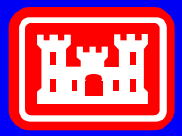
Ecosystem Services and the Corps of Engineers: Now that We've Identified Them, We're Figuring Out What to Do

Jim E. Henderson
Environmental Laboratory



Corps and Ecosystem Services

- Corps Missions and Relations to Ecosystem Services
- Corps work on Ecosystem Services
- Incorporation of Ecosystem Goods and Services into Corps Planning and Operations

Ecosystem Services

- Generally speaking, ecosystem services are conditions and processes, through which natural ecosystems and the species they support, sustain and fulfill human life Natural components
- Ecosystem services produce the substance or structures and processes or functions that sustain life.
- Ecosystem services in the Gulf of Mexico are the direct or indirect contributions that ecosystems make to the well-being of human populations.

Ecosystem Services and the Corps

- Interest in Ecosystem Services as way to improve analysis
- Ecosystem Services as part of water resource planning policy

INITIATIVES

Carbon Capture & Storage

Gulf Coast Ecosystem Restoration

Steps to Modernize and Reinvigorate NEPA

Review of MMS NEPA Procedures

Federal Sustainability

Interagency Ocean Policy Task Force

Recovery Through Retrofit

Updated Principles and Guidelines for Water and Land Related Resources Implementation Studies

View Comments

Climate Change Adaptation Task Force

America's Great Outdoors

Updated Principles and Guidelines for Water and Land Related Resources Implementation Studies

On December 3, 2009, the White House Council on Environmental Quality released a proposal to the National Academy of Sciences (NAS) for their review that would significantly change the principles and guidelines that govern America's water resource planning. The proposal would require that such projects help to improve the economic well-being of the Nation for present and future generations, better protect communities from the effects of floods and storms, help communities and individuals make better choices about where to build based on an understanding of the risk, and protect and restore the environment.

The proposal calls for the development of water resources projects to be based on sound science, increased consideration of both monetary and non-monetary benefits to justify and select a project, improved transparency, and consideration of nonstructural approaches that can solve the flooding problem without adversely impacting floodplain functions. The proposal would also expand the scope of the Principles and Guidelines to cover all Federal agencies that undertake water resource projects.

The Administration sent the new draft Principles and Guidelines to both the Federal Register for public comment and, in accordance with WRDA 2007, to the National Academy of Sciences (NAS) for its review. The NAS review is expected to be completed by November 2010. Additionally, CEQ took public comment on the new draft Principles and Guidelines for 90 days.

1. Principles

Water is a valued and limited natural resource that is an absolute requirement for life and vital to human health and our natural environment. The quality and quantity of water resources affect all levels of our society from the national to the individual citizen. Water resources support our local and national economies, provide environmental security, and support this Nation's vast cultural diversity. We depend upon these resources for myriad of purposes including, drinking water, ecosystem services, irrigation, hydropower, manufacturing, recreation, fish and wildlife, sanitary waste disposal systems, transportation, and public health and safety. Equally important are the management of water to reduce flood risk and storage of water for future use. Therefore, the following principles are established to guide water resources implementation studies. It is the policy of the United States that all Federal water resources implementation studies shall:

A. Protect and restore natural ecosystems and the environment while encouraging sustainable economic development;

B. Account for ecosystem services;

C. Avoid the unwise use of floodplains, flood-prone areas and other ecologically valuable areas;

D. Utilize watershed and ecosystem based approaches;

Environmental Benefit Indicators (EBI) (Boyd and Wainger 2002)

- Definition: EBI are a quantitative, but not monetary, approach to the assessment of habitat and land uses.
- Use GIS and other existing data
- Develop indicators (index, ratio quantity) of existing and future benefits

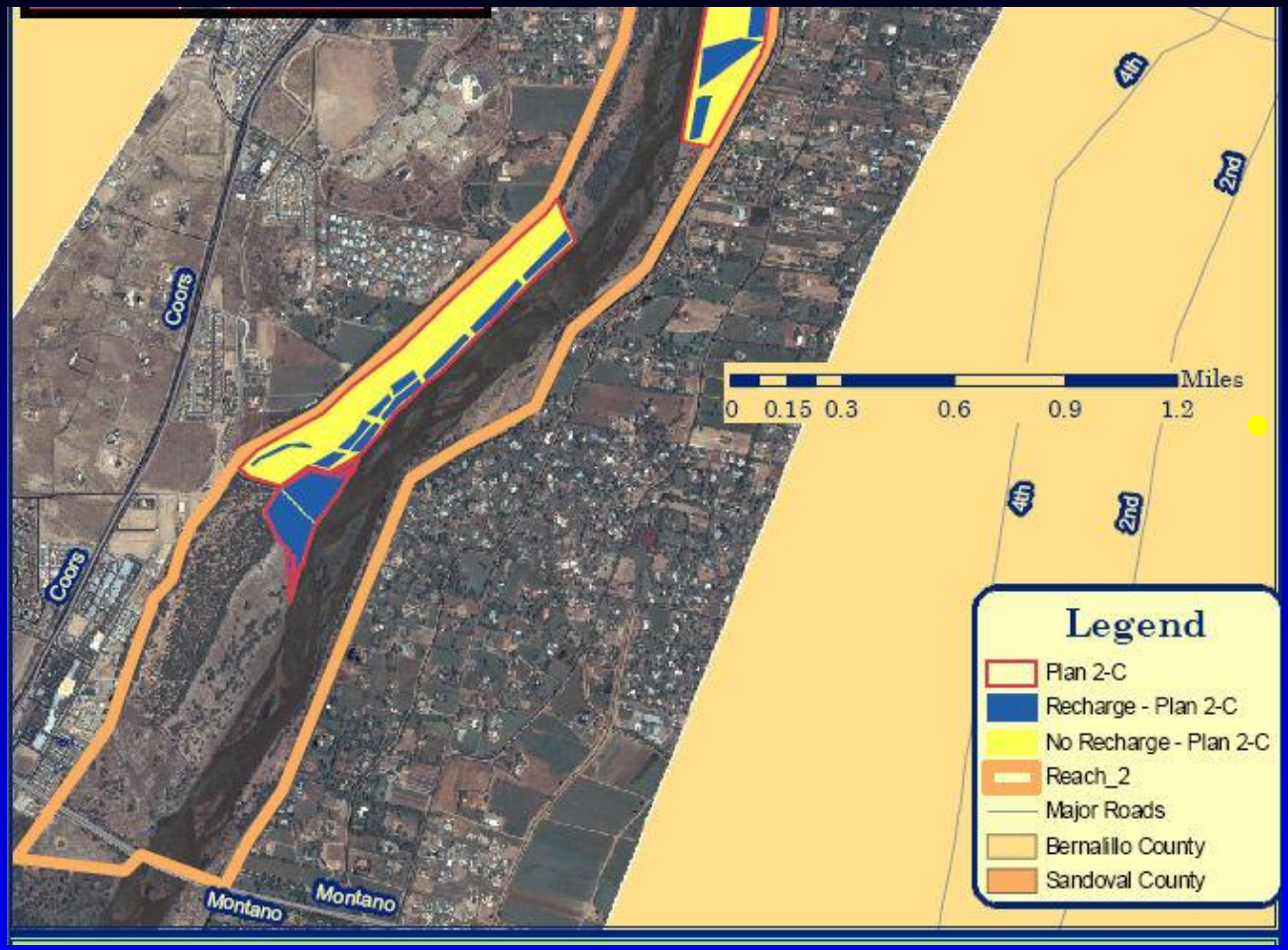
Characteristics of EBI

- Independent of each other
- Balance
- Human demand or use information improves information

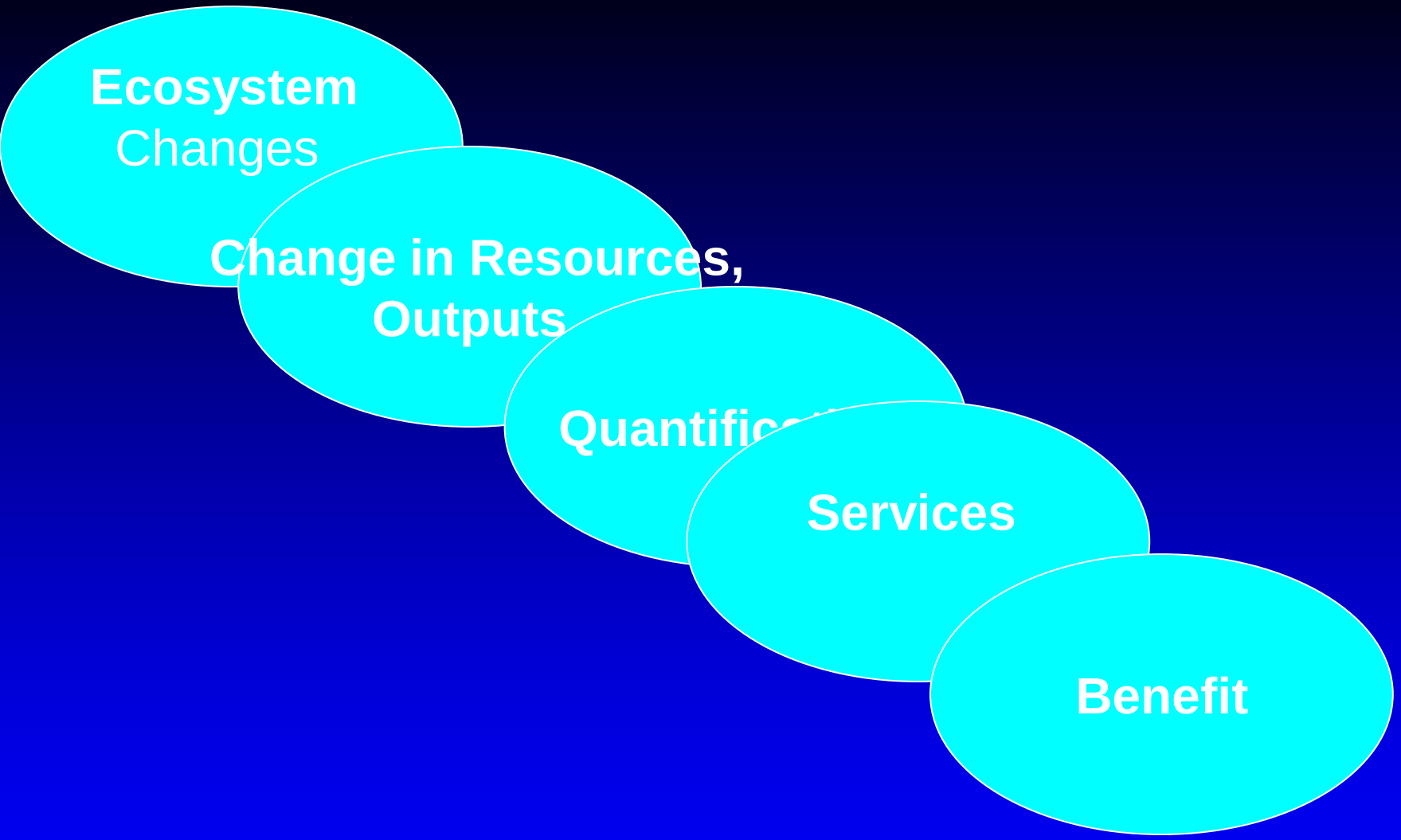
Environmental Benefit Indicators

Wetland mitigation bank, Little Pine Island, FL
(Boyd and Wainger 2001)

- Improved drinking water quality and abundance
- Flood damage avoided
- Improved aquatic recreation
- Provision of open space, aesthetic, and existence benefits



Aquifer Recharge – Percent of Actionable Acres Affected by Management Measures that Provide for Aquifer Recharge

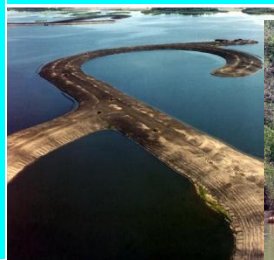

Ecosystem
Changes
Change in Resources,
Outputs
Quantific
Services
Benefit

Corps Missions and Ecosystem Services

Navigation

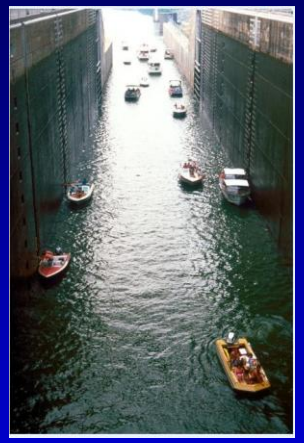
Flood Risk Reduction

Ecosystem Restoration



Navigation

- Infrastructure and channel alignment guided by least costs or BCR
- dredged material management "The Federal Standard" - " least costly dredged material disposal or placement alternative (or alternatives) identified by the USACE that is consistent with sound engineering practices and meets all federal environmental requirements, including those established under the Clean Water Act (CWA) and the Marine Protection, Research, and Sanctuaries Act (MPRSA). "
- If the beneficial use option is part of the Federal Standard, the costs of the beneficial use are assigned to the navigational purpose and shared as with other costs.



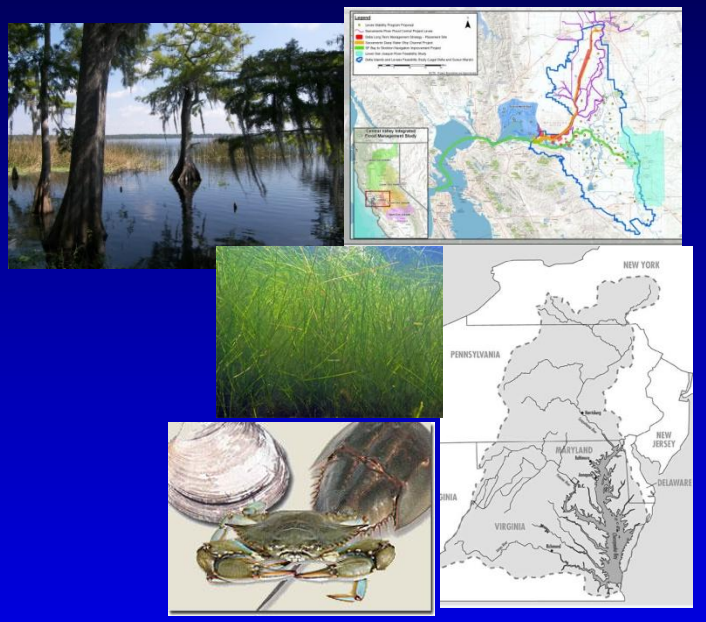
Flood Risk Reduction

- “reduce the frequency of damaging levels of flood inundation”
- magnitude, duration and frequency of inundation

Flood Risk Reduction

Ecosystem Restoration

- "…objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded more natural condition" "should mimic, as closely as possible, conditions which would occur… in the absence of human changes"



- "outputs that result in an increase in ecosystem value and productivity"

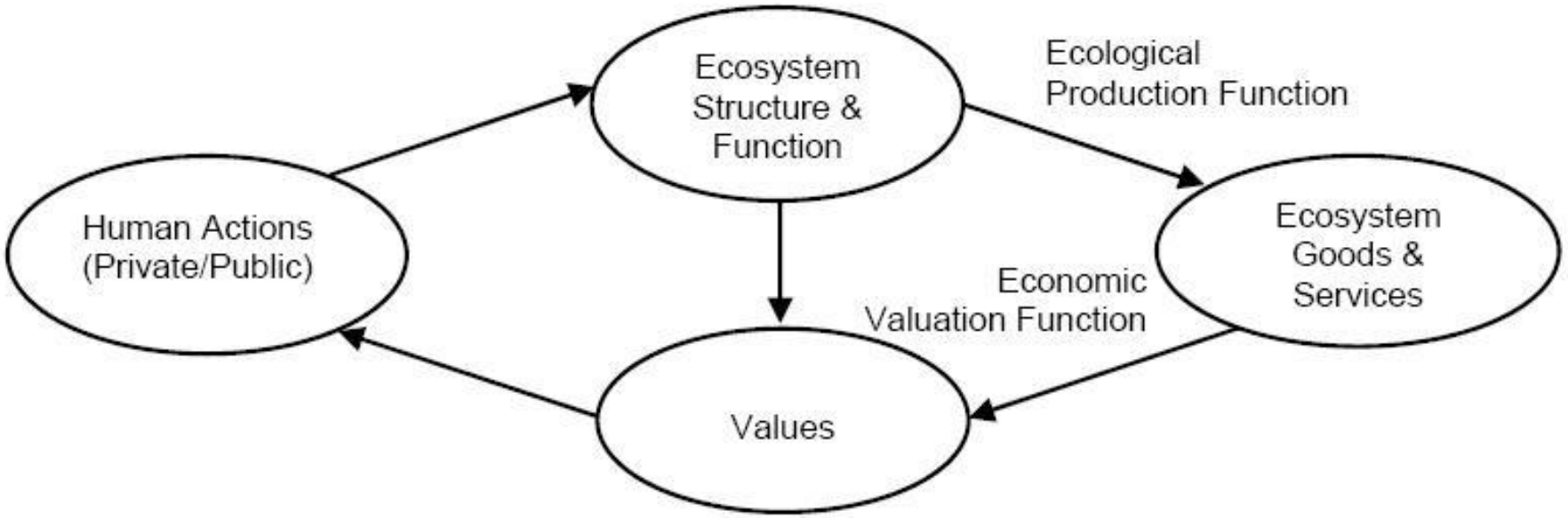
Ecosystem Restoration

Killgore, K. J., Hoover, J. J., and Murphy, C. E. (2008). "Library of Habitat Models to Evaluate Benefits of Aquatic Restoration Projects on Fishes," EMRRP-ER-10, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Environmental Benefits Assessment (EBA)

Ray, G. (2008). "Habitat Equivalency Analysis: A Potential Tool for Estimating Environmental Benefits," EMRRP-EI-02, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Ecosystem Services – Production Functions



Environmental Benefits Analysis Research Program

Themes of EBA Research Program

Conceptual models to link restoration actions to predicted benefits

Empirical, stochastic and mechanistic **forecasts** of ecosystem response to hydro-geomorphic manipulation

Metrics for assessing benefits in different ecosystem types, across regions and applicable at the project and program scale

Multi-criteria **decision analysis** to **support** risk-informed planning, recognizing local needs while ensuring national interest

Environmental benefits quantification in alternatives and post-project evaluation to document contribution to NER account

Ecosystem services using economic principals to account for social, economic, and ecological benefits

Tools for **programmatic assessment** at national and regional levels

"Providing Solutions for Tomorrow's Environmental Challenges"

"The conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life."

- P… …s
  w… …ation
- M… …s
  and floods
- Generation and preservation of soils and renewal of their fertility
- Detoxification and decomposition of wastes
- **Cycling and Movement of Nutrients**
- **Control of the vast majority of potential agricultural pests**

Robert Costanza et al. The value of the wo

flows of materials, energy, and information from natural capital stock which combine with manufactured and human capital services to produce human welfare."

- Floc
  $ 1
- **Foo** **T**
  Pro
- **Genetic Resources $ 0.8 T**
- **Atmospheric Gas Balance**
  $ 0.7 T
- Pollination **$ 0.4 T**
- **All Others $ 1.6 T**

Supply $ 2.3 T

- **Climate regulation $1.8 T**
- **Habitat $ 1.4 T**

Ecological Society of America

" Ecosystem Services : Benefits Supplied to H

"Range of conditions and processes through which natural ecosystems, and the species that are part of them, help sustain and fulfill human life."

- Pro y
- Go
- agr
- Ge
- Maintenance of Biodiversity
- Climate and Life
- Mitigation of Floods and Droughts

Services

- **Aesthetic Beauty and intellectual and spiritual stimulation**

Stakhiv et al. Improving Environmental Benefits Analysis in Ecosystem Restoration

"Ecosystem services are the benefits that humans derive from ecosystems.."

- D
(fl
- Waterway Transportation Links
- Water Storage
- Water Purification
- Sediment Trapping
- Waste Treatment
- Biological Pest Control

Rare and Unique Species/Genetic Store

- **Wildlife Support (e.g., food chain, nursery)**

Services Supplied by Soil

Millennium Ecosystem Assessment 2005
Ecosystems and Human Well Being

- Supporting Services
  - Nutrient Cycling
  - Soil Formation
  - Primary Production
- Cultural Services
  - Aesthetic
  - Spiritual
  - Educational
  - Recreational
- Provisioning Services
  - Food
  - Fresh Water
  - Wood and Fiber
  - Fuel
- Regulating Services
  - Climate Regulation
  - Flood Regulation
  - Disease Regulation
  - Water Purification

Upper Mississippi Ecosystem Services

"Ecosystem services are the benefits that humans derive from ecosystems.."

Supp

- Primary Production
- Nutrient Cycling

Regulating Services

- Biological regulation
- Disturbance (flood) regulation
- Nutrient regulation
- Soil retention
- Waste Regulation

- Raw materials
- Water supply (inc. transport)
- Climate Regulation

Cultural Services

- Aesthetics
- Recreation
- Science/education
- Spiritual/historic

Na
Valuing
E

"links between the structures and functions of natural systems, and the benefits derived by

Great Lakes Structure and Functions
- **Fish and wildlife habitat**

Great Lakes Services
- **Native Species Diversity**
- **Fisheries**

Missouri River Structure and Functions
- **Agriculture**
- **River management; water resources development**

Misso. River Services
- **Food**
- **Flood Protection**
- **Recreation**
- **Hydropower (energy)**
- **Water Supply**
- **Navigation**
- **Aesthetics**

Gulf of Mexico Alliance – Priority Issue Teams

- Ecosystem Integration and Assessment: Ecosystem Services Valuation
- Habitat Restoration and Conservation: Reversing the Downward Trend in Habitat and Ecosystem Services

Level 1: Ecosystem Foundation or Support Services
Nutrition Balance
Hydrological Balance
Biological Interactions
Soil and Sediment Balance

“direct or indirect contributions that ecosystems make to the well-being of human populations” “The Gulf of Mexico Alliance defines ecosystem services as the contributions from the Gulf of Mexico marine and coastal ecosystems that support, sustain, and enrich human life”

Level 2: Provisioning Services – Goods and Services Produced by Support Services

- Pollutant Attenuation
- Air Supply
- Water Quantity
- Water Quality
- Food
- Raw Materials
- Medicinal Resources
- Gas Regulation
- Ornamental Resources
- Climate Regulation

Level 3: Outcomes and Benefits to Society
Hazard Moderation
Aesthetics and Existence
Spiritual and Historic
Science and Education
Recreational Opportunities

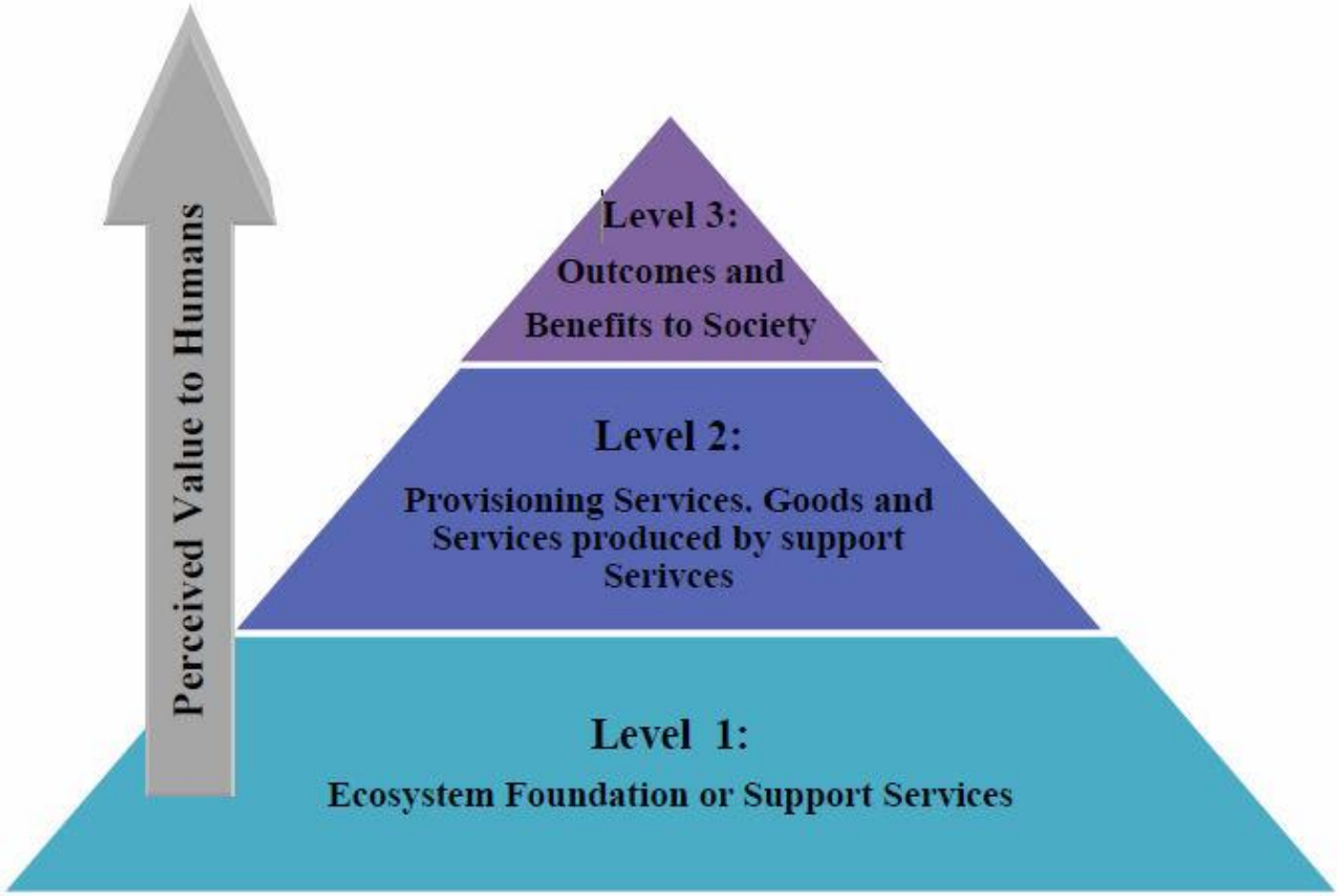
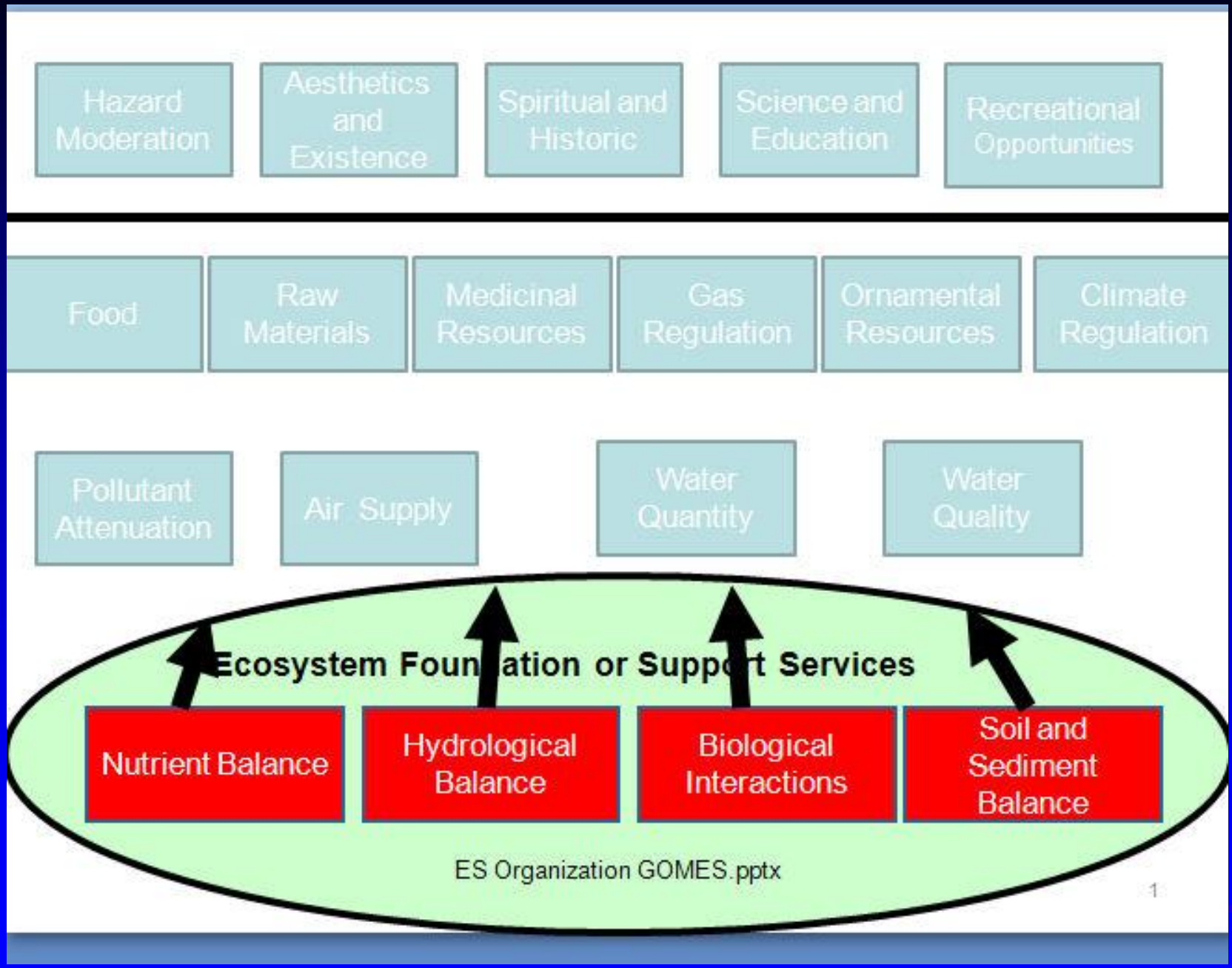


Figure 2: Ecosystem Services Categories and Perceived Impact to Humans.


Hazard Moderation
Aesthetics and Existence
Spiritual and Historic
Science and Education
Recreational Opportunities
Food
Raw Materials
Medicinal Resources
Gas Regulation
Ornamental Resources
Climate Regulation
Pollutant Attenuation
Air Supply
Water Quantity
Water Quality
Ecosystem Foundation or Support Services
Nutrient Balance
Hydrological Balance
Biological Interactions
Soil and Sediment Balance
ES Organization GOMES.pptx
1

Ecosystem Services Affected by Corps Activities[1]

Water Supply and Regulation	Erosion Regulation/ Sediment Management
Water Purification and Waste Treatment	Natural Hazard Regulation
Biodiversity Maintenance	Recreational Opportunities
Food	Fiber, Fuel, and other Raw Materials
Climate Regulation	Clean Air
Science and Education	Maintain Cultural Diversity
Spiritual and Inspirational	Aesthetics

Ecosystem Service	Explanation / Definition	Corps' Influence on Service
Water Supply and Regulation	Abundance, distribution, frequency, and duration for domestic, industrial, agricultural., and ecological responses	Management and operations, including ground/surface infiltration and recharge
Erosion Regulation/ Sediment Management	Protection of infrastructure through natural channel design and other measures to achieve a balance among sediment transport, distribution, and land development	Operations, changes in hydrology, channel use
Water Purification and Waste Treatment	Retention, recovery, and removal of excess nutrients, other pollutants as well as other water parameters	Water management, ecosystem restoration

Ecosystem Service	Explanation / Definition	Corps' Influence on Service
Natural Hazard Regulation	Management of coastal storm protection , fire management, flood damage, disease outbreaks, landslides	Alteration of hydrology, landform, plant communities
Biodiversity Maintenance	Opportunities for future generations; keystone for other services	Ecosystem impacts and restoration (improve resiliency), habitat quality, and diversity
Recreational Opportunities	**Sporting activities, water-based, land-based, consumptive, non-consumptive, ecotourism**	**Alteration of water and land resources**

Ecosystem Service	Explanation / Definition	Corps' Influence on Service
Food	Commercial and subsistence fisheries, crops	Impact on fisheries habitat, fish behavior. Provisions of habitats, including invasive species management
Fiber, Fuel, and other Raw Materials	Production of woody and other vegetation products.	Subsidence prevention. ecosystem improvements
Climate Regulation	Source and sink of greenhouse gases	Ecosystem management

Ecosystem Service	Explanation / Definition	Corps' Influence on Service
Clean Air	Storage and processing of pollutants. Support for alternative fuel productions, transportation, energy production.	Increase or decrease
Science and Education	Ecosystems provide opportunity for science, education, and public outreach	Increase or decrease opportunities
Maintain Cultural Diversity	Certain cultures defined by the ecosystem they are developed in, e.g., , Chesapeake Watermen	Influence: locations, structures, cultural remains, plants affected

Ecosystem Service	Explanation / Definition	Corps' Influence on Service
Spiritual and Inspirational	Source of inspiration; many cultures attach spiritual and religious values to ecosystems	Influence on locations, structures, cultural remains, plants affected
Aesthetics	Attractive landscape attributes for the five senses; experiencing the five senses.	Design, construction, operation, access

Corps and Ecosystem Services

- Work on Ecosystem Services – ERDC and IWR
  - Conceptual underpinnings, principles, definitions and typology of ecosystem goods and services and their human welfare benefits
  - Quantification and valuation, including monetization (where appropriate and feasible)
  - Ecological, engineering, and economic models, modeling and production functions
  - Temporal and spatial scaling issues likely to be encountered

Corps and Ecosystem Services

- Work on Ecosystem Services – Headquarters
  - Coordination of P&S Revision
  - Revision of Corps Planning Guidance

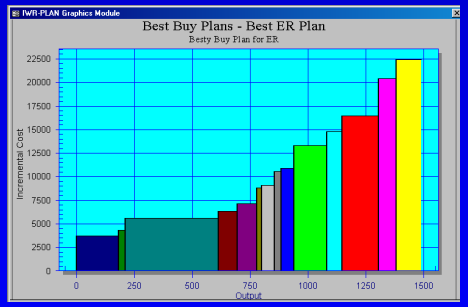
Ecosystem Services – Production Functions

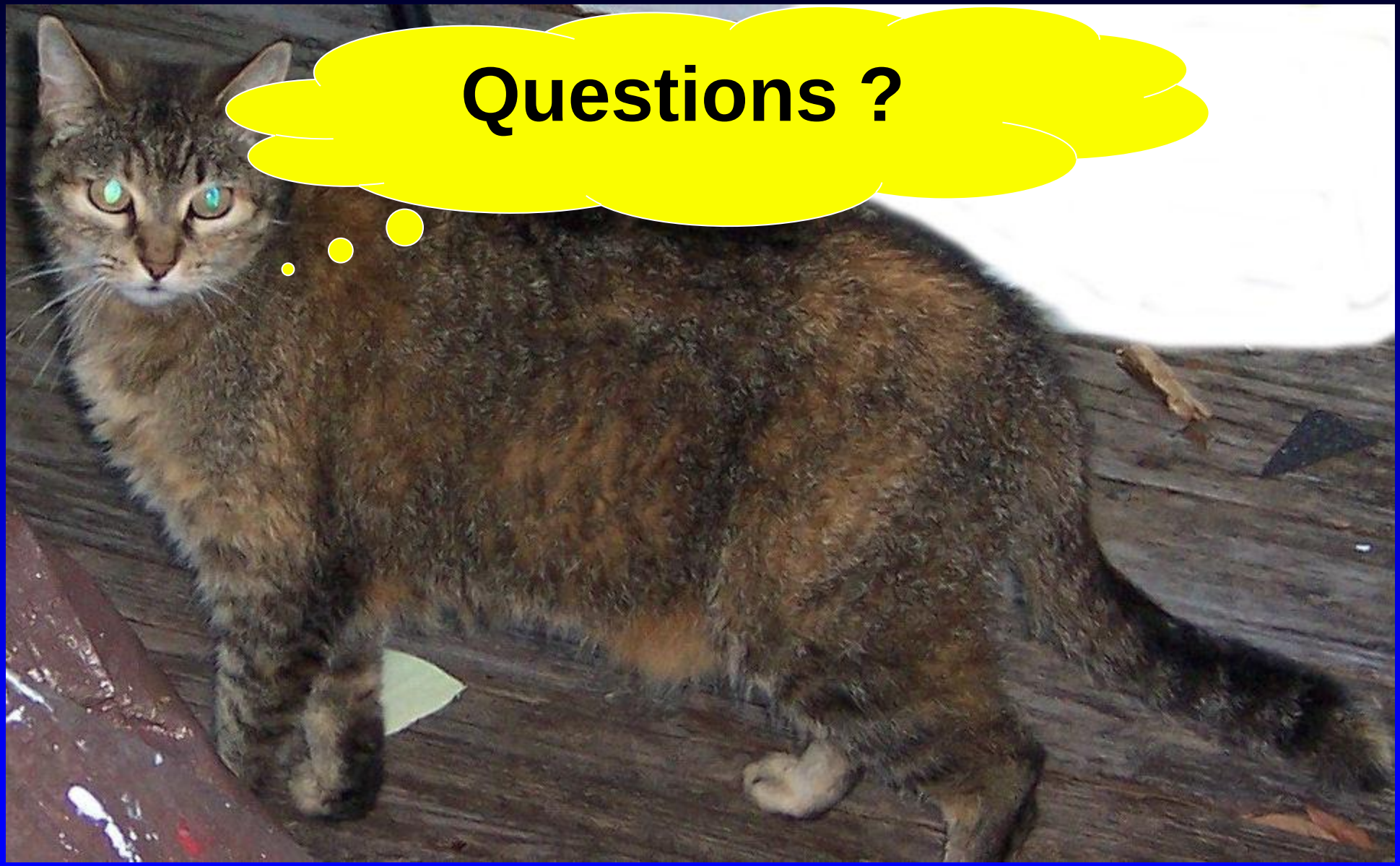
Change in Resources, Outputs

$

Economic

Ecological




Questions ?