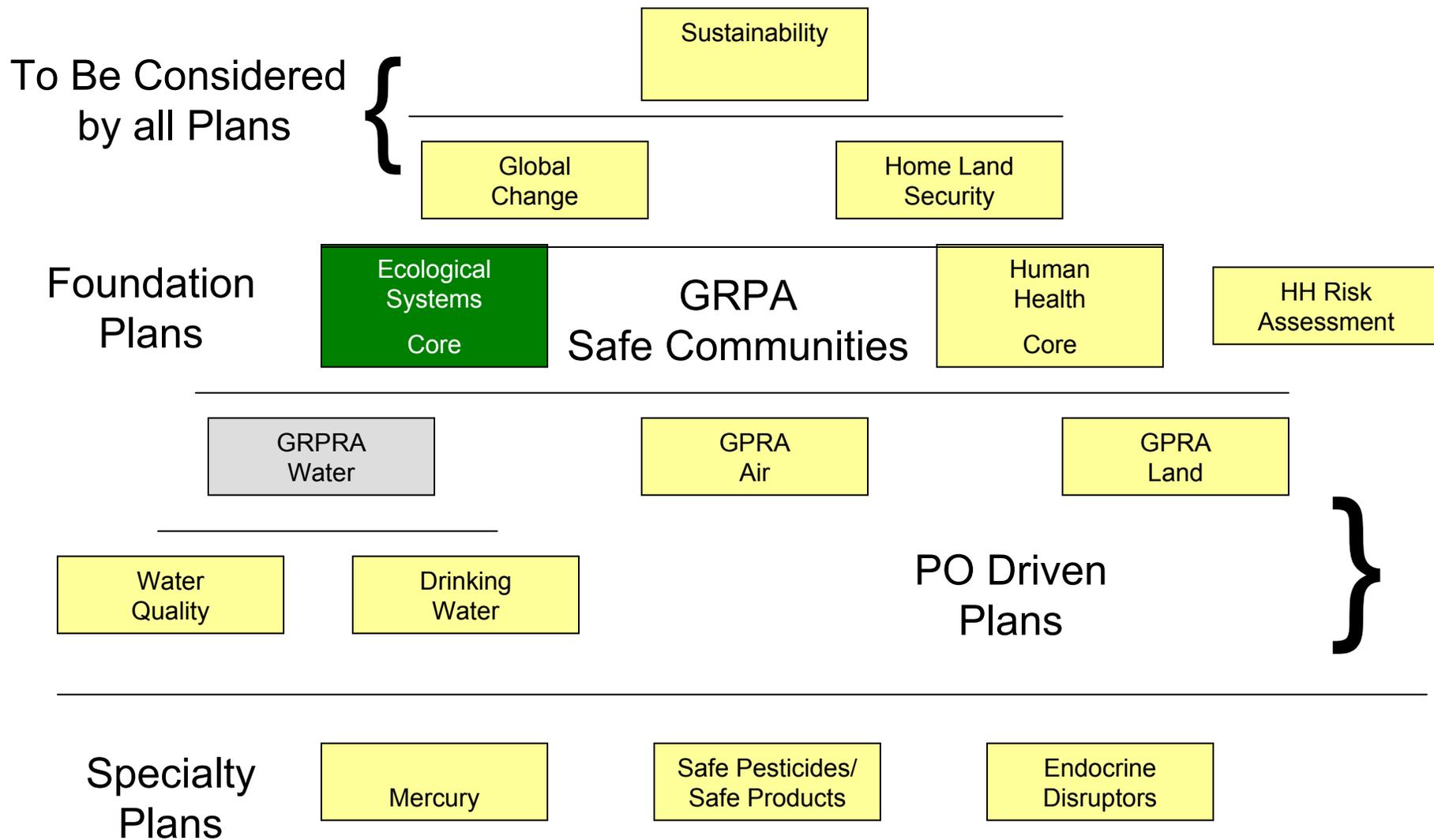
BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

# ***ERP in the ORD Research Context***

***And then there were 13 Plans?***



# ECOLOGICAL RESEARCH PROGRAM



Plans are in yellow, gray is a two part plan, and the green is the ERP

## ***2005 ERP Goals***

- ***Long-Term Goal 1: National policy makers will have the tools and technologies to develop scientifically-defensible assessments of the state of our nation's ecosystems and the effectiveness of existing national programs and policies***
- ***Long-Term Goal 2: States and tribes apply improved tools and methods to protect and restore their valued ecological resources***
- ***Long-Term Goal 3: Decision-makers understand the importance of ecosystem services and make informed, proactive management decisions that consider a range of alternative outcomes***

## ***BOSC Comment***

- *“The research, tools, and analytical technologies developed under the ERP represent the most comprehensive federal government research program examining the provision of ecosystem services and the communication of these to decision-makers. **LTG 3 is a highly relevant activity that is central to EPA’s mandate of improving environmental quality and protecting and restoring the health of the nation’s ecosystems.** ORD and particularly the ERP are uniquely suited and positioned to address these issues.” [emphasis added].*

## ***SAB Valuation Committee***

Several members noted that the committee report is consistent with the direction of the research program and commended Dr. Linthurst for the work done so far. One member noted the value of EPA investment in research directions advocated by the committee.

From U.S. Environmental Protection Agency  
Science Advisory Board (SAB)  
Committee on Valuing the Protection of Ecological Systems and Services (C-VPESS)  
Summary Meeting Minutes of a Public Teleconference Meeting  
12:30 p.m. - 2:30 p.m. (Eastern Time)  
June 12, 2007

**12/10/2007**

# LIVING BEYOND OUR MEANS



## NATURAL ASSETS AND HUMAN WELL-BEING

*Statement from the Board*

## ***Influential Finding Affecting ERP (MEA)***

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

## *Drivers Beyond MEA*

- An Executive Order that has been without ecological input (*Executive Order 12866, 9/30/93*).
  - (<http://www.epa.gov/regulations/follow.htm>)
- The other drivers include:
  - The administrators charge to advance environmental protection while maintaining our economic competitiveness,
  - The increased emphasis on environmental stewardship and information to make better decisions without regulation,
  - Sustainability of ecosystems/services as an Agency theme, and
  - Urban sprawl and rapid loss of natural areas
- Regulatory Authority
  - There is some legal authority to protect services! But a fork will never serve soup as well as a spoon... Jim Salzman, Duke University

## ***Ecological Research Program Goal***

To transform the way we understand and respond to environmental issues **by making clear the ways in which our choices affect the type, quality and magnitude of the services we receive from ecosystems** -- such as clean air, clean water, productive soils and generation of food and fiber.

# **The Challenge:**

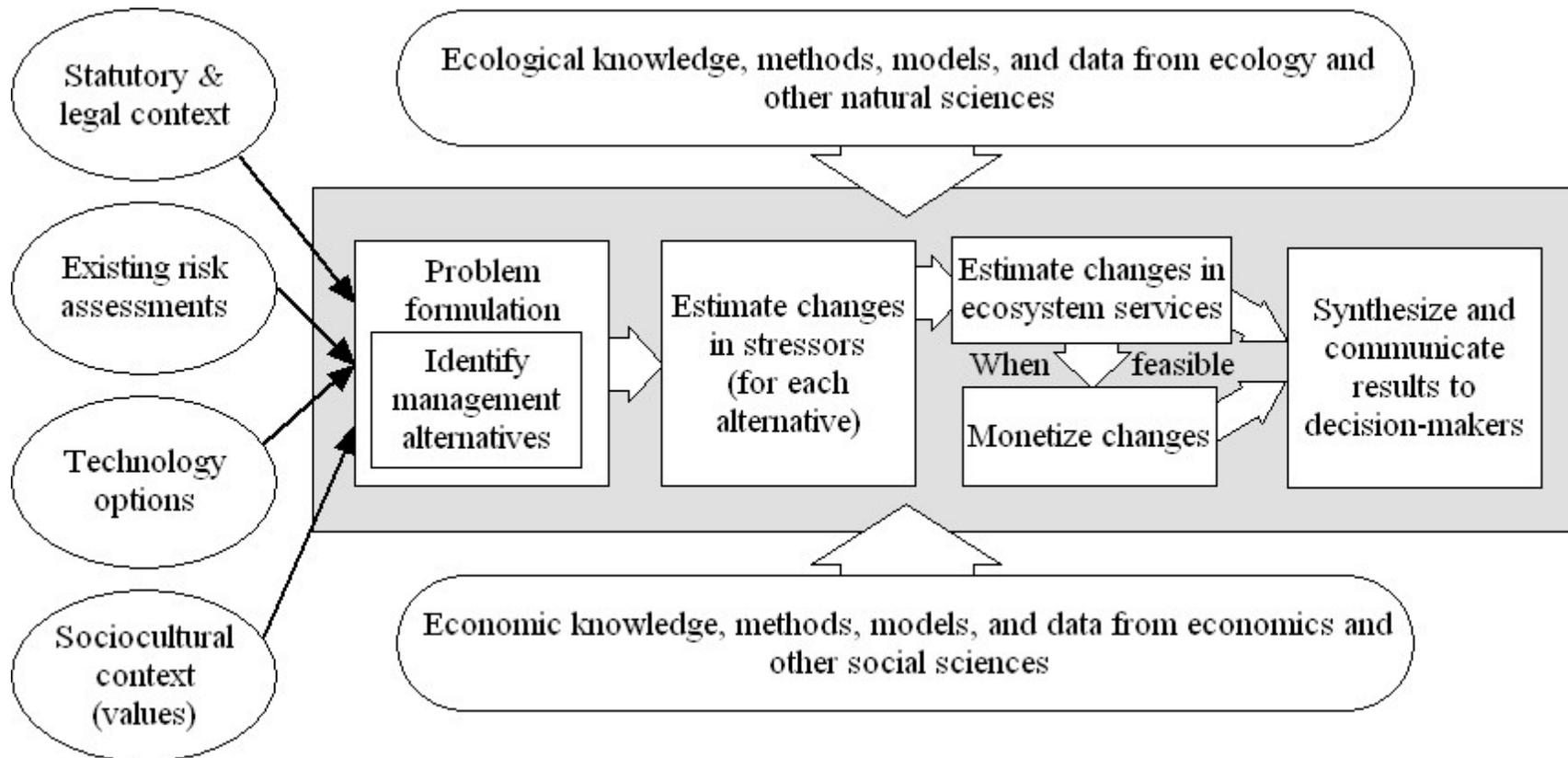
**Change the economic and human  
well-being foundation for  
environmental  
decision-making**

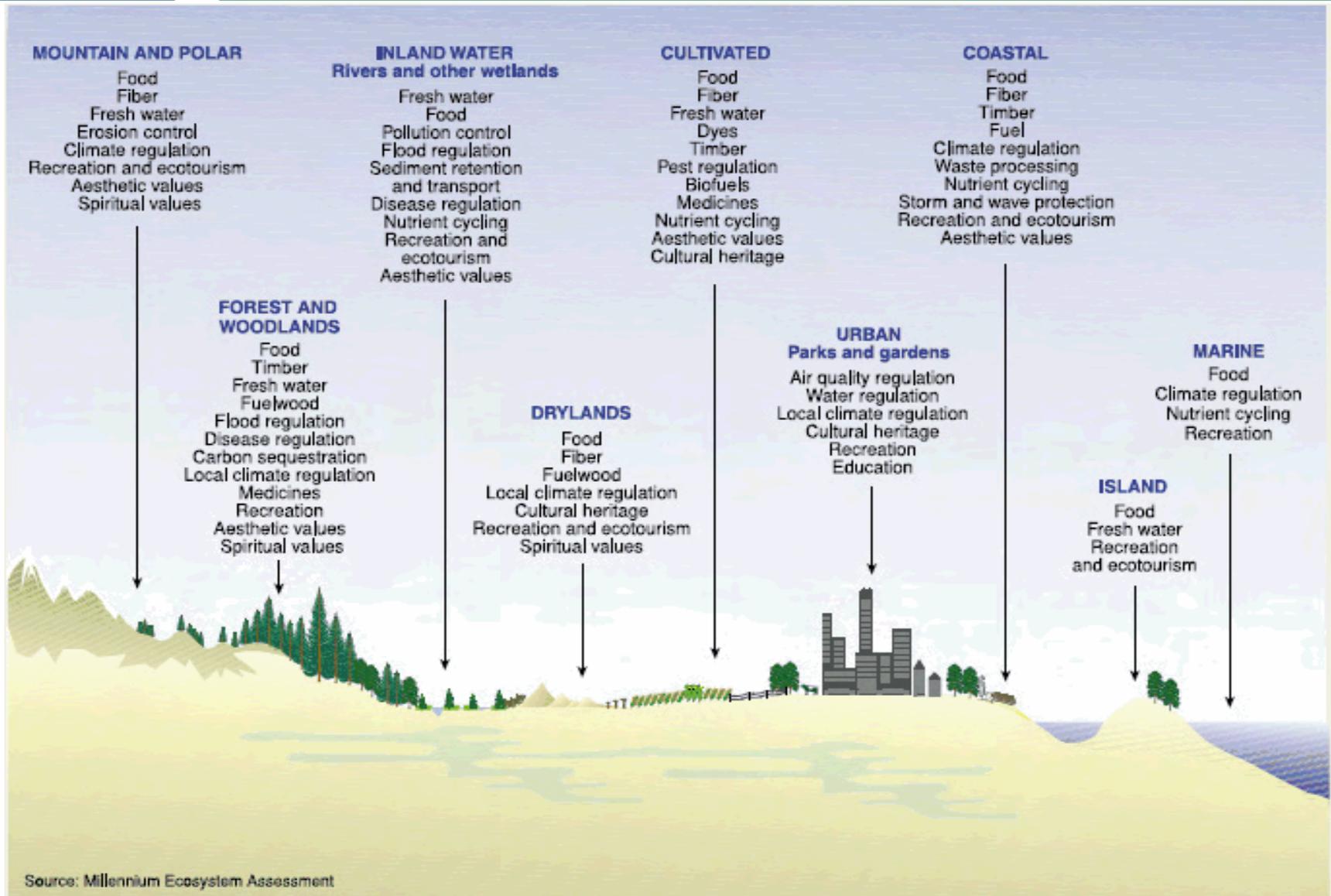
# Ecological Benefits Assessments Strategic Plan

2007

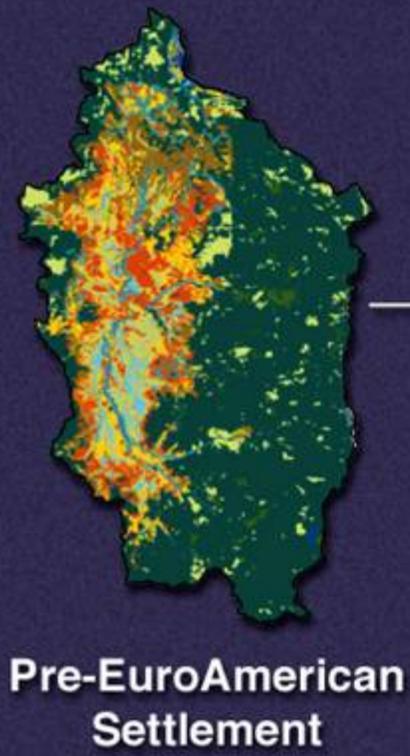


# *Interdisciplinary decision support*





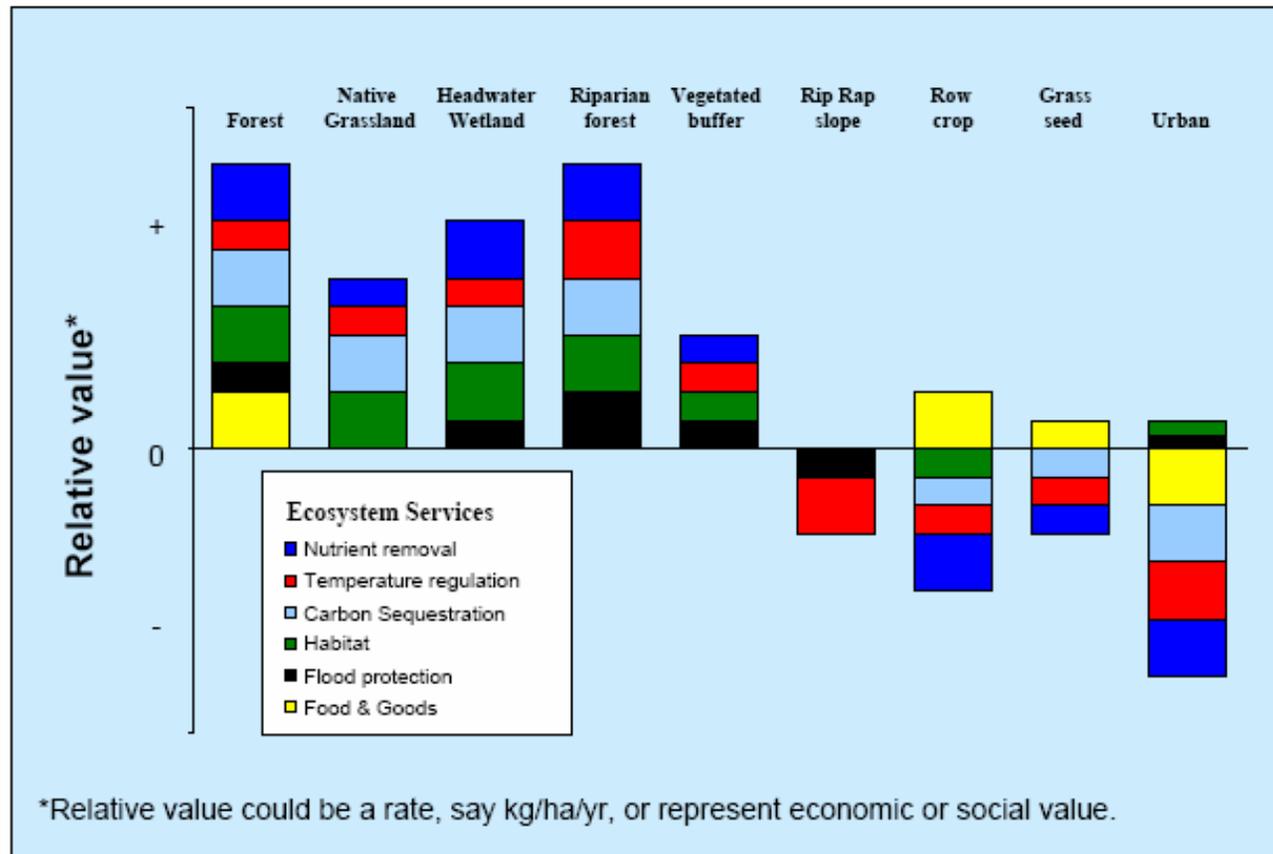
# Trajectories of Landscape Change in the Willamette Basin



Translating services into quantifiable spatial metrics

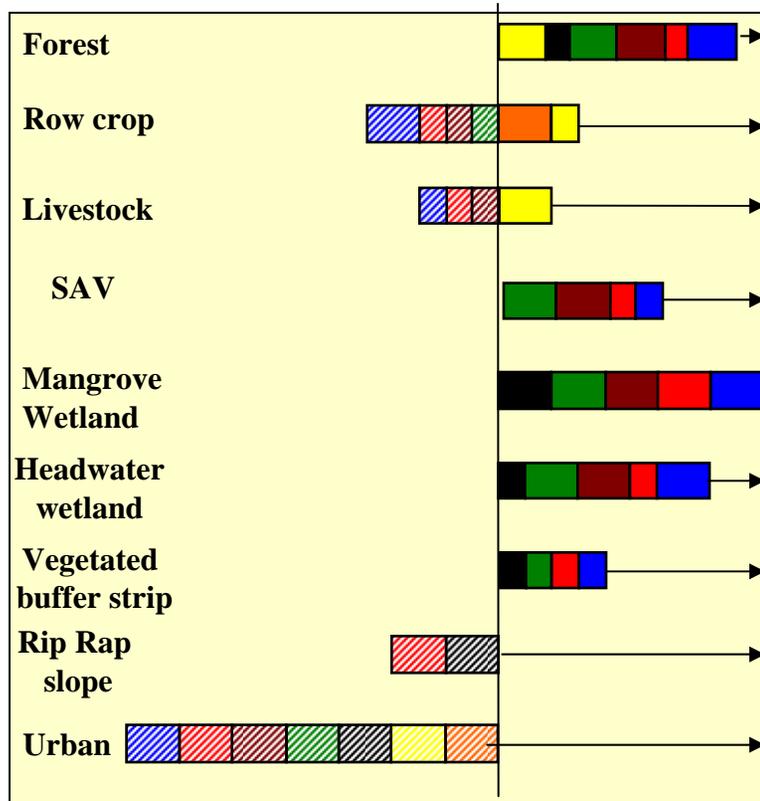
Development 2050

## Hypothetical ecosystem service values: *Bundled by land use in the Willamette ESD*

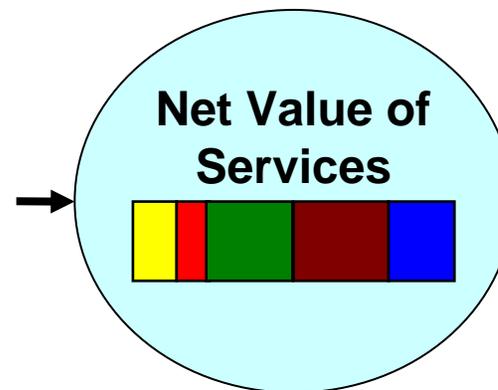
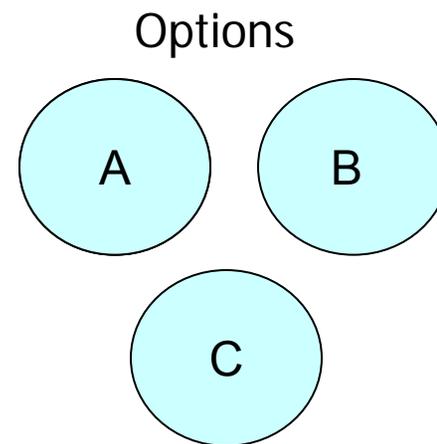


# End Product

## *Relative Ecosystem Services Within an Ecosystem District*



Scaling and Aggregation Under Alternative Management Scenarios



Management Option X

12/10/2007

## *Terms*

- **Ecosystem Services**
  - *the current and future outputs of functioning, complex ecological systems that are enjoyed, consumed, or used by humans and that support their well-being, either directly or indirectly.*
  
- **Ecosystem Service Districts**
  - **a spatial boundary that delimits a core geographic area for the purpose of efficient, simultaneous management of multiple ecosystem services.**

Note that this boundary is not likely to coincide with watershed or municipal boundaries, but rather would be configured to address multiple services desired for an area.

## ***Elements: a three prong approach***

- **Pollutant Driven Ecosystem Services Research**
  - How does a regulated pollutant affect, positively and/or negatively the collection/bundle of ecosystem services at multiple scales?
- **Ecosystem Driven Ecosystem Services Research**
  - How does the collection/bundle of ecosystem services provided by a single ecosystem type change under alternative management options at multiple scales?
- **Place Driven Ecosystem Services Research**
  - How do the collection/bundle of ecosystem services for all ecosystems within an ecosystem district change under alternative management options/drivers?

## ***BOSC Midyear Review May 2007***

- The report also noted that the BOSC recognizes that progressing development and refocusing of the ERP and meeting expectations generated in response to the 2005 review are significant accomplishments in light of budget reductions.



# ECOLOGICAL RESEARCH PROGRAM

Projects and Long term Goals →		Pollutant Specific Studies: Nitrogen Regulation Services LTG 3	Eco-system Specific Studies: LTG 4			Community Based Demonstration Projects: For National, Regional, State and Local Decisions (includes Nitrogen and Wetlands services) LTG 5				Theme Leads
	Cross Program Themes and Research Objectives		Wetlands	Coral Reefs	Willamette	Tampa Bay	Mid-West	Coastal Carolinas		
Inventory, Map, and Forecast Ecosystem Services at multiple scales (National Atlas) LTG 2	Ecosystem Services and Human Health								Laura Jackson	
	Landscape Characterization and Mapping								Anne Neale Megan Mehaffey	
	Inventory and Monitoring of Services								Steve Jordan Mike McDonald	
	Modeling for Scenarios and Forecasting for different management options								John Johnston	
Integration, Decision Support and Outreach LTG 1	Valuation of Ecosystem Services								Wayne Munns	
	Decision Support Platform Created to Integrate Findings from Entire Program								Ann Vega Betsy Smith	
	Outreach & Education to inform decision makers of platform and findings								Suzanne Marcy	
Project Area Leads	Rick Linthurst And Iris Goodman	Jonathan Garber	Mary Kentula/Virginia Engle	Bill Fisher	Dixon Landers	Marc Russell	Randy Bruins/Betsy Smith	Dorsey Worthy	Rick Linthurst	
					Megan Mehaffey Place Based Coordinator				Iris Goodman	
Additional Coordination/Integration Required										
Wetlands										Steve Jordan
Nitrogen										Jonathan Garber

**USEPA, Office of Research and Development  
Ecological Research Program: Strategic Direction,  
September 13, 2007**

**I. Program Context: Impetus and Evolution**

The Ecological Research Program (ERP) is setting a new strategic direction to meet compelling needs for better understanding the implications of human impacts on ecosystems and the resources they provide. The processes and functions of ecosystems, the foundation of our health, livelihoods and well-being, are now at risk worldwide.

Scientific and policy reports over the last decade document the need to conserve irreplaceable services provided by ecosystems (e.g., NAS, 1997<sup>1</sup>; MEA 2005<sup>2</sup>; BOSC, 2005<sup>3</sup>; EPA Stewardship Initiative, 2006<sup>4</sup>; EBASP, 2006<sup>5</sup>; SAB C-VPES 2007<sup>6</sup>; Restoring Nature's Capital, 2007<sup>7</sup>). The United Nations Millennium Ecosystem Assessment (MEA) is one of the most comprehensive reports to date, and documented declines in 15 of 24 ecosystem services worldwide.<sup>8</sup> Of particular note, the MEA concluded that:

*“Even today’s technology and knowledge can reduce considerably the human impact on ecosystems. They are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless, and their full value is taken into account.”  
(MEA 2005)*

The nation’s health, security, economic potential, and much of its culture are directly and intimately tied to ecosystem characteristics and quality. Even so, policy and management decisions have failed to take these relationships into account. The ERP will work to change this.

The ERP has been recognized as being in a unique position within the federal government for its research to establish and communicate a greater understanding of the value of ecosystem services and their interdependent relationship to human activities and well-being (BOSC 2005, 2007<sup>9</sup>). ERP scientists conduct core, multi-media research in support of the Agency’s Healthy Communities and Ecosystems goal and past results directly support EPA program office needs, and are now used by EPA Regions, states, and Tribes (e.g., Office of Water is requesting that Environmental Monitoring and Assessment Program (EMAP) procedures be used in all 50 states).

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<sup>1</sup> "NAS 1997" = *Building a Foundation for Sound Environmental Decisions*, Chapter 4: EPA's Position in the Broader Research Enterprise, National Academy of Sciences, 1997. available at <http://www.nap.edu/openbook/0309057957/html/49.html>

<sup>2</sup> <http://MAweb.org>

<sup>3</sup> BOSC 2005 <http://www.epa.gov/osp/bosc/pdf/eco0508rpt.pdf>

<sup>4</sup> [www.epa.gov/epainnov/pdf/rpt2admin.pdf](http://www.epa.gov/epainnov/pdf/rpt2admin.pdf)

<sup>5</sup> US EPA. 2006. Ecological Benefits Assessment Strategic Plan. EPA-240-R-06-001. U.S. Environmental Protection Agency, Office of the Administrator, Washington, DC.

<sup>6</sup> [http://www.epa.gov/sab/07minutes/c-vpress\\_06-12-07\\_minutes.pdf](http://www.epa.gov/sab/07minutes/c-vpress_06-12-07_minutes.pdf)

<sup>7</sup> Restoring Nature's Capital: An Action Agenda to Sustain Ecosystem Services, 2007" available at [http://pdf.wri.org/restoring\\_natures\\_capital.pdf](http://pdf.wri.org/restoring_natures_capital.pdf)

<sup>8</sup> We define ecosystem services as **the products of ecological functions or processes that directly or indirectly contribute to human well-being, or have the potential to do so in the future.** This definition provides a broad interpretation of ecosystem services to characterize services that may or may not be quantifiable.

<sup>9</sup> BOSC 2007 <http://www.epa.gov/osp/bosc/pdf/ecomc082307.rpt.pdf>

## **II. Strategic Directions, Science Challenges, and Research Needs**

By 2009, the ERP will transition its focus to analyses of ecosystem services. We will conduct innovative, trans-disciplinary research that provides insights, information, and methods that enable decision-makers to assess the benefits of ecosystem services to human well-being. By doing so, we hope to secure the integrity and productivity of our ecological systems over time and at multiple scales. Our goal is to transform the way decision-makers understand and respond to environmental issues, making clear the ways in which their policy and management choices affect the type, quality, and magnitude of services we receive from ecosystems -- such as clean air, clean water, productive soils, and generation of food and fiber.

This new focus will be founded on ERP's extensive experience in environmental monitoring and assessment (EMAP), landscape ecology, modeling ecological stressor-response relationships, assessing vulnerability to natural and human stressors over regional scales (ReVA), and developing alternative future scenarios. It also reflects increased emphasis on ecological forecasting previously described in the ERP's 2003 Research Plan. This new focus parallels recent significant decreases in the ERP's budget and the resulting reduction in the amount of effort that can be placed on collection of regional and national scale field data.

**Scientific Challenges:** It is a significant scientific challenge to translate intuitive concepts about ecosystem services into operational methods for routinely incorporating quantitative information about these services into decision-making at all scales of governance. Doing so will require the development of credible, scientifically-based methods to:

- Inventory, measure and map, ecosystem services at multiple scales.
- Improve understanding of the effects of stressors on ecosystem services using stressor-response relationships and predictive models.
- Define compelling alternative management options and forecast future scenarios and outcomes.<sup>10</sup>
- Develop a decision support platform for decision-makers which enables them to explore outcomes of alternative decision options.
- Identify the "art of the possible" by making intelligent, informed use of knowledge about ecosystem dynamics, thresholds, and resilience; and cross-scale connections among social drivers and natural systems.

**Drivers Prompting these Challenges:** The ERP will be the first integrated US Federal program to address the difficult topic of maintaining, enhancing and restoring the services provided by the natural environment. The need is significant. In addition to national and international assessments noted above, policy drivers unique to EPA (Executive Order 12866), require an examination of the environmental costs and benefits of EPA's regulatory actions (<http://www.epa.gov/regulations/follow.htm>). Since its inception in 1993, implementation of this Order has been hindered by the inability of EPA to account for the value of ecosystem services and the cost of their loss. Having tools to account for ecosystem services will benefit all Agency Program offices responsible for implementing EO 12866. ERP research will also provide a foundation for implementing EPA's Ecological Benefits Assessment Strategic Plan (2006). To

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<sup>10</sup> Forecasting and scenario development yield plausible estimates of future outcomes, not precise predictions of short-term events. The latter is covered in the domain of calibrated modeling techniques.

meet needs for valuation and human health research, the ERP is forming partnerships with economists and social scientists within and outside the Agency to establish trans-disciplinary linkages among social and cultural values, economic and financial assessments, non-monetary valuation, and ecological outcomes. Our research will also support Administrator Johnson's charge to "advance environmental protection while maintaining our economic competitiveness." ERP will also provide methods to "conserve and restore ecosystem functions and services" as called for in EPA's Environmental Stewardship Initiative (2006). Our direction responds to needs identified in the Millennium Ecosystem Assessment (2005), the MEA Action Agenda (2007) and the BOSC 2005 and 2007 Program Review Recommendations.

**Research Questions:** The overarching research question for the Program is: *What are the effects of multiple stressors on ecosystem services, at multiple scales, over time?* To answer this question we need to develop quantitative, operational definitions for ecosystem services; know how these services are distributed throughout the landscape, and in what quantity and quality; project how they will respond to combinations of large and small scale stressors; and determine alternative management options that would optimize their sustainability.

### **III. Current Research Directions: Foundation for Future Research**

In 2007, ERP is conducting research on monitoring, diagnostic and forecasting, and restoration.

**Monitoring:** The ERP developed the Environmental Monitoring and Assessment Program (EMAP) to establish statistically-valid, scientifically defensible monitoring frameworks to measure, assess, and report on the status and trends in ecosystem condition at regional and national scales. EMAP has successfully completed national assessments using this framework and has pioneered research to create landscape atlases that have been widely used in government and by NGOs. The ERP is transferring technical support for survey monitoring and assessment to EPA Program Offices; essential technical support for these activities will continue through the Water Quality Program. ERP will continue to analyze EMAP data and analyses as a starting point for identifying, measuring, mapping, and monitoring ecosystem services. The extensive EMAP data base will be invaluable in early testing of hypotheses focusing on landscape-related ecosystem services, such as provisioning and storage of fresh water, regulating nutrients and biogeochemical cycling, and maintaining diverse, resilient terrestrial and aquatic habitat. In collaboration with the Gund Institute at the University of Vermont and the National Geographic Society, the ERP is currently exploring the feasibility of joint production of a report and atlas describing the "State of the Nation's Ecosystem Services."

**Diagnostics and forecasting:** The ERP is nearing completion on a variety of new methods to diagnose impairments to ecosystems. These include the Causal Analysis / Diagnosis Decision Information System (CADDIS); on-line decision tool-kits to assess regional vulnerability to natural and human stressors in the Mid-Atlantic, Southeast, and Midwest; new multi-media models to estimate the time needed for decreased air mercury emissions to result in fish safe for human consumption; and a suite of studies that are developing ways to quantify and forecast thresholds, or tipping points, in aquatic ecosystems. The ERP will build on its experience in diagnostic and forecasting methods for developing models and spatial techniques to forecast the response of ecosystem services to natural and human stressors at multiple scales and to quantify these responses in biophysical terms.

**Restoration:** The ERP has focused its research on restoration on aquatic systems. We are nearing completion of studies that document the effectiveness of riparian buffers on water quality; the effectiveness of small wetlands in restoring water quality in agricultural watersheds; prioritizing watersheds for restoration in the Mid-Atlantic highlands; examining the restoration potential for streams affected by mining; and restoring large floodplain rivers to obtain multiple ecosystem services, including innovative use of natural groundwater cooling to treat thermal discharges while simultaneously improving aquatic habitat, non-structural flood control, and recreational opportunities.

**Future Research and Critical Path:** The proposed research is designed to answer multiple questions about ecosystem services. We will develop multiple measures of services, including biophysical and monetary measures, to estimate incremental changes to ecosystem services, as well as suites of “bundled” services associated with land, air, and water systems over explicitly defined spatial and temporal scales.

Our goal 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. ERP will meet high-priority EPA program office and region needs with direct relevance to EPA’s mission. We will address (a) *a national-scale pollutant – reactive nitrogen*, (b) *a priority ecosystem – wetlands*, and (c) *complex ecosystems —at community-specific locations* (Mid-west, Willamette, Tampa Bay and the Coastal Carolinas) representing a spectrum of physiographic and socioeconomic characteristics; local, regional, and national drivers of change to ecosystems; and the type and impact of decisions. In addition, cross cutting themes for *human health, landscape, inventory design, model development* and *valuation* will be investigated. Each research project and theme is currently being developed into a research and implementation plan that will include a critical path for work to be done.

**Our Role and Partnerships:** The ERP is pursuing a strategy of leadership and collaborative partnerships in order to implement its research program. The EPA mandate to “protect human health and safeguard the natural environment” places us in a unique position to lead efforts to characterize the critical link between ecosystem services and human well-being. However to meet our research objectives we must mobilize our own expertise and engage strong partners.

We have established partnerships with EPA Regions 4, 5, 7, 8, 10 and with EPA’s National Center for Environmental Economics (NCEE). We are benefiting from existing partnerships with the academic community via the extramural STAR grant program, representing about 15 universities through 2008 (currently there is no future funding for the ERP STAR program due to budget constraints). We are currently developing non-traditional partnerships with NGOs and other organizations. The ERP has established (or in process) collaborative agreements the Gund Institute for Ecological Economics, the Willamette Partnership, the Natural Capital Project, National Geographic, and NSF’s National Ecological Observatory Network (NEON). Finally, the ERP is co-chairing with USDA Forest Service, an Interagency Workgroup on Ecosystem Services under the auspices of OSTP’s Committee on Environment and Natural Resources (CENR) Subcommittee on Ecological Systems. Several individual collaborations are underway with NOAA related to coastal systems, and with USDA related to biofuels development.

We are also seeking ways to harness the capabilities of internet communications in order to achieve the widest possible review of our research program and to seek input and suggestions from others.

#### **IV. Making a Difference**

The ERP will collaborate with partners to create a decision support platform housing models, maps, animations, and other data-rich displays that make possible the proactive examination of a range of management options for user issues at multiple explicit spatial and temporal scales. We intend to present a new generation of decision support tools, models and visual arrays to better engage and meet the needs of policy makers and managers, and enhance ecological, social and financial knowledge and resources needed to protect and restore ecosystems and their services. The ERP is meeting with federal partners, planners and others to investigate what is needed and by whom to build the architecture for this on-line product.

**Research Products:** The Ecological Research Program has created four major categories of research products: (1) *Measurements and dynamic maps of ecosystem services*: spatial representations of ecosystem services for communication, outreach, planning, assessment, and resource management; (2) *Predictive models relating to the response of stressors*: forming a foundation to forecast change and proactively assess how ecosystem functions and services are likely to respond to natural and human stressors; (3) *Management Options* using prospective tools, singly and in complex arrays, to develop alternative future scenarios; and (4) *Decision Support* to allow managers and decision-makers to explore how various policies may affect the likely distribution of ecosystem services, human health and well-being outcomes, now and in the future.

**Applying Research Results in the Public and Private Sector:** The ERP research program is designed to act as a catalyst for innovation in policies, rules, and governance by (1) *Setting policies and guidelines* that can achieve our mission through a variety of policy instruments that do not have the legal force of national rules; (2) *Quantifying benefits for national rule-making* in response to the Office of Management and Budget data requirements for benefit–cost assessments; (3) *Developing environmental metrics and indicators for ecosystem services* for use in periodic reports on the environment or for establishing environmental accounts within our national Gross Domestic Product accounts; and (4) *Catalyzing market innovations* that engage the private sector for environmental protection. ERP research can provide information useful for reducing transactions costs; estimates on the availability, reproducibility, permanence and/or longevity of ecosystem services over space and time; identify opportunities for maximizing multiple services per investment; recommend metrics for documenting environmental outcomes; and provide credible timelines required to achieve expected outcomes (i.e., there is often a lag between action and environmental response).

**Environmental Outcomes:** Measures of success for the ERP will best be found in enhanced environmental stewardship at local, regional, and national levels:

- \* Ecosystem services from natural and restored ecosystems are sustained for future generations.
- \* Ecosystem services are conserved or enhanced while maintaining use of ecosystem resources.

## Contact

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**Ecological Research Program (ERP)**  
**GPRA Hierarchy**  
September 4, 2007

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**ERP Vision**

A comprehensive theory and practice for characterizing, quantifying, and valuing ecosystem services, and their relationship to human well-being is consistently incorporated into environmental decision making.

**ERP 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.

**ERP Overall 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.<sup>11</sup>

**ERP Performance Goal:**

An increasing number of decision-makers (5% increases per year beginning in 2009) regularly apply information and methods developed by the Program to make proactive policy and management decisions

**Performance Measure:**

Cumulative number of local, state, regional, national and/or other environmental decision makers confirming the use of ERP products, information and/or assistance to support decision making as measured by written, verifiable, documentation by the users.

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<sup>11</sup> One of the current goals of the Ecological Research Program from which the current program is founded was: Decision-makers understand the importance of ecosystem services and make informed, proactive management decisions that consider a range of alternative outcomes.

**Ecological Research Program**  
**Long-term Goals**  
September 4, 2007

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**LTG 1: Decision Support Platform**

By 2014 ORD will provide an innovative online decision support platform that offers EPA, Regions, States, local communities and resource managers the ability to integrate, visualize, and maximize use of diverse data, models and tools at multiple scales to generate alternative decision options and understand the consequences of management decisions on the sustainability of ecosystem services, their value and human well-being.<sup>12</sup>

**LTG 2: National Mapping and Inventory**

By 2013 ERP will deliver a publicly accessible, scalable, national atlas and inventory system for selected ecosystem services that can be quantified directly or indirectly across the U.S. to be used by the Agency, NGO's, and other decision makers to support prioritizing policy and management actions and their consequences.

**LTG 3: Nitrogen Assessment**

By 2013 ERP will provide an assessment of the positive and negative impacts on ecosystem services resulting from changes in nitrogen loadings from major source categories to support policy and management decisions in EPA's Offices of Air Resources and Water.

**LGT 4: Wetlands Assessment**

By 2013 ERP will provide guidance and decision support tools to target, prioritize, and evaluate policy and management actions that protect, enhance, and restore ecosystem goods and services of wetlands at multiple scales.

**LTG 5: Community Based Demonstration Projects**

By 2013 ERP will complete 4 site-specific demonstration projects that illustrate how regional and local managers can use alternative future scenarios to proactively conserve and enhance ecosystem goods and services in order to benefit human well-being and to secure the integrity and productivity of ecological systems.

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<sup>12</sup> This long-term goal integrates the products of the other four long-term goals

**Ecological Research Program**  
**New Annual Performance Goals and Annual Performance Measures**  
**Fiscal Years 08 and 09**

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**Decision Support Platform**

09 APG: Complete Multi-Year Development Path for the On-line Decision Support Platform

08 APM: Peer reviewed valuation strategy for ERP

09 APM: Peer reviewed plan for an ecosystem services national characterization system

09 APM: Peer reviewed decision support development plan

09 APM: Guidance produced for characterizing ecosystem service production functions

**National Mapping and Inventory**

09 APG: Complete multi-year research and development plan for a national atlas and monitoring system.

09 APM: National ecological services inventory system design, research and development plan.

08 APM: Peer reviewed research and development plan for a national atlas of Ecosystem Services

09 APM: Production of first national ecosystem services maps in support of nitrogen and wetlands LTGs

**Nitrogen Assessment**

08 APG: Peer reviewed multi-year research and implementation plan for the nitrogen assessment including expectations of demonstration projects and wetlands team.

09 APG: Report on expected changes in ecosystem services as a result of decreased nitrogen inputs from multiple sources for the Eastern US

09 APM: Report for Regions 1, 2 and 3

09 APM: Report for Region 4

**Wetlands Assessment**

08 APG: Peer reviewed wetlands research/implementation plan including expectations of demonstration projects and nitrogen team.

09 APG: Report on the relationship between ecological function and delivery of services by wetlands by Region

APM 2009 - Report on the state of the science on linkages between wetland functions and ecosystem services at multiple scales

### **Community Based Demonstration Projects**

08 APG: Complete research and development plans for demonstration projects

08 APM: Peer reviewed research and implementation plan for the Willamette, including special studies on nitrogen and wetlands

08 APM: Peer reviewed research and implementation plan for Tampa Bay, including special studies on nitrogen and wetlands

08 APM: Peer reviewed research and implementation plan for the Mid-west including special studies on nitrogen and wetlands

09 APM: Peer reviewed research and implementation plan for the Coastal Carolinas including special studies on nitrogen and wetlands

09 APG: Delineate and quantify the ecosystem services provided by the demonstration Projects and complete stressor scenarios.

09 APM: Map and inventory the status of key ecosystem services in the Willamette ESD to the level of current ability.

09 APM: Map and inventory the status of key ecosystem services in Tampa Bay Area to the level of current ability.

09 APM: Map and inventory the status of key ecosystem services in the Upper Mid-west to the level of current ability.

09 APM: Map and inventory the status of key ecosystem services in the Coastal Carolinas to the level of current ability.

09 APM Produce an assessment of the likely changes in environmental stressors and land use patterns and first analyses of possible changes in ES from 2005 through 2050 in Tampa Bay.

09 APM Produce an assessment of the likely changes in environmental stressors and land use patterns and first analyses of possible changes in ES from 2005 through 2050 in the Willamette

09 APM Produce an assessment of the likely changes in environmental stressors and land use patterns and first analyses of possible changes in ES from 2005 through 2050 in upper Mid-west

10 APM Produce an assessment of the likely changes in environmental stressors and land use patterns and first analyses of possible changes in ES from 2005 through 2050 in Coastal Carolinas