Methods for Ecosystem Service Valuation

Bruce Peacock
National Park Service
Environmental Quality Division
Perspective

“Not everything that can be counted counts, and not everything that counts can be counted.”

Albert Einstein

Courts have warned against making “a fetish [of market value] since that may not be the best measure of value in some cases”

Ohio v. U.S. Department of the Interior 1989
Overview

- Why value ecosystem services?
- How are ecosystem services valued?
- What are equivalency methods?
Why value ecosystem services?

- The economy and ecosystems are interrelated
  - The strength of the economy depends on:
    - Ability of ecosystems to provide inputs
    - Ability of ecosystems to assimilate residuals
- The economy functions best when it recognizes all ecosystem values
  - Markets fail to maximize net benefits if ecosystems have no prices to guide their allocation to higher valued uses
Why value ecosystem services?

- Valuation avoids “all or nothing” policy choices
  - Just like normal market resources, ecosystems have:
    - Decreasing marginal benefits of provision
    - Increasing marginal costs of provision
  - At some point of provision, additional benefits do not outweigh additional costs
    - The point of diminishing returns
    - Generally occurs somewhere between “all” and “nothing”
Why value ecosystem services?
How are ecosystem services valued?

- What exactly is valued?
  - Defining this is challenging with ecosystems
    - **Natural resources**: tangible assets provided by nature
      - Air, water, minerals, biota
    - **Functions**: biophysical processes of natural resources that can be assessed independently of the human context
      - Habitat provision, nutrient cycling, photosynthesis
    - **Services**: beneficial outcomes of functions that are appreciated by people
      - Recreation, subsistence, flood control, existence
How are ecosystem services valued?

- Ecosystem valuation focuses on **services**
  - People understand the beneficial outcomes they appreciate (services)
  - People may not understand the underlying biophysical processes (functions)
  - Functions are necessary but not sufficient for the provision of services
    - To be beneficial, people must also demand the outcomes of functions
      - Preferences
      - Opportunity
How are ecosystem services valued?

- Types of ecosystem values
  - Use values: values derived from physical interaction with ecosystems
    - Examples
      - Consumptive uses: values for hunting and fishing
      - Non-consumptive uses: values for wildlife viewing and hiking
    - Involve observable behavior
    - Current or future use
    - On or off-site use
How are ecosystem services valued?

- Types of ecosystem values (cont.)
  - **Non-use values:** values derived independently from physical interaction with ecosystems
    - Value of knowing ecosystems exist or will be preserved in a given condition
    - Motivations include bequest, altruism, and ethics
    - Courts have recognized non-use values as potentially valid components of damage assessment awards (*Ohio v. DOI* 1989)
How are ecosystem services valued?

- **Fundamental economic approach**
  - Assign economic values according to the ability of resources to satisfy human needs
    - Anthropocentrism without apology!
    - Key determinants of economic value
      - **Preferences:** resources provide services that people demand and appreciate to various degrees
      - **Scarcity:** abundant resources are better able to provide services than scarce resources
  - Economic valuation of ecosystems follows this fundamental approach
How are ecosystem services valued?

- Economic valuation methods
  - *Revealed preference methods*: observe people making binding choices regarding real alternatives
    - Cannot estimate non-use values
    - Cannot value un-experienced scenarios
  - *Stated preference methods*: observe people making non-binding choices regarding constructed alternatives
    - Can estimate non-use values
    - Can value un-experienced scenarios
    - Concern about “hypothetical bias”
How are ecosystem services valued?

- **National Park Service database of values**
  - Value ranges by activity (1996 $ per visitor day)
    - Backpacking $22.35 - $66.95 (1 study)
    - Bird watching $4.83 - $65.38 (4 studies)
    - Fishing $1.73 - $464.02 (129 studies)
    - Hiking $0.33 - $218.37 (21 studies)
    - Mountain biking $17.38 - $246.41 (7 studies)
    - Picnicking $7.45 - $118.95 (8 studies)
    - Rock climbing $22.18 - $113.18 (4 studies)
    - Swimming $1.83 - $111.95 (11 studies)
    - Wildlife viewing $2.00 - $289.90 (69 studies)
How are ecosystem services valued?

Suggested references

- [http://www.ecosystemvaluation.org](http://www.ecosystemvaluation.org)
What are equivalency methods?

- Habitat Equivalency Analysis (HEA)
  - Determines the amount of restoration required to offset ecosystem losses
    - First developed for CWA § 404 permitting
    - Commonly used in natural resource damage assessments
    - Applied to ecological risk assessment consequence analyses
  - Does not measure ecosystem attributes
  - Does not measure economic values
What are equivalency methods?

- HEA determines the amount of restoration such that...
  - Sum of replacement services = Sum of lost services
  - Services quantified in units such as *acre-years*
    - One acre-year represents the ecosystem services provided by 1 acre of habitat for 1 year
    - Captures *space* and *time* dimensions of service provision
    - Quantification is specific to habitat and landscape settings
  - Accounts for the time preferences of people through *discounting*
What are equivalency methods?

- HEA assumes that the unit values of lost and replacement services are *equal and constant*
  - Given that…

  \[ \text{Sum of replacement services} = \text{Sum of lost services} \]

  implies

  \[ \text{Value of replacement services} = \text{Value of lost services} \]

  and

  The concept of *compensation* is satisfied
What are equivalency methods?

- This assumption also implies *in-kind* replacement of lost services
  - Similar services reasonably have similar values
    - Habitat setting
    - Landscape setting
  - Appropriate restoration opportunities must exist
  - Lost and replacement services must be quantified by a common metric (e.g., percent cover of an indicator plant species)
What are equivalency methods?

- CWA § 404 permitting example
  - Development of a 10-acre wetland
  - Must specify a time path of loss
    - 100% lost services from 2008 to 2013
    - Decreasing to 80% lost services by 2018
    - Remaining at 80% lost services into perpetuity
  - Indicated total lost services = 289.08 acre-years
What are equivalency methods?

- CWA § 404 permitting example (cont.)
  - Restoration of a degraded wetland of similar habitat and landscape settings
  - Must specify a time path of replacement
    - 0% replacement services in 2010
    - Increasing to 70% replacement services by 2020
    - Remaining at 70% replacement services into perpetuity
  - Indicated rate of replacement = 19.324 acre-years of replacement services per acre of mitigation
What are equivalency methods?

- CWA § 404 permitting example (cont.)
  - Calculation of the amount of required mitigation

\[ \frac{289.08 \text{ acre-years}}{19.324 \text{ acre-years/acre}} = 14.96 \text{ acres} \]

This compensatory mitigation requirement can be monetized by estimating implementation and maintenance costs.
What are equivalency methods?

- Suggested references