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# Methods for Ecosystem Service Valuation

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# 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*

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# Overview

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

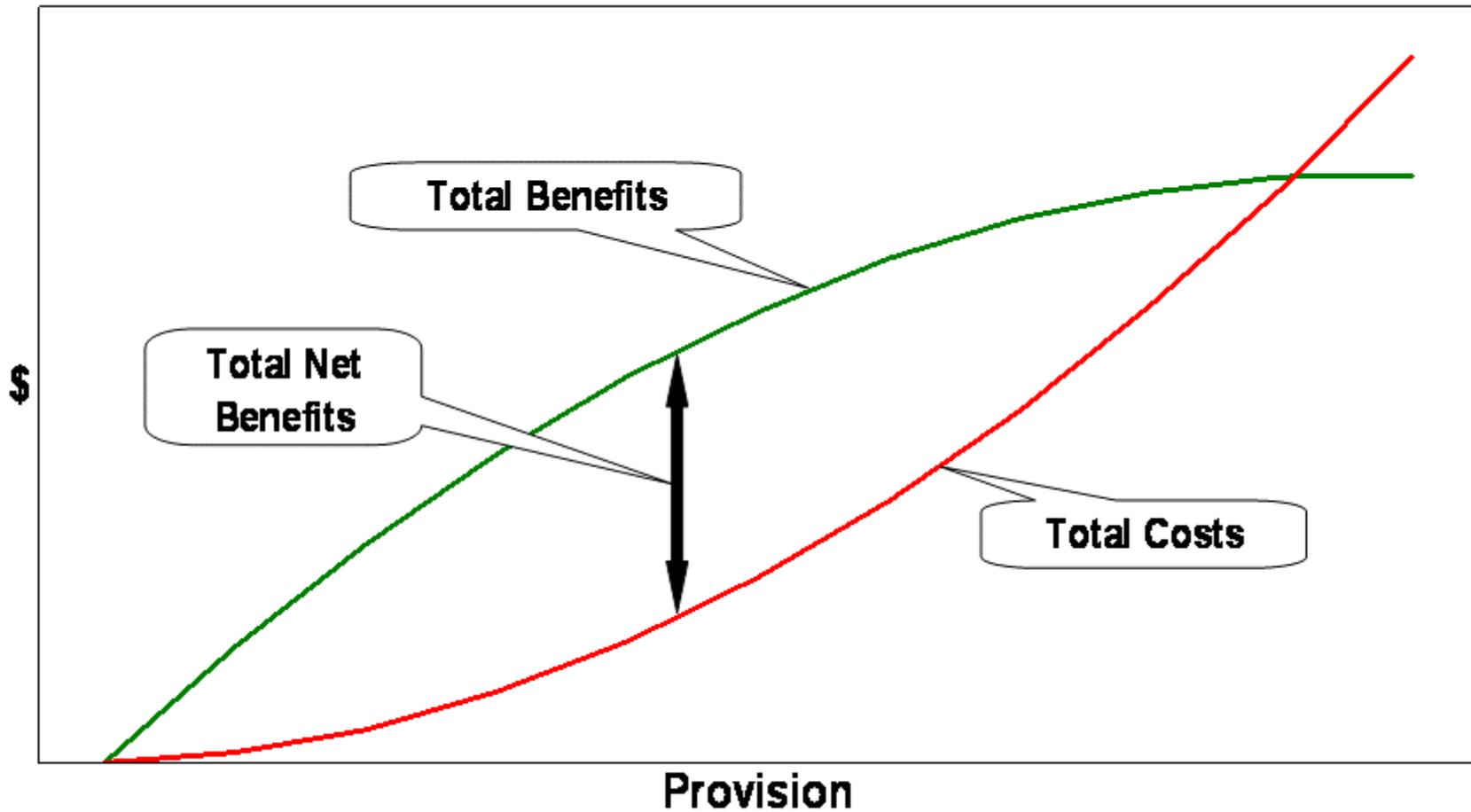
- The economy and ecosystems are interrelated
    - The strength of the economy depends on:
      - Ability of ecosystems to provide inputs
      - Ability of ecosystems to assimilate residuals
  - The economy functions best when it recognizes all ecosystem values
    - Markets fail to maximize net benefits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



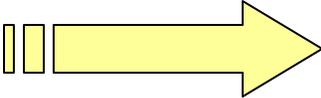
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# How are ecosystem services valued?

- 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
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# 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
-  Landscape Setting

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# 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
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# 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*)
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# 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
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# 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”
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# 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)
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# How are ecosystem services valued?

- Suggested references

- <http://www.ecosystemvaluation.org>
  - King, D.M., L.A. Wainger, C.C. Bartoldus, and J.S. Wakeley. “Expanding Wetland Assessment Procedures: Linking Indices of Wetland Function with Services and Values.” Engineer Research and Development Center, U.S. Army Corps of Engineers, September 2000.
  - Hackett, S.C. Environmental and Natural Resources Economics: Theory, Policy, and the Sustainable Society, 3<sup>rd</sup> edition. M.E. Sharpe, 2006
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# 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
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# 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**
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# What are equivalency methods?

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

***Sum*** of replacement services = ***Sum*** of lost services

**implies**

***Value*** of replacement services = ***Value*** of lost services

**and**

The concept of ***compensation*** is satisfied

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# 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)
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# 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
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# 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
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# What are equivalency methods?

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

$$289.08 \text{ acre-years} \div 19.324 \text{ acre-years/acre} = 14.96 \text{ acres}$$

This compensatory mitigation requirement can be monetized by estimating implementation and maintenance costs

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# What are equivalency methods?

- Suggested references

- King, D.M., and K.J. Adler. “Scientifically Defensible Compensation Ratios for Wetland Mitigation.” Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, January 1991.
  - Allen, P.D., II, D.J. Chapman, and D. Lane. “Scaling Environmental Restoration to Offset Injury Using Habitat Equivalency Analysis.” In Economics and Ecological Risk Assessment, edited by R.J.F. Bruins and M.T. Heberling. CRC Press, 2005.
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