Principles to Guide Comprehensive Ecosystem Service Valuation – Insights from Great Dismal Swamp (GDS) and Hurricane Sandy Restoration (HSR) Assessments

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"We've funded several valuation studies (……) and interesting as they've been, I'm not convinced they have persuaded any policy maker one way or the other. Having said that, they are certainly useful as a reminder to decision-makers that there is broad value to be acknowledged and considered, and helpful for communications about the value proposition for conservation action (Anonymous)."

GDS case (Parthum et al 2017; Pindilli et al 2018)

HSR case (NOAA and ERG 2016)

Purposes

1. Summarize science-based principles that can guide comprehensive quantitative and qualitative assessments of salient ecosystem service values using monetary and non-monetary approaches.
2. Use the Great Dismal Swamp and Hurricane Sandy Restoration evaluations to identify opportunities for and limitations to comprehensive assessments.

Principle #1

Identify salient ecosystem services using a transparent and inclusive stakeholder process

- Crucial to frame context and tailor metrics for knowledge production to assist decision processes (Cash et al., 2003; Cowling et al., 2008, Ruckelshaus et al., 2015)
- GDS assessment had exemplary stakeholder engagement
- HSR assessment tapped resource agency managers in lieu of ES users due to time and resource constraints

Principle #2

Use interdisciplinary teams to develop 1) monetary and 2) non-monetary (as appropriate) measures that capture relevant human welfare effects

- Engaging relevant disciplines fosters inclusion of salient monetary and non-monetary effects (Ervin et al 2014; National Research Council 2013; Olander et al 2015).
- GDS used biophysical scientists and economists; add other social scientists, e.g., anthropology?
- HSR assessment was dominated by economists

Principle #3

Specify conceptual (causal chain) model of ecological structure, function and process to determine salient service flows

- Building CC models enhances communication among scientists and stakeholders for developing benefit relevant indicators (BRIs) (Olander et al 2018a, Wainger and Ervin 2017).
- GDS leaders developed simple flow diagram to capture basic linkages
- HSR project leaders did not construct a conceptual model but endorse the usefulness of such an exercise

Principle #4

Conduct assessments at geographic scales that are ecologically appropriate (supply side) and for which demand-side preferences are understood

- Spatial scale varies from a local city park, to a community watershed, to a region; assessments encompass a scale that recognizes the importance of the full suite of benefits to stakeholders (Graedel et al. 2013; Iniesta-Arandia et al. 2014)
- GDS focused within swamp boundaries, but assessed services and disservices affecting regional communities, e.g., smoke
- HSR assessment required regional supply and demand frames

Principle #5

Estimate 1) monetary and 2) non-monetary (as appropriate) value metrics for all salient services using the <u>best available science</u>

- Monetization may not be feasible nor appropriate for some ES; non-monetary BRIs can complement monetary measures (Olander et al. 2018; Wainger and Ervin 2017)
- Credible monetary and non-monetary approaches exist to guide ES valuation for tradeoff analysis (Polasky 2018)
- GDS and HSR assessments relied heavily on state of the science monetary approaches to valuation

Principle #6

Characterize confidence intervals due to temporal variation in biophysical and socioeconomic factors and effects on resilience.

- Uncertainty about biophysical and socioeconomic linkages pervades ES valuation (Ervin et al 2014) ; assess sensitivity of value estimates to varying assumptions and identify threshold effects (Johnson et al. 2012)

- GDS and HS assessments conducted standard sensitivity analyses, e.g., social discount rate variations

Principle #7

Identify key gaps in theory, methods and data that limit the accuracy and relevance of the value estimates to inform Federal policy

- Broaden the set of services to be quantified and develop framework to integrate non-monetary with monetary measures as appropriate (Wainger and Ervin 2017)
- GDS and HSR assessments lacked key missing biophysical and economic data but creatively used secondary data (Johnston and Wainger 2015) and conducted limited primary surveys

Key Take-Aways

- Advances in theory and data enable (fairly) comprehensive ES valuation!
- Engaging relevant stakeholders tailors ES metrics and methods to statutory authorities, local conditions and data limitations
- Interdisciplinary and collaborative teams of scientists lead to more salient value information
- Monetize benefits where appropriate, but add benefit-relevant indicators when monetization is inappropriate or infeasible
- Strategic investments in science and data are necessary to measure and value more non-market ecosystem services

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Appendix – Principles Summary

1. **Identify salient ecosystem services (and disservices) in a transparent and inclusive stakeholder process.**
2. **Use interdisciplinary teams to develop benefit-relevant monetary and non-monetary indicators to capture the full spectrum of human welfare effects.**
3. **Specify the conceptual model (causal chain) of ecological structure, function and process that determines the salient service benefit flows.**
4. **Conduct assessments at a geographic scale that has ecological integrity (supply side) and for which demand-side preferences are understood.**

Appendix – Principles Summary

5. **Estimate monetary and non-monetary value metrics for all salient services using the best available science.**
6. **Characterize confidence intervals for the values due to uncertain changes in determining factors over time and the effects on natural system resilience.**
7. **Identify key missing theory, methods and data that limit the accuracy and relevance of the value estimates to inform federal policy.**

Benefit relevant indicators (BRIs)

- BRIs: measurable indicators that capture the human benefits of ES by considering use and non-use values (Olander et al., 2018b).
- Examples:
  - non-game wildlife population densities (for recreationists)
  - number of downstream residential properties protected from flood damages