A Demonstration of an Ecosystem Services Valuation Methodology for Reclaimed Phosphate Mined Lands

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What are Ecosystem Services?

- Ecosystems provide resources and functions that we value
  - Resources & functions are valued because they provide benefits to people in a variety of forms (clean water, habitat for wildlife, aesthetics, timber, recreation opportunities)
- Because we value these benefits, we recognize that ecosystems provide a service to people
  - Hence the term “Ecosystem Services”
Ecosystem Services: The Benefits People Obtain From Ecosystems

Millennium Ecosystem Assessment

Ecosystems and Human Well Being (2005)

ECOSYSTEM SERVICES

Provisioning
- FOOD
- FRESHWATER
- WOOD AND FIBER
- FUEL
- ...

Supporting
- NUTRIENT CYCLING
- SOIL FORMATION
- PRIMARY PRODUCTION
- ...

Regulating
- CLIMATE REGULATION
- FLOOD REGULATION
- DISEASE REGULATION
- WATER PURIFICATION
- ...

Cultural
- AESTHETIC
- SPIRITUAL
- EDUCATIONAL
- RECREATIONAL
- ...

ENVI RON
Focus: Consequences of Ecosystem Change for Human Well-Being

Millennium Ecosystem Assessment *Ecosystems and Human Well-Being* (2005)
Ecosystem Services: Categorization

**Natural resources**
- Property/land
- Habitats

**Ecological**
- Nesting area for birds
- Breeding area for fish
- Benthic habitat
- Sediment stabilization
- Water quality

**Indirect/Passive Uses**
- Existence value
- Aesthetic value
- Preservation of diversity
- T&E species

**Direct Human Uses**
(e.g., recreational, commercial)
- Bird watching
- Swimming
- Hunting and fishing
- Energy development
- Industrial processes
- Land development

**ENVI RON**
How Did We Get to Ecosystem Services?
Why Formal Quantification of Ecosystem Services is Important?

• Enables you to:
  – Document the ecosystem value of a parcel of property
  – Document the ecosystem cost/benefit of an action
  – Compare ecosystem benefits/costs between actions (i.e., NEBA, NESA)
  – Select/modify actions that maximize ecosystem benefits

• Subsequently, quantified values provide supporting information for decision-makers and other stakeholders
Value of Reclaimed Phosphate Mined Lands

- Reclaimed phosphate mined lands provide valuable ecosystem services, which include:
  - Providing wildlife habitat
  - Providing water recharge areas
  - Providing buffers for aquatic habitats
  - Sequestering carbon
  - Providing wildlife corridors and connectivity to overall ecosystem
  - Providing recreational and fishing opportunities
Value of Reclaimed Phosphate Mined Lands

- Traditional approaches to evaluating and monitoring reclaimed phosphate mined lands typically do not quantify ecosystem services.
- We demonstrate a methodology for quantifying ecosystem services for reclaimed phosphate mined lands using two examples.
Value of Reclaimed Phosphate Mined Lands

- We use economics based ecological and human use metrics to evaluate the ecosystem services of:
  - Landscape perspective: A portion of the mined landscape in Polk County, Florida
  - Reclaimed lakes
Valuation Approaches

• Use Habitat Equivalency Analysis (HEA) Framework to quantify ecological habitat services
  – Upheld by the United States District Court for the Southern District of Florida as appropriate method to value impact and restoration

• Direct Human Use Methods
  – e.g., benefits transfer (e.g., WTP)
Landscape-Level Example

- Pre-Mined Area in Polk County, Florida in 1968
- Post-Mined Area in Polk County, Florida in 2012
Net Ecosystem Service Analysis

• In this case, compares discounted service flows generated by different patch configurations (i.e., different landscapes).

• Each landscape is consider a different form of natural capital, some configurations provide higher levels of service flows than others.

• The contribution of a patch to landscape services will vary by habitat quality within a patch and its spatial context (i.e., its spatial relationship with other patches).

• When trading patches within a landscape, NESA incorporates the importance of the spatial context of patches lost and gained.
Valuing the Resource

• Increased Commercial Value (mining versus agriculture)
• Reclaimed lakes contribute to local economy

1. Increased Ecological Value
   ✓ Increased quality of habitat: A change from cropland/pasture to aquatic

2. Increased Human Use Value
   ✓ Significant positive economic and social impact
Quantifying Net Ecosystem Services: Comparing Impacts and Benefits Over Time

Impacts and benefits are based on changes from the baseline (pristine?)

Area B - Services Provided (Benefit)

Ecosystem Services

-20%

20%

0%

Baseline

Environmental Economics-based Approaches

Years
Example: Evaluate and compare pre- and post-mined areas

<table>
<thead>
<tr>
<th>Scenario #1</th>
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<tbody>
<tr>
<td>Column 1</td>
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<td>Alternative Management Action</td>
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<tr>
<td>Landscape 1</td>
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<td>Landscape 2</td>
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Quantifying Ecosystem Services

• Too many services provided to practically measure all of them
  – Typically select one or more metrics to use as a surrogate to represent services

• Ecological Services metrics
  – Fish density (fish/hectare, fish/km, etc.)
  – Suitable habitat (ha for key species)
  – Water quality (N in mg/L)
  – Soil preservation (erosion rates)
  – Others

• Direct human use services metrics
  – Recreation (bird watching days)
  – Visitor Days (converted to $)
  – Food production
  – Economic well-being

• Can select specific metrics or combination
Ecological Services – Polk County Example

Habitat Quality Increase
Lake habitat: 200 Ha ≈ NPV$_{25}$ 2,490 dSHYs
Hydrophilic zone: 205 Ha ≈ NPV$_{25}$ 2,550 dSHYs

Area B Represents the Gain of Ecological Services Over Time
Units: Services Per Hectare Per Year: (SHY’s)

(NPV gain over 25 years)

B

B$_1$

Reclaimed Lake Creation

Baseline

Years


% of Services

100%

80%

60%

40%

20%

0%
• **Park Activities**
  - Bicycling
  - Camping (Equestrian, full facility, Group, Primitive)
  - Canoeing and Kayaking
  - Fishing
  - Hiking/Nature Trail
  - Horse/Equestrian Trail
  - Pets
  - Picnic pavilion
  - Picnicking
  - Playground
  - Restroom facilities
  - Showers Day Visitors
  - Wildlife Viewing

• **Park Economic Impact**
  - 2010-2011: about 60,000 visitors
  - $2,909,676/year Economic Impact
    - (FL State Parks 2012 data; economic impact is calculated as the amount of new dollars spent in the local economy by non-local park visitors and park operations: expenditures, jobs, etc.)
      - $NPV_{25} \approx 52$ Million
      - $NPV_{50} \approx 77$ Million

• **Net Economic User Value**
  - $900,000
    - $NPV_{25} \approx 16$ Million
    - $NPV_{50} \approx 24$ Million
Human Use Services - Polk County Example

- **Land Management Area**
  - Fishing
  - Hunting
  - Wildlife Viewing

- **Economic Impact and Net Economic User Value?**
  - Visitors? 13,000 since 2001
  - 53,000 hours of fishing
    - largemouth bass and crappie
  - Fin and Feathers Club, 700 members
  - Tilapia harvesting: commercial

  - $NPV_{25} \approx \$? Million$
  - $NPV_{50} \approx \$? Million$
Reclaimed Lakes Example

• Lake Vegetation Index (LVI) developed by the FDEP to evaluate the ecological health of a lake
• LVI score $\geq 43$ indicates healthy lake
• LVI scores resulting from recent evaluation of **reclaimed** lakes in Central Florida averaged 46 (ranged from 37-53; only 1 was below 43)
• LVI scores resulting from recent evaluation of **natural** lakes in Central Florida averaged 41 (ranged from 0-85)
LVI Data Suggests These Curves are Similar

Graph: Ecosystem Services vs. Years

- Area B - Services Provided (Benefit)
- Baseline
- 0%

Legend: ENVIROMON
Reclaimed Lakes Example

- LVI evaluations indicate that reclaimed lakes are ecologically healthy
- Reclaimed lakes used by many bird species
- Reclaimed lakes typically do not have developed shorelines
- Watersheds of reclaimed lakes typically do not include non-point source pollution from residential, commercial, and industrial development (e.g., metals)
- Watersheds of reclaimed lakes typically do not include agricultural runoff (e.g., pesticides, herbicides)
Conclusions

• Reclaimed lakes can offer significant and valuable ecosystem services
• At the landscape-level, reclaimed phosphate mined lands can offer valuable ecosystem services (tens to Hundreds of Millions of $)
Conclusions

• Ecosystem services offered by reclaimed phosphate mined lands should be considered during the permitting process and development of reclamation plans
  – Balance risks, benefits, and tradeoffs associated with competing alternatives

• Metrics to quantify ecosystem services should be included in monitoring plans of reclaimed lands
Acknowledgements

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