Estimating Non-Use Values for Alternative Operations of the Glen Canyon Dam: An Inclusive Value Approach
Innovations in Non-Market Valuation in Complex, Coupled Systems

✧ Logic of non-use, non-market valuation in complex human and natural systems

✧ New theoretical developments in NMV
  • “Net WTP” and when it applies
  • Multiple dimensions of value
Overview of Protocol

- Loomis non-use value report (2014)
- Replication of early non-use value estimates
  - Experiments and proof of concept (2014)
- Analytical literature review (2015-2016)
  - Sandia White Paper
- Text analysis of public hearings on dams and hydropower (2015-2016)
- Survey 1: Stakeholder perspectives (2016)
- Survey 2: Value Demonstration and Definition (VDD) Survey (2016)
- Survey 3: Value Elicitation Survey (VES) (2016)
Characterizing the Change

- Many kinds of changes have non-use value impacts, beyond environmental resources
  - Changes in cultures that are important to the publics’ sense of history, identity, diversity
  - Changes in land use that result from alterations in patterns of production

- Changes in complex systems may extend beyond the proximate source of change
  - Well beyond the narrow reach of the river below the dam

- Formal governmental calls for public input provide an open, credible source for identification of the affected values
  - We focused on aggregation and coding of public testimony at Congressional hearings
Text analysis of public testimony

From 1995 to 2013, congress held 34 hearings that included 409 statements by 344 individuals about hydropower, water storage, and/or dams in the US

- Government (68%)
- Non-government (32%)
- National/Regional (60%)
- State (13%)
- Tribal (5%)
- Local (22%)
- Energy (14%)
- Water (16%)
- Environment (14%)

In these statements, individuals expressed policy preferences and justified their preferences by invoking one or more dimensions of value:

- Culture (10%)
- Recreation (6%)
- Water (52%)
- Hydropower (22%)
- Economy (45%)
- Environment (34%)
- Governance (36%)

Hydropower (sentences)
- Energy production (23%)
- Cost of hydropower (26%)
- Reduction of air pollution and/or fossil fuel consumption (33%)

"Hydropower enables the development of the region’s wind energy resource, because it can respond immediately to fluctuating energy demand and the intermittent nature of wind."
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**Governance (sentences)**
- Legal expectation (25%)
- Federalism (15%)
- Bureaucratic burden (21%)
- Coordination/collaboration (21%)

“…landowners were told that they could lease the land back at the same rate until the project went through and that they could buy their land back for the same price if the project did not materialize. Neither one of those promises have been fulfilled.”
Survey #1: Stakeholder Perspectives

- Web-based survey conducted in March-April 2016
- Included listed leadership of three stakeholder groups:
  - Farming
  - Species conservation
  - Power marketing
- Asked about relative priorities of value dimensions for deciding about GCD operations
- Focus is on identification of additional value dimensions not included in the DEIS
- Overall more than 23% of those contacted agreed to participate (some responded as groups)
Stakeholder identification of dimensions of value

- DEIS dimensions affirmed
- Air quality/visibility (air emissions)
- Greenhouse gas emissions
- Human health (air emissions)
- “Ways of life” for farmers and ranchers tied to a particular distribution of hydropower (sustainable rural communities and social inequalities),
- Climate change (air emissions)
- Governance (existing agreements, process)
### Dimensions of Value by Source of Identification and Characterization

<table>
<thead>
<tr>
<th>Dimension of Value</th>
<th>Source(s) of Identification</th>
<th>Source(s) of Characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Beaches</td>
<td>Lit review, public hearings, stakeholder interviews</td>
<td>DEIS</td>
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<tr>
<td>Native and Non-Native Fish</td>
<td>Lit review, public hearings, stakeholder interviews</td>
<td>DEIS</td>
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<tr>
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<td>DEIS</td>
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<tr>
<td>Air Quality and Visibility</td>
<td>Lit review, public hearings, stakeholder interviews</td>
<td>DEIS</td>
</tr>
<tr>
<td>Greenhouse gas emissions</td>
<td>Lit review, public hearings, stakeholder interviews</td>
<td>DEIS</td>
</tr>
<tr>
<td>Health Effects of Air Pollution</td>
<td>Lit review, stakeholder interviews</td>
<td>Lit review</td>
</tr>
<tr>
<td>Farmer/Rancher/Rural Communities</td>
<td>Lit review, public hearings, stakeholder interviews</td>
<td>Lit review</td>
</tr>
<tr>
<td>GCC Impacts of Hydropower</td>
<td>Lit review, stakeholder interviews</td>
<td>Lit review</td>
</tr>
<tr>
<td>Ancillary Hydropower Benefits</td>
<td>Lit review, public hearings</td>
<td>Lit review</td>
</tr>
<tr>
<td>Governance/Process</td>
<td>Public hearings, stakeholder interviews</td>
<td>Lit review</td>
</tr>
</tbody>
</table>
Survey #2: Value Demonstration and Definition (VDD) Survey

- Nationwide Internet survey fielded June 18-21, 2016
  - 3002 completed surveys
  - Opt-in sample, based on large pool of willing respondents
  - Filtered to approximate national demographics
- Not intended to provide nationally representative estimates
- Results of VDD Survey were used in final design:
  - Technical input (e.g., “bid amount” ranges)
    » “Fat tails” problem identified
    » Use of fully randomized bid structure
  - Tests of relevance of dimensions of value for WTP
  - Tests of respondent comprehension and cognitive load
Assessment of Confusion & Fatigue

(a) Information on Survey

- River Beaches
- Native and Non-Native Fish
- Recreation and Tourism
- Vegetation and Wildlife
- Cultural Sites and Native Americans
- Hydropower
- Air Quality and Visibility
- Health Effects of Air Pollution
- Farmers, Ranchers, and Rural Communities
- Climate Change
- Additional Benefits of Hydropower
- Decision Making Process

- Learned something new
- Already knew the information
- Don't understand the information

(b) Feedback on Survey

- The survey was confusing; I did not understand some of the information or questions
- The survey was too long; it was hard to stay focused the entire time
- The survey was irrelevant to me; I don't care about the Glen Canyon Dam
- There was not enough information on the survey for me to answer the questions
- The survey was interesting; I enjoyed the information and questions

- Strongly Disagree (1)
- Neither Agree nor Disagree (4)
- Strongly Agree (7)
Survey #3: Value Elicitation Survey (VES)

- We utilized results of VDD Survey in final design
  - Technical input (e.g., “bid amount” ranges)
  - Comprehension and cognitive load
  - Relevance of dimensions of value for WTP
  - Model validation tests
- VES employed random sample of US residents
  - Permits inference from sample to households nationwide
VES Data

- 3017 interviews collected August 5-25, 2016
- Employed GfK’s online address-based sample
  - Non-internet households provided with devices and access
  - Provides a random sample of the US public
  - 54% completion rate (proportion of invited sample that completed an interview)
  - Sample closely mirrors the demographics of the adult US Census
  - Weights used to precisely match sample to Census
  - GfK sampling method compliant with the “Standards and Guidelines for Statistical Surveys” by the OMB
### Voting Results for GCD Operational Preferences with Inclusive Treatment

<table>
<thead>
<tr>
<th>Option</th>
<th>Number of Respondents</th>
<th>Percentage of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vote to Change Operations</td>
<td>175</td>
<td>17.4%</td>
</tr>
<tr>
<td>Would pay &gt;$0 payment amount</td>
<td>54</td>
<td>5.2%</td>
</tr>
<tr>
<td>Would not pay &gt;$0 payment amount</td>
<td>56</td>
<td>5.7%</td>
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<tr>
<td>Not sure if would pay &gt;$0 payment amount</td>
<td>65</td>
<td>6.5%</td>
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<tr>
<th>Option</th>
<th>Number of Respondents</th>
<th>Percentage of Sample</th>
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<tbody>
<tr>
<td>Vote to Continue Operations</td>
<td>669</td>
<td>65.4%</td>
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<tr>
<td>Would pay &gt;$0 payment amount</td>
<td>218</td>
<td>21.7%</td>
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<tr>
<td>Would not pay &gt;$0 payment amount</td>
<td>217</td>
<td>20.4%</td>
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<tr>
<td>Not sure if would pay &gt;$0 payment amount</td>
<td>234</td>
<td>23.4%</td>
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<tr>
<th>Option</th>
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<tr>
<td>Would Not Vote</td>
<td>155</td>
<td>17.2%</td>
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</table>
Estimation of WTP

\[ WTP_i = e^{X_i'\beta + \varepsilon_i} \]

\[ \Pr(WTP_i > Payment_i) = \Pr(\theta_i > \delta \ln(Payment_i) - X_i'\beta^*) \]

where \( \theta = \varepsilon / \sigma \), \( \delta = 1 / \sigma \)

and \( \beta^* = \beta / \sigma \)

\[ MD(WTP) = e^{X_i'\beta} \]

• WTP is estimated separately for those who prefer each option, weighted by the proportion of the sample that preferred each option

• The difference between them is “net” WTP (Carlson et al 2016)
Estimate of Net Median WTP

- Multiple models employed, parametric and non-parametric
- Model controls in parametric model reflect familiarity with the GCD, preferences for hydropower, views of nature, and household income
- “Hypotheticality” in responses was addressed by including as “yes” votes only those who were very sure that they are willing to pay
- Estimated net median household WTP to retain the current operations is $19.76 per household (=$20.19 - $0.43)

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<th></th>
<th>(1)</th>
<th>(2)</th>
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<tr>
<td>Payment Only</td>
<td>$9.32</td>
<td>$0.35</td>
<td>$10.14</td>
<td>$0.43</td>
<td>$89.13</td>
<td>$22.43</td>
<td>$87.40</td>
<td>$20.19</td>
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<tr>
<td>(80%)</td>
<td>(7.88)</td>
<td>(1.04)</td>
<td>(8.02)</td>
<td>(1.23)</td>
<td>(21.55)</td>
<td>(9.57)</td>
<td>(21.36)</td>
<td>(8.20)</td>
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</tbody>
</table>

| **Continue**   |      |      |      |      |      |      |      |      |
| Payment Only   |      |      |      |      |      |      |      |      |
| (80%)          |      |      |      |      |      |      |      |      |
| Median WTP     |      |      |      |      |      |      |      |      |
| (7.88)         |      |      |      |      |      |      |      |      |
Concluding Thoughts

♦ These estimates apply to the balance of an inclusive set of non-use value dimensions within a complex, coupled human and natural system
  • Non-use value estimates are highly sensitive to inclusion of a wider range of value dimensions than is standard in non-market analyses

♦ A representative sample of the US public would prefer *not* to change GCD operational patterns as identified in the DEIS preferred option
  • The net WTP to avoid that change is estimated to be ~$20 per household
Questions?

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# Experimental Treatments

## Value Definition Survey

<table>
<thead>
<tr>
<th>Resource</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>Value Elicitation Survey</th>
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<tr>
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<td>Health Effects of Air Pollution</td>
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