Valuing Ecosystem Services from Sandy-Related Salt Marsh Restoration at Forsythe National Wildlife Refuge (NJ)

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Our project

• Estimate values of ecosystem services that can be used in guiding post-Sandy restoration decisions
  • Trade-offs

• Focus on New York and New Jersey area

• Take into account transferability
All project components

- Coastal protection in Jamaica Bay, NYC
- Trade-offs in salt marsh ecosystem services at Forsythe NWR in NJ
- Benefit transfer guidelines (Jamaica Bay)
- Social cost of carbon at Forsythe
Forsythe NWR

- Managed by US FWS
- 50 miles along the NJ coast
- Major stop-over for migratory birds
- More then 37K acres
  - 78% is a salt marsh
- Significant damage from Sandy
Forsythe Restoration

• Forsythe NWR restoring 3,000 acres of salt marsh
  • Thin layer placement
  • Tidal flow restoration
  • More than just repairing damage from Sandy

• How do people value trade-offs between ecosystem services?
  • Protection from surge
  • Protection from non-surge flooding
  • Habitat
  • Recreation
Method: Stated Preference

• Contingent valuation
  • Describe a project/scenario and ask people whether they are willing to pay a certain amount or not
  • Vary the cost, but not the project/scenario parameters

• Choice experiment
  • Let’s make this more complicated!
  • Vary the cost AND vary the project parameters
  • Assess trade-offs
Choice experiment survey

• Respondents are asked to choose between two options and a status quo (choice set)

• Each option has attributes (ecosystem services)

• Each option has a “level” for each attribute and a cost

• Each respondent was asked three valuation questions
Survey sequence/design

- Background/education
- Familiarity/visits to FNWR
- Concern about FNWR
- Impact of Sandy
- Instructions for valuation
- Valuation matrix (3x)
- “Debrief” questions
- Altitudinal questions (CC, future storms, restoration)
- Outdoor activities
- Demographics provided by GfK
Phrasing ecosystem service benefits to respondents

• Habitat and recreation (qualitative)
  • “None”
  • “Minimal” improvements
  • “Significant “improvements

• Surge and non-surge flooding
  • Number of homes protected

• Acres - number
## Choice table

### Attributes (ecosystem services)

<table>
<thead>
<tr>
<th>Category</th>
<th>Status quo</th>
<th>Option A</th>
<th>Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of the marsh that is restored</td>
<td>None</td>
<td>[1K, 3K, 5K] acres</td>
<td>[1K, 3K, 5K] acres</td>
</tr>
<tr>
<td>Storm protection</td>
<td>Homes in the coastal area are under increased risk from storm damage.</td>
<td>Protects [1K, 3K, 6K] homes and businesses from a 5-foot storm surge (a rise of water generated by a storm that is 5 ft over and above the predicted tide level)</td>
<td>Protects [1K, 3K, 6K] homes and businesses from a 5-foot storm surge (a rise of water generated by a storm that is 5 ft over and above the predicted tide level)</td>
</tr>
<tr>
<td>Flood protection</td>
<td>Homes in the coastal areas are under increased risk of suffering flood damage.</td>
<td>Protects [3K, 7K, 10K] homes and businesses from a 20-year flood (a flood that would occur only once every 20 years)</td>
<td>Protects [3K, 7K, 10K] homes and businesses from a 20-year flood (a flood that would occur only once every 20 years)</td>
</tr>
<tr>
<td>Habitat</td>
<td>Habitats for migratory birds continue to deteriorate with the marsh; over time fewer birds would visit the marsh.</td>
<td>&quot;NONE&quot;, &quot;MINIMAL&quot;, &quot;SIGNIFICANT&quot;</td>
<td>&quot;NONE&quot;, &quot;MINIMAL&quot;, &quot;SIGNIFICANT&quot;</td>
</tr>
<tr>
<td>Recreation</td>
<td>Recreational opportunities decline as the marsh deteriorates; over time there would be fewer places to fish, hunt, and hike trails.</td>
<td>&quot;NONE&quot;, &quot;MINIMAL&quot;, &quot;SIGNIFICANT&quot;</td>
<td>&quot;NONE&quot;, &quot;MINIMAL&quot;, &quot;SIGNIFICANT&quot;</td>
</tr>
<tr>
<td>Cost - Increase in your annual income tax</td>
<td>$0</td>
<td>[$20, $65, $130]</td>
<td>[$20, $65, $130]</td>
</tr>
<tr>
<td>Vote</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
Implementation: GfK Knowledge Network Panel

- Pre-tested in late winter/early Spring of 2015 by ERG and then again by GfK in mid-Summer 2015

- Full implementation: mid-August 2015
  - 541 total responses

Note: Gradations of blue indicate relative numbers of households.
Wildlife and water purification were most important to respondents.
What we can estimate

• Habitat and recreation – qualitative
  • “None” to “minimal”
  • “None” to “significant”

• Flooding – number of homes
  • Combined surge and non-surge
  • Homes – converted to 5K homes

• Acres - number
  • Converted to 1K acres
## Willingness to pay (WTP) Estimates

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Incremental change</th>
<th>Estimated WTP (per HH per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat provision</td>
<td>None to minimal improvements</td>
<td>$50.33</td>
</tr>
<tr>
<td></td>
<td>None to significant improvements</td>
<td>$90.95</td>
</tr>
<tr>
<td>Recreation</td>
<td>None to minimal improvements</td>
<td>$30.71</td>
</tr>
<tr>
<td></td>
<td>None to significant improvements</td>
<td>$45.35</td>
</tr>
<tr>
<td>Protecting homes from surge</td>
<td>5,000 homes</td>
<td>$9.95</td>
</tr>
<tr>
<td>Restoring acres of marsh</td>
<td>1,000 acres</td>
<td>$8.96</td>
</tr>
</tbody>
</table>
Distance from Forsythe

Number of Respondents

- 0-20 MILES: 15
- 20-40 MILES: 40
- 40-60 MILES: 204
- 60-80 MILES: 176
- 80-100 MILES: 87
- 100 OR MORE MILES: 4

Number
Economic Value and Distance from Forsythe

- Habitat benefits do not decay over distance
- Recreation benefit decay quickly over distance
- Flood protection benefits decay moderately over distance

![Chart showing economic value and distance from Forsythe National Wildlife Refuge (FNWR). Bars represent percentage of value at 60 and 100 miles from FNWR for different benefits: Protecting 5,000 Homes from Flooding, Minimum Habitat Improvements, Significant Habitat Improvements, Minimum Recreation Improvements, Significant Recreation Improvements. The chart shows that habitat benefits remain high even at 100 miles, while recreation benefits decrease significantly at 60 miles and moderately at 100 miles.]
Self-Reported Impact of Sandy

- None: 22%
- Small: 43%
- Moderate: 27%
- Very significant: 8%
## WTP and reported impact of Sandy

<table>
<thead>
<tr>
<th>Reported Impact</th>
<th>Protecting 5,000 Homes from Flooding</th>
<th>Minimum Habitat</th>
<th>Significant Habitat</th>
<th>Minimum Recreation</th>
<th>Significant Recreation</th>
<th>Restoring 1,000 acres of salt marsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>-$4.43</td>
<td>$27.30</td>
<td>$67.27</td>
<td>$2.07</td>
<td>$17.42</td>
<td>$2.21</td>
</tr>
<tr>
<td>Small</td>
<td>$7.65</td>
<td>$46.69</td>
<td>$86.65</td>
<td>$25.56</td>
<td>$40.91</td>
<td>$7.80</td>
</tr>
<tr>
<td>Moderate</td>
<td>$19.73</td>
<td>$66.07</td>
<td>$106.04</td>
<td>$49.06</td>
<td>$64.41</td>
<td>$13.39</td>
</tr>
<tr>
<td>Very significant</td>
<td>$31.81</td>
<td>$85.46</td>
<td>$125.43</td>
<td>$72.55</td>
<td>$87.90</td>
<td>$18.97</td>
</tr>
<tr>
<td>Overall estimate</td>
<td>$9.95</td>
<td>$50.33</td>
<td>$90.95</td>
<td>$30.71</td>
<td>$45.35</td>
<td>$8.96</td>
</tr>
</tbody>
</table>
## Trade-offs: ratios between qualitative changes

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Minimum habitat improvements</th>
<th>Significant habitat improvements</th>
<th>Minimum recreation improvements</th>
<th>Significant recreation improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum habitat improvements</td>
<td>-</td>
<td>1.81</td>
<td>0.61</td>
<td>0.90</td>
</tr>
<tr>
<td>Significant habitat improvements</td>
<td>0.55</td>
<td>-</td>
<td>0.34</td>
<td>0.50</td>
</tr>
<tr>
<td>Minimum recreation improvements</td>
<td>1.64</td>
<td>2.96</td>
<td>-</td>
<td>1.48</td>
</tr>
<tr>
<td>Significant recreation improvements</td>
<td>1.11</td>
<td>2.01</td>
<td>0.68</td>
<td>-</td>
</tr>
</tbody>
</table>
Trade-offs between qualitative changes and homes protected

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum habitat improvements</th>
<th>Significant habitat improvements</th>
<th>Minimum recreation improvements</th>
<th>Significant recreation improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of homes protected from flooding</td>
<td>28,078</td>
<td>50,742</td>
<td>17,133</td>
<td>25,303</td>
</tr>
</tbody>
</table>
How do we use those ratios?

• Min habitat improvement project vs. a sig. habitat improvement project (ratio: 1.81)
  • Look at ratio of costs (sig to min)
  • Less than 1.81 $\rightarrow$ sig. habitat project

• Min recreation project to flood protection project
  • The flood protection project would need to protect at least 17K homes
Contact information

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Willingness to pay over distance

Percentage of value that remains after 60 and 100 miles from Forsythe

<table>
<thead>
<tr>
<th>Miles from FNWR</th>
<th>Protecting 5,000 Homes from Flooding</th>
<th>Minimum Habitat Improvements</th>
<th>Significant Habitat Improvements</th>
<th>Minimum Recreation Improvements</th>
<th>Significant Recreation Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>74%</td>
<td>95%</td>
<td>97%</td>
<td>61%</td>
<td>70%</td>
</tr>
<tr>
<td>100</td>
<td>60%</td>
<td>95%</td>
<td>95%</td>
<td>35%</td>
<td>49%</td>
</tr>
</tbody>
</table>

Value associated with habitat improvements is stable over distance

Recreation-related values decline rapidly