Valuation of Services from Natural Systems in Estimating Benefits & Costs of Changes in the ADHS: The Role of USGS Data

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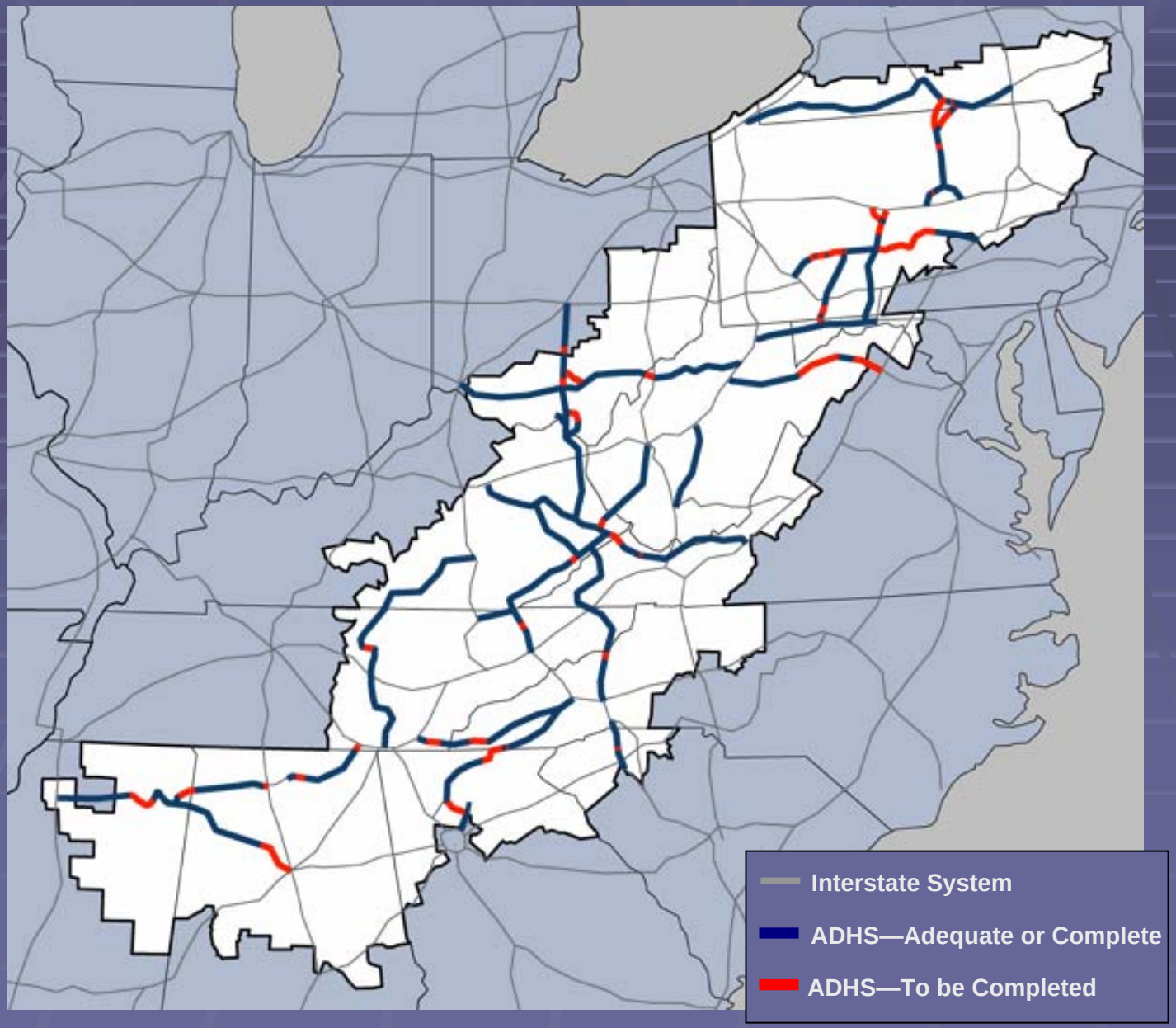
Overview of Presentation

- Overview of Appalachian Development Highway System;
- Evaluating Proposed Changes in Appalachian Development Highways;
- Evaluation Issues of EIS Methods and Limitation of Physical Impact Measures;
- Advances in Non-Market Economic Valuation Applications to Services from Natural Systems;
- Role in Valuing Information from Natural Sciences.

Appalachian Development Highway System

- From its inception, the ADHS highway system has been designed to be an instrument of economic development:
  - linking key centers in the region to national and international markets
  - improving regional traffic efficiency by connecting to the interstate system
  - facilitating access to jobs and public services, and
  - opening up remote areas within Appalachia for development and job creation.
- Completion of the ADHS will permit:
  - the nation to realize the efficiencies of linking the network to the interstate and other transportation modes;
  - And enable the Region to further develop its assets, and ensure that traffic does not simply bypass the Region.

Appalachian Development Highway System



- ADHS 3,090 miles authorized, 85% built or under construction.
- Links region to interstate and key ports for global trade.

Evaluating Proposed Changes in Appalachian Development Highways

- Unbuilt sections of ADHS are among the most costly, often in the most rugged terrain.
- Environmental concerns and historical sites have also led to proposed realignments.
- Traffic changes and economic issues have contributed to proposed realignments.
- Such proposed changes raise geological & related economic and environmental issues.

Evaluation Issues of EIS Methods

- Environmental Impact Statements of changes are based on mixed methodologies from physical & social sciences.
  - Incommensurate methods;
  - Lack any valuation of services from natural systems;
  - Economic valuation mostly restricted to compensation of affected parties and cost changes.

Advances in Non-Market Economic Valuation Techniques

- Recent advances in economic analysis of the valuation of services from natural systems could improve assessments.
- Review these techniques and potential applications.
- Examine current case of ADHS corridors.

US 219 IMPROVEMENTS PROJECT
Meyersdale to Somerset

RECORD OF DECISION

SR 6219, Section 020
Somerset County, Pennsylvania

November 2006

Prepared by:

Federal Highway Administration

Pennsylvania
Department of Transportation

Table 1
Phase II Impact Analysis

Impacted Resource	DEIS Alternatives					
	No-Build	Alignment B	Alignment C	Alignment C-1	Alignment D	
					Interchange @ US 219	Interchange @ Mud Pike
Total Impact Area (hectares (acres))	0	155 (382)	157 (389)	156 (386)	183 (453)	175 (432)
State Game Lands No. 50 (hectares (acres))	0	4 (10)	4 (10)	4 (10)	4 (10)	4 (10)
Productive Agricultural Lands (hectares (acres))	0	60 (148.2)	49.5 (122.2)	49.3 (121.8)	113.1 (279.5)	108.7 (268.7)
Agricultural Security Areas (hectares (acres))	0	41.8 (103.2)	25.7 (63.4)	22.0 (54.3)	71.2 (176.0)	66.9 (165.2)
Prime Farmlands (hectares (acres))	0	41 (101)	28 (69)	27 (67)	50 (124)	48 (118)
Soils of Statewide Importance (hectares (acres))	0	25 (63)	29 (72)	28 (68)	44 (108)	37 (92)
Perennial Streams (meters (feet))	0	125 (410)	457 (1,500)	251 (825)	50 (165)	34 (110)
Intermittent Streams (meters (feet))	0	1,370 (4,495)	1,186 (3,890)	709 (2,325)	1,652 (5,420)	1,559 (5,115)
Wetlands (hectares (acres))	0	10.0 (24.6)	4.3 (10.7)	5.1 (12.5)	6.6 (16.3)	6.5 (16.2)
Floodplains (hectares (acres))	0	2 (5)	2 (5)	1 (3)	1 (3)	<1 (1)
Forests (hectares (acres))	0	78 (192)	79 (194)	77 (191)	86 (213)	80 (197)
Potential Threatened and Endangered Species Habitiat						
Indiana Bat [1] Eastern Small-footed Myotis [1] (shagbark hickory areas) (hectares (acres) of poletimber/sawtimber forest)	0	10 areas 44 (108)	6 areas 30 (75)	7 areas 23 (56)	16 areas 58 (144)	16 areas 52 (129)
Longnose Sucker [2] (Perennial Stream) (meters (feet))	0	125 (410)	457 (1,500)	251 (825)	50 (165)	34 (110)
Upland Sandpiper [3] (hectares (acres) of cropland, pasture and grasslands)	0	57 (141)	64 (157)	62 (153)	78 (192) 1 observed location	76 (187) 1 observed location
Timber Rattlesnake (hectares (acres) of deciduous forest)	0	73 (179)	73 (180)	71 (175)	83 (207)	77 (191)
Allegheny Woodrat (observations of suitable habitat)	0	0	0	0	0	0
Appalachian Blue Violet (observed locations)	0	1	0	0	8	8
Fraser's Sedge (observed locations)	0	0	0	0	0	0

[1] The Indiana bat and eastern small-footed myotis use shagbark hickory as potential roosting sites.
[2] There were no observations of this species within the Study Area.
[3] These numbers represent the worst case scenario for potential impact to habitat.
Due to crop rotation, it is not possible to determine which crop fields would represent potential habitat during construction.
[4] Same building for all alignments; no residential structures impacted.
[5] Construction cost estimates do not include utility costs or environmental mitigation costs.

- Least Impact
- Medium Impact
- Highest Impact

Table 1
Phase II Impact Analysis

Impacted Resource	DEIS Alternatives					
	No-Build	Alignment B	Alignment C	Alignment C-1	Alignment D	
					Interchange @ US 219	Interchange @ Mud Pike
Surface Mining (hectares (acres))	0	31 (76)	40 (99)	50 (123)	37 (91)	39 (96)
Deep Mining (hectares (acres))	0	50 (123)	59 (147)	56 (139)	33 (81)	34 (85)
Archaeology						
Zone 1 (High Potential for Rock Shelters) (hectares (acres))	0	19 (47)	16 (40)	16 (40)	20 (50)	20 (50)
Zone 2 (High Potential for Stratified Sites) (hectares (acres))	0	<1 (1)	<1 (1)	<1 (1)	2 (5)	1 (2)
Zone 3 (High Potential for Shallow Sites) (hectares (acres))	0	27 (67)	26 (64)	24 (60)	26 (64)	25 (62)
Zone 4 (Moderate Potential for Shallow Sites) (hectares (acres))	0	80 (198)	78 (192)	69 (170)	102 (251)	93 (230)
Zone 5 (Low Potential for Shallow Sites) (hectares (acres))	0	28 (69)	37 (92)	47 (116)	34 (84)	35 (87)
Potential Historic Archaeological Sites (sites)	0	1	1	1	1	1
Swamp Creek Valley Historic District						
Contributing Resources Directly Impacted (number)	0	3	3	3	8	8
Potential Noise Impacts (sites)	50	10	6	4	8	8
Potential Waste Site Impacts (sites)		2	0	0	0	0
Residential/Commercial Buildings (number)	0	1 Commercial Structure [4]				
Bridges (number)	0	9	9	8	12	9
Major Culverts (number)	0	12	11	9	15	15
Potential Right-of-Way Required (hectares (acres))	0	145 (358)	151 (374)	150 (371)	170 (420)	162 (399)
Preliminary Costruction Costs [5] (Million $)		$275.3	$277.8	$281.0	$331.9	$255.8

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- Least Impact
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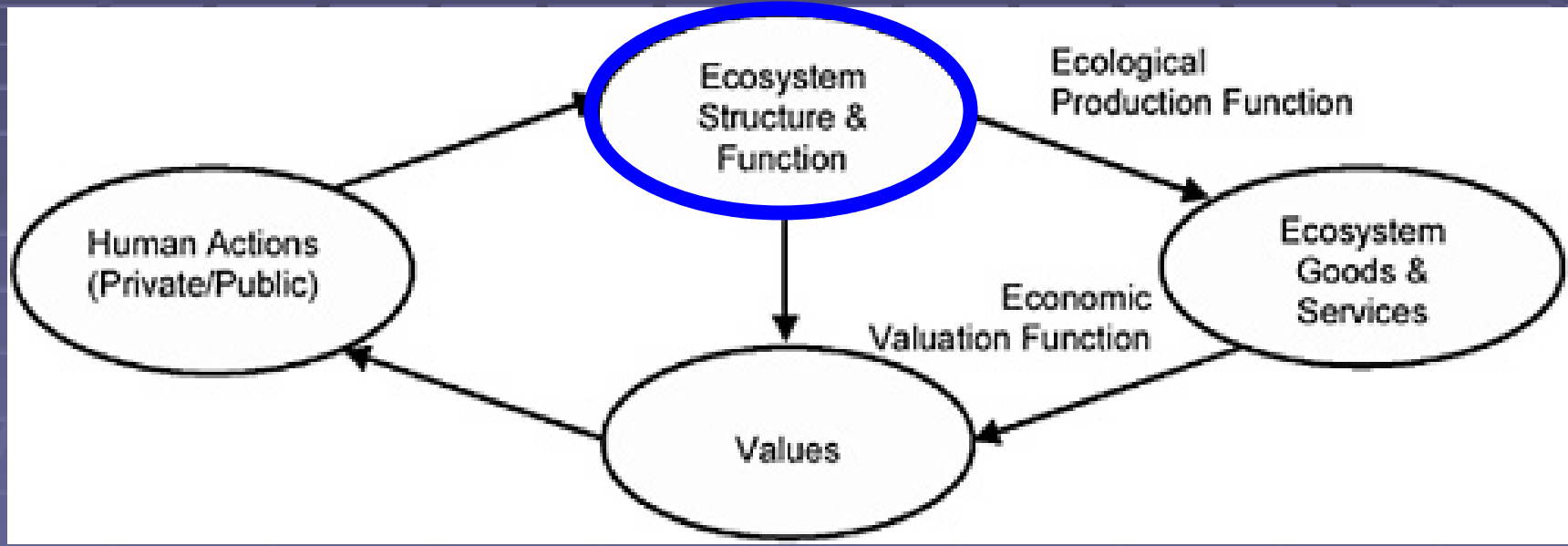
Limitation of Physical Measures

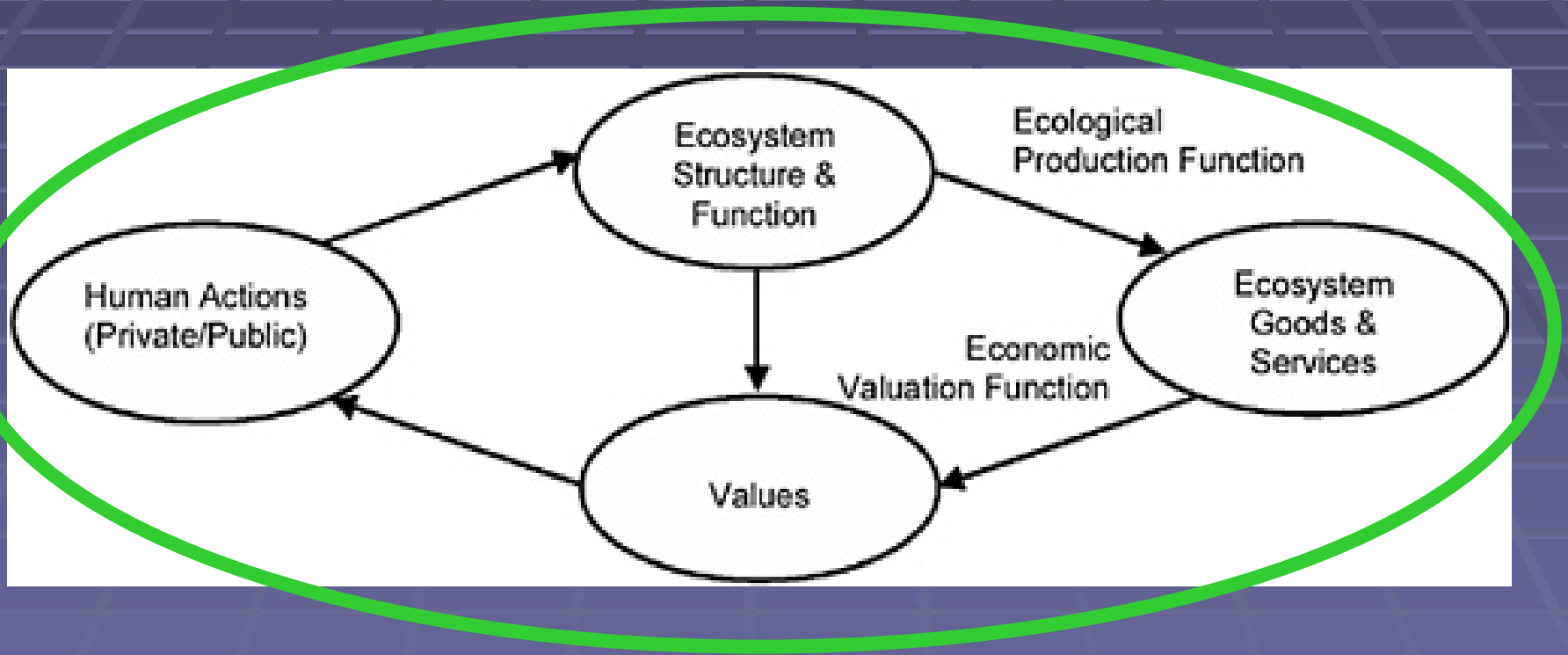
- Impacts as measured by areas, ecosystems and numbers of species affected are difficult to compare.
- Often do not measure many impacts due to changes in complex *services* provided by ecosystems to both humans and other species.
- Lack of market price for these services leads to no valuation in the assessment.
- Lack of valuation of information used in studies.

Ecosystem Analyses Often Focus Only on Ecosystem Structure and Function



Source: John Hoehn, derived from *Valuing Ecosystem Services*, NRC, 2005

Effective Ecosystem Management Requires Knowledge of Ecol-Econ System



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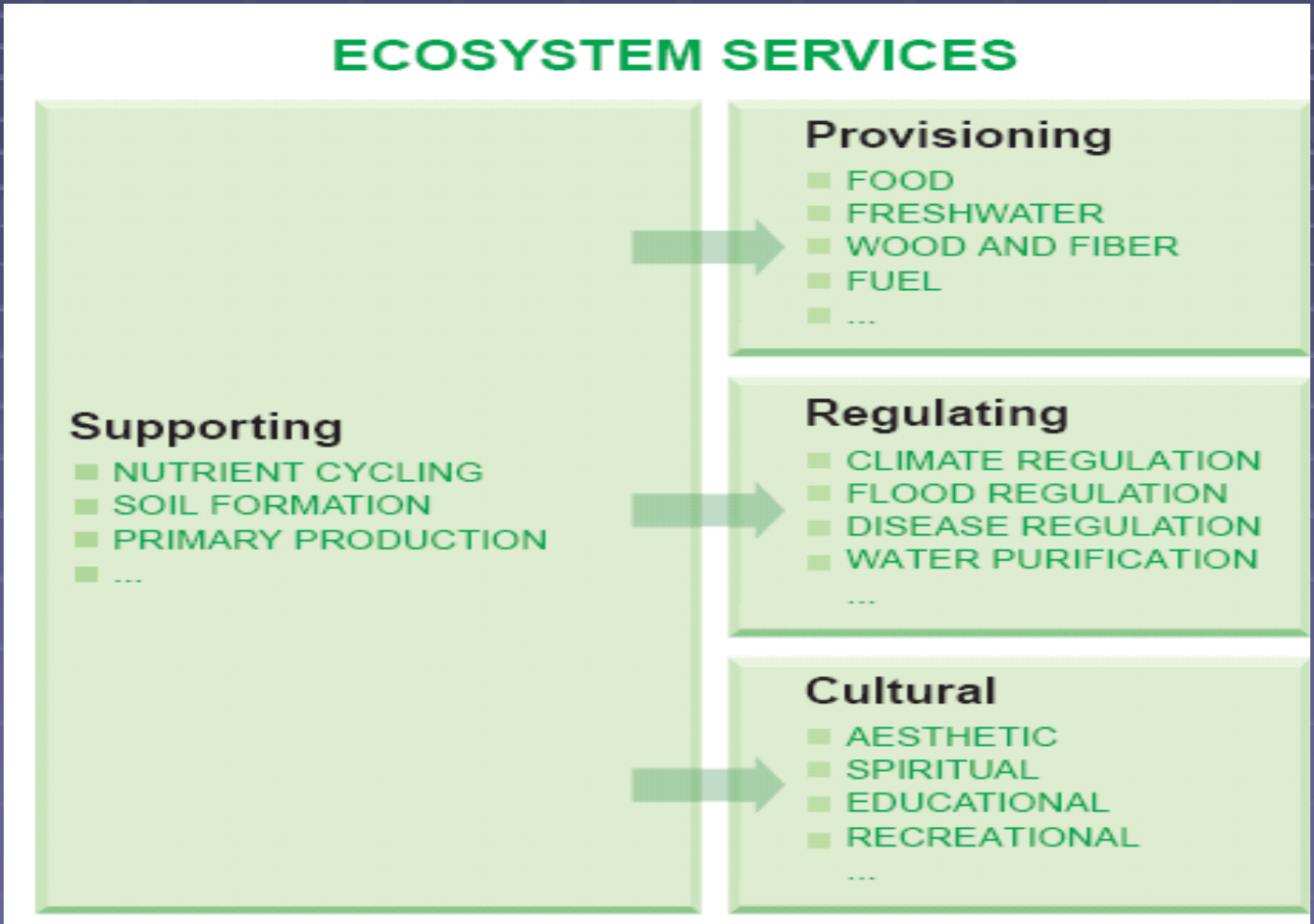
Benefits People Obtain from Ecosystems



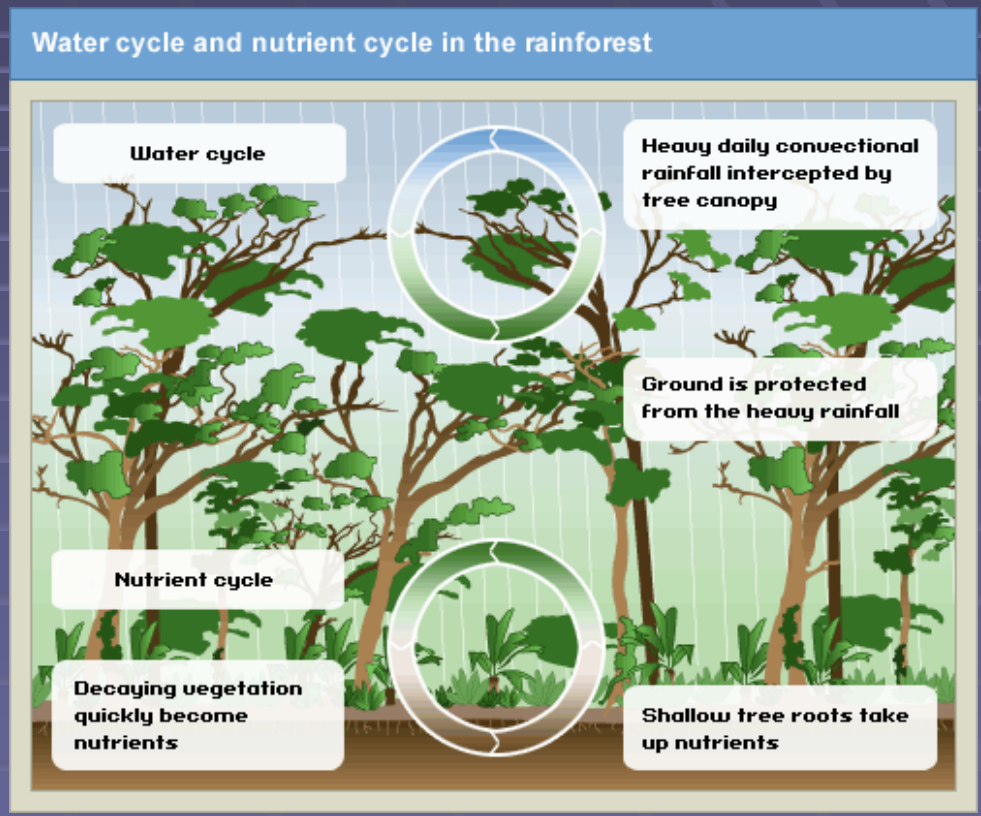
Source: Millennium Assessment www.MAweb.org

Types of Ecosystem Services

- **Provisioning**:
  - Food,
  - Water,
  - Fuel,
  - Genetic and medicinal resources,
  - Fiber and materials.

Supporting Services

- Soil formation /retention;
- Nutrient cycles,
- Precipitation/water cycle;
- Transpiration cycles;
- Habitat formation & stability.



Natural regulating services

- Water quality, flood & erosion control,
- Biological propagation/control,
- Climate/gas regulation,
- Disturbance mitigation/ resilience.

Cultural services

- Recreational uses.
- Aesthetic & spiritual value of nature.
- Scientific & educational value of natural resources;
- Intrinsic value of natural systems and ecology.

Worldwide Industries Based on Provisioning Services are Economically Significant

- Market value of provisioning ecosystem-service industries (2004)
  - Food production: $980 billion per year
  - Timber industry: $400 billion per year
  - Marine fisheries: $80 billion per year
  - Marine aquaculture: $57 billion per year
  - Recreational hunting and fishing: >$75 billion per year in the United States alone

Source: Millennium Assessment www.MAweb.org

Policy Focus & Tools for Assessment

- Quantify risks arising from natural hazards & human impacts on ecological systems.
  - National Research Council, *Valuing Ecosystem Services: Toward Better Environmental Decision-Making, 2005.*
  - *Millennium Ecosystem Assessment , 2005.*
  - *World Resources Institute*
- Examine non-market and alternative measures of the value of ecoservices.

Scope & Limits of Economic Valuation Methods

- Methods to compare the benefits of natural systems with costs and savings of various human activities.
- Challenge is to identify values for tangible & intangible goods & services provided by natural systems.
- Human-centered approaches to valuation.

Valuation & Quantification

- Valuation doesn't necessarily imply quantification or monetization:
  - Endangered Species Act
  - Intrinsic values of species & natural systems.
- Economic valuation may include both market and non-market valuation estimates:
  - Both are usually expressed monetarily;
  - Future value of benefits (discount rate +/-).
- Constraints: critical natural thresholds, considerations of justice, and uncertainties.

Non-Market Valuation Methods

- Consumer behavior studies:
  - How much people would spend to avoid impacts, improve quality or travel somewhere.
- Production studies:
  - How changes in ecoservices affect outputs.
- Behavioral studies:
  - How a given change affects people's behavior.
- Surveys of people's preferences.
- Replacement costs for services/restoration.
- Benefit transfers between winners/losers.

Methods for Valuing Ecosystem Services

Method	Type	Applications	Services Valued
Market prices	Market use	Goods & services that are exchanged and priced by markets	Construction services; research; water supply; transport
Travel demand (travel cost)	Use	Activities that involve travel, such as tourism and recreation	Site visits, fish catch, boating, rafting, rock climbing
Property value (economists often call hedonic pricing)	Use	Effects of local amenities and hazards on residential property values	Proximity to an ecosystem; water clarity; aesthetics; storm/flood protection
Production function ($s = f{$x_1$,…,$x_n$}) Input/output relation	Use	Fishing and food harvesting; hydrological functions; prey-predator populations	Fishery values; water quality; invasive species; storm/flood protection
Stated preference (contingent, conjoint)	Use; Non-use	Recreation; water quality; human health; access; aesthetics; existence	Fishery values; recreation; water quality; existence; etc

Source: *Valuing Ecosystem Services*, National Research Council, 2005

Data Needed for Valuation

- Travel demand method
  - Minimum
    - Visit counts for recreation over time, activities, and sites
    - Visit counts over different ecosystem quality levels if quality is to be valued
  - Typical
    - Mail or telephone survey of visitors and non-visitors
    - Visit counts for individuals over time, site, and quality
    - Demographic data
- Stated preference
  - Minimum
    - Small focus group of users
    - Questions to elicit behavior and values in terms of realistic choices
  - Typical
    - Statistically representative mail or telephone survey with sample drawn from relevant population
    - Demographic data

Source: John Hoehn, derived from *Valuing Ecosystem Services*, NRC, 2005

Benefit Transfer: Use *Existing* Value Estimates to Value New Policies

1. Adjust existing values to fit the new setting
   - demographic differences among users?
   - ecosystem differences?
   - availability of substitutes?
   - differences in activities?
2. Estimate the change in use due to the change in ecosystem and management costs.
3. Value of management change = (transferred value) x (change in use).

Source: John Hoehn, derived from *Valuing Ecosystem Services*, NRC, 2005

Values from Existing Studies

Mean User Day Values by Recreation Activity Type

Activity Type	Mean $
Swimming	$21 per person day
Camping; wildlife viewing; motorized boating	30 to 35 per person day
Picnicking; Sightseeing, fishing, hiking	35 to 37 per person day
Biking	45 per person day
Rock climbing	52 per person day
Boating, non-motorized	62 per person day

Source: Rosenberger and Loomis, 2001

Examples of Key Applications

- Watershed conversation, floodplains and wetlands valuation studies;
  - NYC Watershed Catskills, Lower Mississippi Floodplain (risk reduction of potential losses);
- Columbia River Basin multiple services;
  - drinking water, fishing, navigation, flood control;
- Recreational valuation studies (numerous);
- Restoration of lost Ecoservices;
  - Everglades, Fox River WI.

Potential Applications

- Impacts of Large-scale highway changes:
  - Watershed and flood control impacts;
  - Recreational impacts;
  - Eco-services, particularly habitat impacts;
  - Overall economic development impacts;
- Value of information from physical sciences can be measured by potential savings and risk reduction.
  - Prorated basis across sciences, including economic analysis.

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