Science, Service, Stewardship

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

Daniel K. Lew
Alaska Fisheries Science Center
National Marine Fisheries Service (NMFS)
National Oceanic and Atmospheric Administration (NOAA)
Dan.Lew@noaa.gov

NOAA FISHERIES SERVICE

*Opinions expressed are those of the author and do not reflect those of NMFS, NOAA, or the U.S. Department of Commerce.

NOAA FISHERIES SERVICE

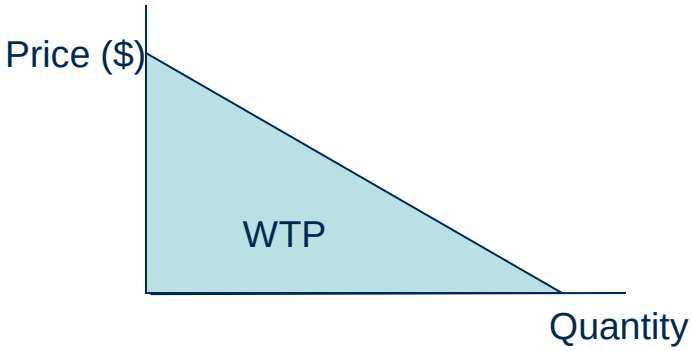
Non-market valuation of marine resources

- 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?

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

Sample CE question

	Results in 60 years for each alternative		
	Alternative A Current program	**Alternative B**	**Alternative C**
Western Stock Population status…….. (Endangered now)	Endangered	Endangered	Threatened
Population size……. (45,000 now)	26,000	30,000	75,000
Eastern Stock Population status……... (Threatened now)	Recovered	Recovered	Recovered
Population size…….. (45,000 now)	60,000	80,000	60,000
Added cost to your household each year for 20 years……..	$0	$20	$40

	Alternative A	**Alternative B**	**Alternative C**
Which alternative do you prefer the most? *Check one box------>*	☐	☐	☐
Which alternative do you prefer the least? *Check one box------>*	☐	☐	☐

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

Protected species valuation in the U.S.: NOAA studies

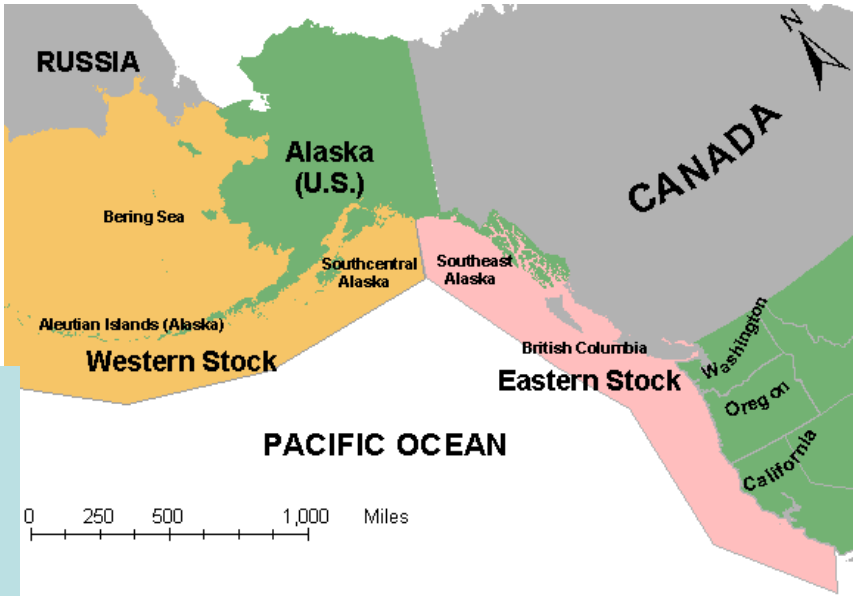
- Measure the value of protecting threatened and endangered marine species using stated preference methods
  - Economic surveys of the public
  - Developing and estimating economic models of preferences
  - Investigating key issues related to economic values and preferences
  - Evaluate and improve methods 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

NOAA FISHERIES SERVICE

Steller sea lion study

- Lew, Layton, and Rowe (2010, *Marine Resource Economics*)
  - 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)

NOAA FISHERIES SERVICE

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)

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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*)

NOAA FISHERIES SERVICE

Sea turtles

Species	Mean WTP* to Improve to Threatened	Mean WTP * to Recover
Hawksbill sea turtle	$51.17 (47.04-55.29)	$85.95 (81.27-90.20)
Leatherback sea turtle	$36.04 (33.13-38.84)	$64.53 (60.64-68.49)
Loggerhead sea turtle	N/A	$41.52 (39.05-44.08)

NOAA FISHERIES SERVICE

Marine mammals

Species	Mean WTP* to Improve to Threatened	Mean WTP * to Recover
Southern resident killer whale	$48.30 (44.38-52.41)	$84.38 (79.15-89.69)
North Pacific right whale	$39.61 (36.36-42.95)	$69.46 (65.07-73.85)
North Atlantic right whale	$36.83 (33.65-40.13)	$68.00 (63.96-71.88)
Humpback whale	N/A	$60.98 (57.47-64.52)
Hawaiian monk seal	$34.43 (31.55-37.68)	$62.96 (59.29-66.81)





NOAA FISHERIES SERVICE

Fish

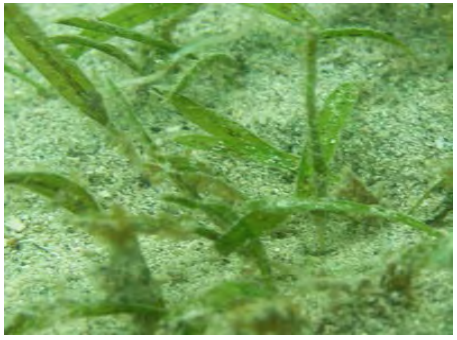
Species	Mean WTP* to Improve to Threatened	Mean WTP * to Recover
Southern California steelhead	$45.71 (41.76-49.83)	$71.06 (66.29-75.96)
Central California Coast coho salmon	N/A	$51.96 (47.59-54.67)
Smalltooth sawfish	$30.81 (26.70-35.08)	$49.28 (44.40-54.47)
Upper Willamette River Chinook Salmon	N/A	$38.59 (36.07-41.01)
Puget Sound Chinook Salmon	N/A	$38.44 (35.99-40.70)




NOAA FISHERIES SERVICE

Invertebrates, plants, and coral

Species	Mean WTP* to Improve to Threatened	Mean WTP * to Recover
Black abalone	$39.56 (35.62-43.59)	$70.50 (66.19-74.58)
Johnson's seagrass	N/A	$43.83 (40.67-46.87)
Elkhorn coral	$38.00 (33.93-42.15)	$71.78 (67.30-76.23)



NOAA FISHERIES SERVICE

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)

NOAA FISHERIES SERVICE

Example: Linking economic values to population viability analysis

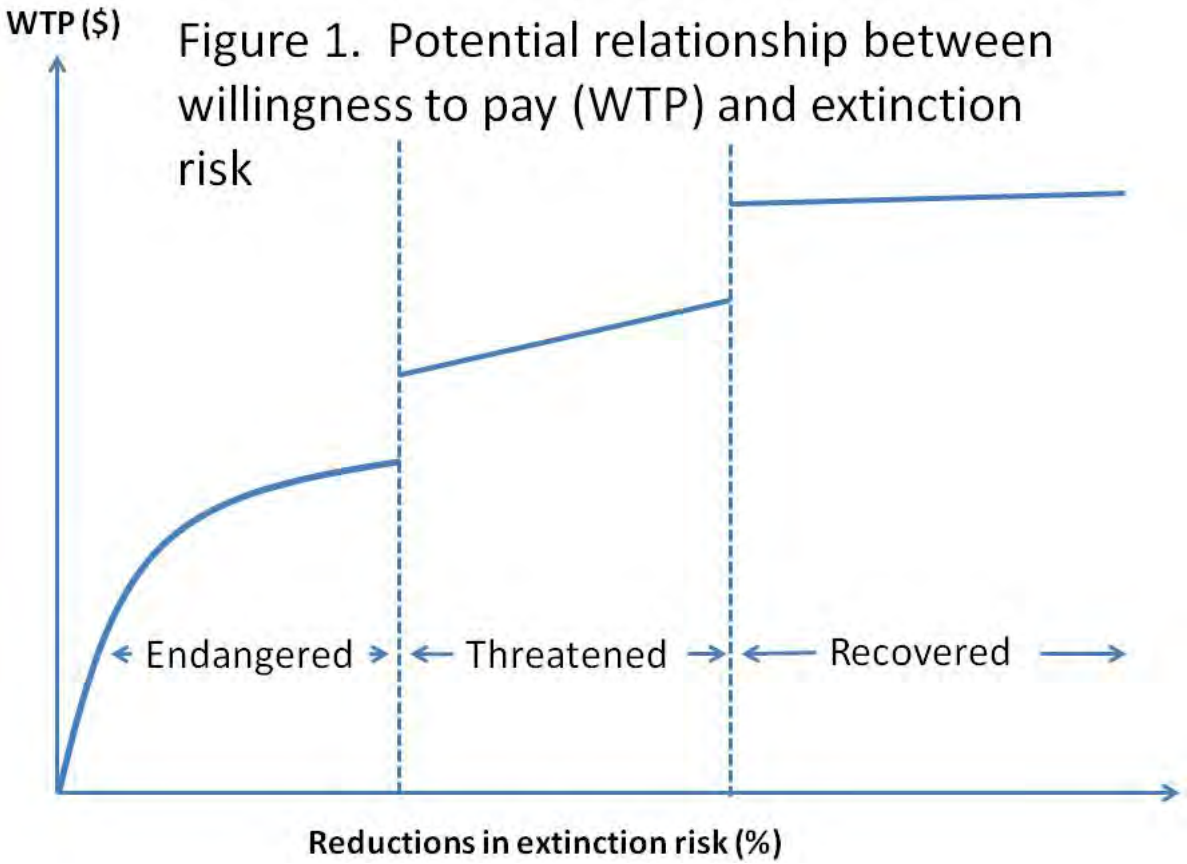


Figure 1. Potential relationship between willingness to pay (WTP) and extinction risk

NOAA FISHERIES SERVICE

Sample CE question: CIBW study

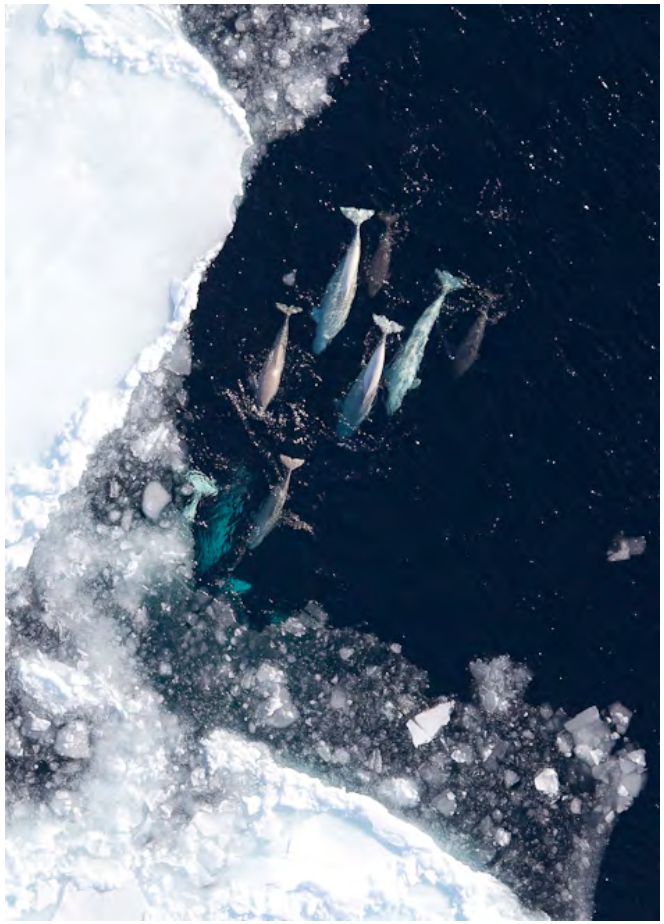
Q12 **Here is the current program with two alternatives. Which alternative do you most prefer and which alternative do you least prefer?** *Please indicate your responses below the table.*

	Alternative A Current program	Alternative B	Alternative C
Population status in 50 years…..... (endangered now)	**Endangered**	**Threatened**	**Threatened**
Risk of extinction by the year 2112…….. (25% now)	**25%**	**15%**	**10%**
Added cost to your household each year for 10 years……....	**$0**	**$40**	**$50**
	Alternative A	**Alternative B**	**Alternative C**
Which alternative do you prefer the most? *"X" only one box →*	☐	☐	☐
Which alternative do you prefer the least? *"X" only one box →*	☐	☐	☐

NOAA FISHERIES SERVICE

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)



NOAA FISHERIES SERVICE

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!)

NOAA FISHERIES SERVICE

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

NOAA FISHERIES SERVICE

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?

NOAA FISHERIES SERVICE

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)

NOAA FISHERIES SERVICE

Questions?

NOAA FISHERIES SERVICE

Related studies

Johnston, Robert, Daniel Jarvis, Kristy Wallmo, and Daniel K. Lew (In press) "Characterizing Large Scale Spatial Pattern in Nonuse Willingness to Pay: An Application to Threatened and Endangered Marine Species." *Land Economics.*

Lew, Daniel K. (2015) "Willingness to Pay for Threatened and Endangered Marine Species: A Review of the Literature and Prospects for Policy Use." Working paper.

Lew, Daniel K., David F. Layton, and Robert D. Rowe (2010) "Valuing Enhancements to Endangered Species Protection Under Alternative Baseline Futures: The Case of the Steller Sea Lion." *Marine Resource Economics* 25(2): 133-154.

Lew, Daniel K., and Kristy Wallmo (2011) "External Tests of Embedding and Scope in Stated Preference Choice Experiments: An Application to Endangered Species Valuation." *Environmental and Resource Economics* 48(1): 1-23.

Lew, Daniel K., and Kristy Wallmo (2015) "Temporal Stability of Preferences in Stated Preference Choice Experiments." Working paper.

Sanchirico, James, Daniel K. Lew, Alan Haynie, David Kling, and David F. Layton (2013) "Conservation Values in Marine Ecosystem-Based Management." *Marine Policy* 38: 523-530.

Wallmo, Kristy, and Daniel K. Lew (2012) "Public Values for Recovering and Downlisting Threatened and Endangered Marine Species." *Conservation Biology* 26(5): 830-839.

Wallmo, Kristy, and Daniel K. Lew (2015) "Public Preferences for Endangered Species Recovery: An Examination of Geospatial Scale and Non-Market Values." *Frontiers in Marine Science* 2:55.