Economic values of protected marine species in the U.S.: Empirical studies and conceptual challenges for ecosystem-based management*

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*Opinions expressed are those of the author and do not reflect those of NMFS, NOAA, or the U.S. Department of Commerce.
Non-market valuation of marine resources

• Non-market goods and services
  • No explicit markets
  • Protection or conservation of protected species are a type of non-market good

• Economic values of marine protected species
  • What is the public’s willingness to pay (WTP) to protect threatened and endangered species? What factors affect WTP?
  • What is the marginal value of improving status or recovery of species?
What economic values are measured?

Willingness to pay (WTP)

- Marine protected species
  - For preservation of the species
  - For enhancement of the species
  - For conservation programs

- Primarily composed of nonuse (e.g., existence) and non-consumptive use (e.g., viewing) benefits
Why care about non-market values of marine protected species?

- Ecosystem-based management (EBM)
  - U.S. National Ocean Policy
  - EU’s Marine Strategic Framework Initiative
  - UN’s Millennium Ecosystem Assessment
  - Intergovernmental Platform on Biodiversity and Ecosystem Services
  - Ecosystem services valuation
    - The Economics of Ecosystems and Biodiversity (TEEB) initiative emphasizes importance of taking steps to incorporate economic values for ecosystem services into decision-making

- Benefit-cost analysis (BCA)
  - Evaluations of policies affecting marine protected species often employ some type of BCA
    - EO12866 (and EO13563) requires benefit and cost consideration
    - U.S. Endangered Species Act

- Damage assessments
Methods for measuring economic values (WTP) of marine protected species

• Stated preference (SP) methods

  • **Contingent valuation** (CV): Respondents respond to (hypothetical market) questions that directly or indirectly reveal their WTP
    • Referendum CV: Would you pay $X for good Y?
    • Open-ended CV: How much would you pay for Y?

  • **Choice experiments** (CE): Respondents choose between multiple options that differ in the attributes that describe and differentiate the options
### Sample CE question

#### Results in 60 years for each alternative

<table>
<thead>
<tr>
<th></th>
<th>Alternative A Current program</th>
<th>Alternative B</th>
<th>Alternative C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Western Stock</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population status</td>
<td>Endangered</td>
<td>Endangered</td>
<td>Threatened</td>
</tr>
<tr>
<td>(Endangered now)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population size</td>
<td>26,000</td>
<td>30,000</td>
<td>75,000</td>
</tr>
<tr>
<td>(45,000 now)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Eastern Stock</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population status</td>
<td>Recovered</td>
<td>Recovered</td>
<td>Recovered</td>
</tr>
<tr>
<td>(Threatened now)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population size</td>
<td>60,000</td>
<td>80,000</td>
<td>60,000</td>
</tr>
<tr>
<td>(45,000 now)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Added cost to your household</strong></td>
<td>$0</td>
<td>$20</td>
<td>$40</td>
</tr>
<tr>
<td>each year for 20 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Which alternative do you prefer the most?**  
*Check one box*  

- Alternative A
- Alternative B
- Alternative C

**Which alternative do you prefer the least?**  
*Check one box*

- Alternative A
- Alternative B
- Alternative C
Stated preference-related controversies

- Critics argue that people do not answer SP questions consistently with their actual behavior (e.g., Hausman [1993, 2012])

- Recent evaluation by Kling et al. (2012)
  - Criterion validity (stated value = actual value?)
  - Convergent validity (other values the same? RP/SP)
  - Construct validity (theoretically consistent? Scope)
  - Content validity (best practices used?)

  **Bottom line**: Except for criterion validity (hypothetical bias has mixed results), SP methods appear to pass validity tests when best practices are followed
Willingness to pay for threatened and endangered marine species

- Lew (2015, working paper)
  - Reviews the peer-reviewed literature of SP studies valuing threatened and endangered (T&E) marine species
  - Focuses on disaggregate species valuation studies
    - Enable estimation of species-specific values
    - Over 30 studies
    - Most use CV methods, but recent studies predominantly use CE methods
Summary of findings

• Most species valued have been charismatic megafauna and well-known fish species
  • Cetaceans, pinnipeds, sea turtles, salmonids, etc.
  • Only small handful of lesser known

• Geographic coverage has been limited
  • U.S., Canada, Australia, U.K., Spain, and Greece

• Economic values vary widely (up to $356), but depend upon frequency of payment, entity paying, and specific good being valued

• Choice experiment studies lead to most flexible values for policy
Protected species valuation in the U.S.: NOAA studies

• Measure the value of protecting threatened and endangered marine species using stated preference methods
  • Economic surveys of the public
  • Developing and estimating economic models of preferences
  • Investigating key issues related to economic values and preferences
  • Evaluate and improve methods for incorporating these values into economic analyses (benefits transfer)

• Projects/species
  • Steller sea lion study
  • Multi-species protected species valuation study
    • Phase 1: 8 species
    • Phase 2: 8 species
  • Cook Inlet beluga whale study
Steller sea lion study

  - Valued population increases and improvements in ESA status
  - Examined role of changing baseline population trajectories on WTP
  - CE questions
  - Survey thoroughly tested via focus groups, interviews, and SSL scientists’ input
  - Mail survey fielded in 2007
  - “Good” response rate (~60%)

**ESA Listing Status**

Endangered = species at risk of extinction now
Threatened = likely to be endangered in the near future
Recovered = removed from ESA list (de-listed)
General results: SSL study

• Individuals are WTP for small changes, but large improvements have diminishing (or no) value

• Values are dependent upon assumed future baselines
  • Significant differences between preferences and WTP results for different baselines

• “Increasing version” appears closest to actual population trajectory
  • Modest WTP for improvements in population and ESA status ($34 - $112 per year)
Multi-species protected species valuation (PSV) study

- Stated preference choice experiment surveys
- Value protection (improved ESA listing status) of 16 T&E species
  - Phase 1
    - North Pacific right whale, North Atlantic right whale
    - Hawaiian monk seal
    - Upper Willamette River Chinook salmon, Puget Sound Chinook salmon
    - Smalltooth sawfish
    - Loggerhead sea turtle, leatherback sea turtle
  - Phase 2
    - Humpback whale, Southern resident killer whale
    - Central California Coast coho salmon, Southern California steelhead
    - Hawksbill sea turtle
    - Black abalone, elkhorn coral, Johnson’s sea grass
PSV study implementation

- Web survey using Knowledge Networks’ general population panel (contains ~50,000 panel members)

- Phase 1 fielded in May to early July 2009
  - 19,330 invited to participate
  - Cooperation rate of 70.8% (N=13,684)

- Phase 2 fielded in October to early December 2010
  - 16,359 invited to participate
  - Cooperation rate of 64.7% (N=10,582)

- Results
  - Phase 1: Wallmo and Lew (2012, Conservation Biology)
  - Phase 2: Wallmo and Lew (2015, Frontiers in Marine Science)
## Sea turtles

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean WTP* to Improve to Threatened</th>
<th>Mean WTP * to Recover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawksbill sea turtle</td>
<td>$51.17 (47.04-55.29)</td>
<td>$85.95 (81.27-90.20)</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td>$36.04 (33.13-38.84)</td>
<td>$64.53 (60.64-68.49)</td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td>N/A</td>
<td>$41.52 (39.05-44.08)</td>
</tr>
</tbody>
</table>
## Marine mammals

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean WTP* to Improve to Threatened</th>
<th>Mean WTP * to Recover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern resident killer whale</td>
<td>$48.30 (44.38-52.41)</td>
<td>$84.38 (79.15-89.69)</td>
</tr>
<tr>
<td>North Pacific right whale</td>
<td>$39.61 (36.36-42.95)</td>
<td>$69.46 (65.07-73.85)</td>
</tr>
<tr>
<td>North Atlantic right whale</td>
<td>$36.83 (33.65-40.13)</td>
<td>$68.00 (63.96-71.88)</td>
</tr>
<tr>
<td>Humpback whale</td>
<td>N/A</td>
<td>$60.98 (57.47-64.52)</td>
</tr>
<tr>
<td>Hawaiian monk seal</td>
<td>$34.43 (31.55-37.68)</td>
<td>$62.96 (59.29-66.81)</td>
</tr>
<tr>
<td>Species</td>
<td>Mean WTP* to Improve to Threatened</td>
<td>Mean WTP * to Recover</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Southern California steelhead</td>
<td>$45.71 (41.76-49.83)</td>
<td>$71.06 (66.29-75.96)</td>
</tr>
<tr>
<td>Central California Coast coho salmon</td>
<td>N/A</td>
<td>$51.96 (47.59-54.67)</td>
</tr>
<tr>
<td>Smalltooth sawfish</td>
<td>$30.81 (26.70-35.08)</td>
<td>$49.28 (44.40-54.47)</td>
</tr>
<tr>
<td>Upper Willamette River Chinook Salmon</td>
<td>N/A</td>
<td>$38.59 (36.07-41.01)</td>
</tr>
<tr>
<td>Puget Sound Chinook Salmon</td>
<td>N/A</td>
<td>$38.44 (35.99-40.70)</td>
</tr>
</tbody>
</table>
**Invertebrates, plants, and coral**

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean WTP* to Improve to Threatened</th>
<th>Mean WTP * to Recover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black abalone</td>
<td>$39.56 (35.62-43.59)</td>
<td>$70.50 (66.19-74.58)</td>
</tr>
<tr>
<td>Johnson’s seagrass</td>
<td>N/A</td>
<td>$43.83 (40.67-46.87)</td>
</tr>
<tr>
<td>Elkhorn coral</td>
<td>$38.00 (33.93-42.15)</td>
<td>$71.78 (67.30-76.23)</td>
</tr>
</tbody>
</table>
Cook Inlet beluga whale (CIBW) study

- **Goals**
  - Value ESA status improvements
  - Value reductions in extinction risk (to enable linking to PVA results)
  - Examine differences in WTP between rural and urban households

- Mail survey fielded in 2013 to 4,200 Alaska households (44.4% overall response rate)
Example: Linking economic values to population viability analysis

Figure 1. Potential relationship between willingness to pay (WTP) and extinction risk
Sample CE question: CIBW study

Q12 Here is the current program with two alternatives. Which alternative do you most prefer and which alternative do you least prefer? *Please indicate your responses below the table.*

<table>
<thead>
<tr>
<th>Population status in 50 years</th>
<th>Alternative A</th>
<th>Alternative B</th>
<th>Alternative C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endangered</td>
<td>25%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Threatened</td>
<td>$0</td>
<td>$40</td>
<td>$50</td>
</tr>
<tr>
<td>Added cost to your household each year for 10 years</td>
<td>□ □ □</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which alternative do you **prefer the most?** “X” only one box → □ □ □

Which alternative do you **prefer the least?** “X” only one box → □ □ □
Preliminary results: CIBW study

• Estimated model features
  • Account for scale and preference heterogeneity

• Are there differences in preferences between urban and rural Alaska households?
  • LR statistical test → Yes

• Are there differences in WTP between urban and rural Alaska households?
  • Confidence bounds of mean WTP overlap considerably (45 to 62% overlap) → No
  • Mean WTP for rural (urban) subsample ranged from $11 to $143 ($16 to $169)
Benefits transfer

• Conducting primary data collection is often infeasible due to time and/or resource constraints
  • Survey-based studies often take years!

• Benefits transfer (aka environmental value transfer)
  • Methods for applying existing economic values and value functions to new applications (Johnston and Rosenberger 2010; Navrud and Ready 2007)

• Common benefit transfer methods
  • Unit value transfer
  • Value function transfer
  • Meta-regression function transfer

• Sanchirico, Lew, Kling, Haynie, and Layton (2013, Marine Policy)
  • Benefit transfer used to incorporate conservation values into BCA of hypothetical fisheries policies (numerous challenges!)
Some challenges: Availability of quality values/studies

• Existing primary studies and values
  • Economic valuation databases: TEEB, Envalue, EVRI, et al. (see http://www.es-partnership.org/esp/80136/5/0/50)
  • Literature review paper suggests numerous coverage issues for protected species values
  • Temporal stability: Have values changed as a result of preference changes or population (e.g., demographic) changes? (Lew and Wallmo, working paper)

• Quality of original studies/values
  • Changes to “state-of-the-art” methods
  • Methodological versus policy studies/values
  • Researcher judgment/decisions and data quality

• Assessing study quality requires significant expertise and knowledge of underlying methods
More challenges: Matching primary value information to policy applications (transfer error)

- Population differences
  - Are values/preferences for one population transferable to a different population?

- Good/service definition differences
  - Does the value you want to transfer precisely and accurately match up with the good/service you wish you value?
    - E.g., valuing conservation versus improvements; local population vs global population; TEV vs use vs non-use value

- Aggregation/spatial issues
  - How do you aggregate transferred values?
    - Are there adding up/embedding effects with other ecosystem services?
    - Market size issues, translation issues to enable per unit estimates based on area or number of animals when original values are at the species level
  - Scaling up/down values?
Looking forward

• More and better values needed that cover the species and populations of interest – but we’re on the right track!

• Cautious application of benefits transfer is warranted (always), and particularly for applying values from the T&E marine species valuation literature

• Challenges to transfer value information exist (in general), but many of the issues are actively being studied

• NOAA Protected Resources (Species) Working Group recently formed
  • Identified past and current research and policy analyses related to protected marine species
  • Developing a “road map” for future research on protected marine species (incl. valuation)
Questions?
Related studies


