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Using choice models to inform marine spatial planning: a case study of marine protected area designs off the U.S. west coast

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What is Marine Spatial Planning?

- A multi-sector, comprehensive, and integrated approach to managing human uses and activities in the marine environment
- Allows for coordination between all ocean and coastal users, draws upon the best available science, and creates an inclusive decision-making process that carefully **considers economic, social, ecological, and cultural interests**
- Emphasizes **valuing and analyzing tradeoffs in decision-making**

Marine Spatial Planning Information Needs



NOP Framework for MSP identifies key science and data issues inherent to informed decision-making, including:

The economic and environmental benefits and impacts of ocean, coastal, and Great Lakes uses in the region

Public Preferences for Marine Protected Areas off the U.S. West Coast

How do households on the U.S. west coast value different size/use configurations of offshore MPAs?



For west coast households, what are preferred sizes for an MPA and what are the associated values?



When (if ever) do MPAs generate negative values?



How do restrictions within the MPA (i.e. use type) including no human access, no harvesting, and limited take, affect preferences for MPA size and associated value?

Methodology: Stated Preference Choice Experiment Survey

- Survey describes a good – in this case marine protected areas sited in west coast Federal waters – in terms of attributes
- Respondents choose their most and/or least preferred option from different bundles of the good in a choice set
- Model estimated from data on respondent choices

Background Information on West Coast Protected Areas



- About 2.95% of west coast Federal waters are permanently protected as **Multiple Use MPAs**
 - commercial and recreational fishing, nature-based recreation and tourism, and scientific research activities allowed as long as they do not destroy marine biodiversity or habitat.
- About 0.05% of west coast Federal waters are permanently protected as **No-Take MPAs**
 - human access and activities that do not extract or harvest any marine resource allowed.
- 0% of West Coast Federal Waters are permanently protected as **No-Access MPAs**
 - closed to all human access except limited monitoring; used to prevent potential ecological disturbance and as a refuge for marine wildlife.

Within the boundaries of all permanent marine protected areas in west coast Federal waters industrial uses including mining, oil and gas exploration or drilling, and windmill or turbine construction are prohibited.

MPAs West Coast Federal Waters	Option 1 (Current Status)	Option 2	Option 3
% of West Coast Federal Waters designated No-Access MPAs	0%	0.5%	0%
% of West Coast Federal Waters designated No-Take MPAs	0.05%	0.5%	1%
% of West Coast Federal Waters designated Multiple Use MPAs	2.95%	3%	4%
Total amount of West Coast Federal Waters designated as a Marine Protected Area	3%	4%	5%
Cost to your Household This cost will be added to your household's Federal Income Tax <u>every year for three years</u>	\$0	\$25	\$15
Q6e. Which option do you most prefer for West Coast Federal Waters? (check only one box)	Option 1 <input type="checkbox"/>	Option 2 <input type="checkbox"/>	Option 3 <input type="checkbox"/>
Q6f. Which option do you least prefer for West Coast Federal Waters? (check only one box)	Option 1 <input type="checkbox"/>	Option 2 <input type="checkbox"/>	Option 3 <input type="checkbox"/>

Choice Model and Willingness-to-Pay

- Estimate random parameters logit model for panel data from choice observations
 - Allows for heterogeneity among respondents

$$\pi_j^s = R^{-1} \sum_{r=1}^R \frac{\exp(v_j(\beta^y))}{\sum_k \exp(v_k(\beta^y))}$$

$$\Pr[j, k, l] = \pi_j^s \cdot \pi_k^s \cdot \pi_l^s$$

- Estimate willingness-to-pay

$$CV_i = WTP_i = \frac{1}{\beta_p} \ln \left\{ \frac{\sum_i \exp V_i^1}{\sum_i \exp V_i^0} \right\}$$

Implementation and Sample Demographics

Survey Implementation

- Implemented using Knowledge Networks randomly recruited panel.
- Implemented from Dec. 2012 to Jan. 2013.
- 6,617 panel households from CA, WA, and OR contacted with invitation to participate in survey
- 3,354 completes

Sample Demographics

- Mean age 51
- 60% female
- 69% white, non-Hispanic
- 45% had college degree or higher
- 35% had household income > 100K

Choice Model Results

% of west coast
Federal waters

Attribute	Parameter estimate	Z statistic
Random parameters		
No-access**	.57632	11.41
No-access ² **	-.11720	-11.58
No-take**	.15999	6.26
No-take ² **	-.01625	-6.29
Multiple use**	.17295	6.38
Multiple use ² **	-.01051	-6.59
Non-random parameters		
Cost**	-.02295	-32.56
Standard deviation parameters		
No-access**	.66837	19.37
No-access ²	.00164	0.16
No-take**	.32913	22.25
No-take ²	.00222	1.05
Multiple use**	.25310	17.06
Multiple use ²	.00029	0.27
**parameters significant at $p < 0.01$		

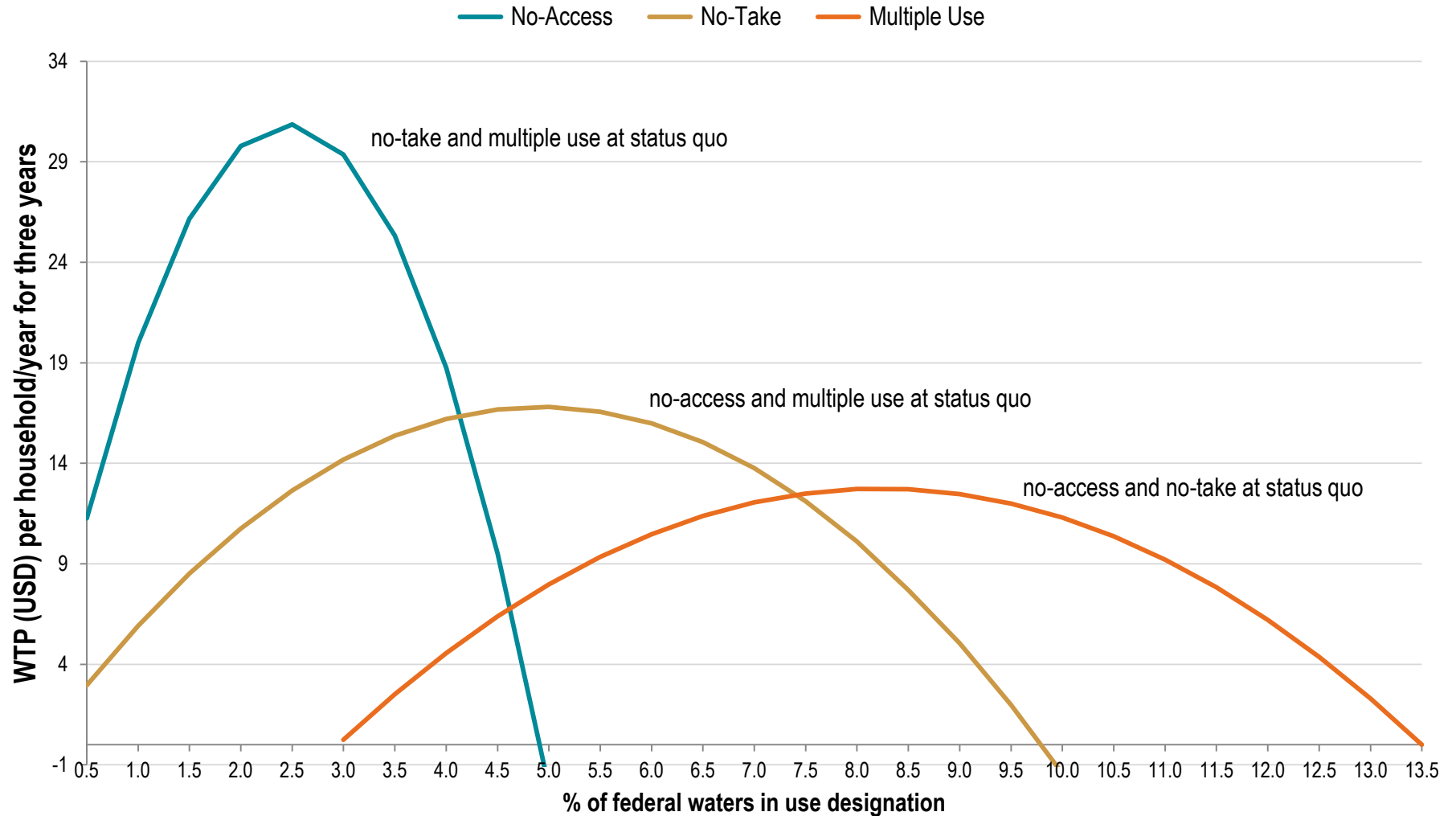


Value-maximizing size for single use-type

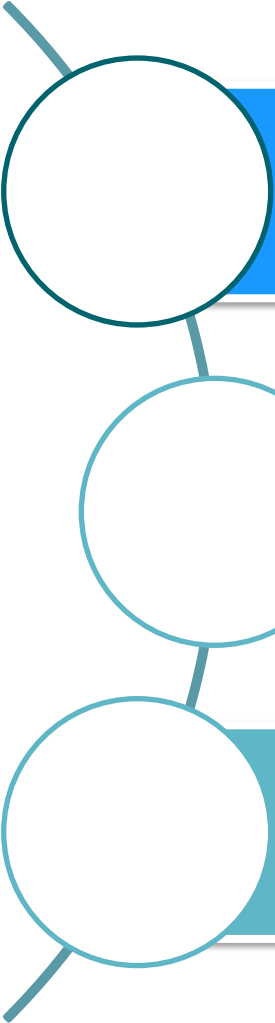
- 2.5% of west coast Federal waters in No-access MPAs
- 4.9% of west coast Federal waters in No-take MPAs
- 8.2% of west coast Federal waters in Multiple use MPAs

	2.5% No-access (other use types at status quo level)	4.9% No-take (other use types at status quo level)	8.2% Multiple use (other use types at status quo level)
WTP	\$30.86	\$16.81	\$12.75
(95% Confidence Interval)	(24.73 – 37.00)	(10.90 – 22.73)	(7.63 – 17.86)

WTP Values and Size



Assuming an MPA is a single use type...



< ~ 4.2% of Federal waters will yield the highest value designated as no-access

~4.2% to 7.5% will yield the highest value if designated as no-take

> ~ 7.5% will yield the highest value if designated as multiple use

When do MPAs yield negative economic value*?



Designating > ~ 4.8% of Federal waters as no-access

Designating > ~ 9.8% of Federal waters as no-take

Designating > ~ 13.5% of Federal waters as multiple use

*assumes MPA is designated in a single use type

Assuming MPA is a mix of use types...

Total Size (% of Federal waters)	% No-access	% No-take	% Multiple use	Value (\$ per household every year for 3 years)
15	2.5*	4.9*	8.2*	60.42
	3	10	2	22.94
	2	3	10	55.29
	1	7	7	45.82
10	3	4	3	45.82
	2	3	5	51.98
	1	5	4	41.39
5	3	1	1	26.13
	2	2	1	29.40
	1	1	3	26.16

Conclusions

- The west coast public is generally supportive of the notion of large marine protected areas.
- Optimal size from a west coast public perspective = 15.6% of Federal waters (2.5% no-access, 4.9% no-take, 8.2% multiple use)
 - *Other designs also utility-enhancing*
- Small size, high economic value = no-access protected area.
 - *In small sizes no-access is very valuable – designating 2.5% of Federal waters as no-access yields more value than a 5% designation of no-take or multiple use.*
- Marginal increases to MPAs larger than ~ 9.75% of Federal waters should be in multiple use designation.

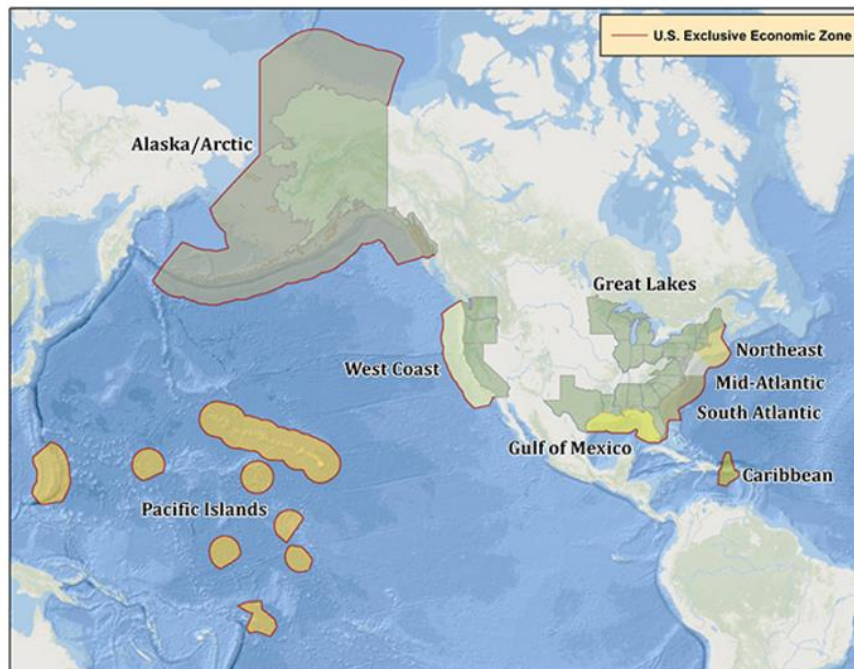
Next steps

- Parameter heterogeneity
 - certain MPA designations will likely have negative value for some respondents
 - Latent class model may be able to identify winners and losers from specific designations
- Can benefits be transferred among different MPA sites
- Can net benefits be estimated?
 - Opportunity costs, other costs

U.S. Policy & Marine Spatial Planning

- The National Ocean Policy identifies marine planning as one of nine priority implementation objectives

Ocean – Regional Planning Efforts



Planning Regions

- › Alaska/Arctic Region
- › Caribbean Region
- › Great Lakes Region
- › Gulf of Mexico Region
- › Mid-Atlantic Region
- › Northeast Region
- › Pacific Islands Region
- › South Atlantic Region
- › West Coast Region

Marine Spatial Planning Data Needs

Consider economic, social, ecological, and cultural interests & analyze tradeoffs

Economic and environmental benefits and impacts of ocean, coastal, and Great Lakes uses in the region



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Understand human values and preferences

Respondent Attitudes



- Over 75% of respondents agree that it's important to protect areas of the ocean even if they never get to see or use them
- About 50% of respondents agree that some parts of west coast Federal waters should be restricted to all human access



- About 50% of respondents think that commercial fishing in west coast Federal waters is extremely important for the region
- About 20% of respondents think that recreational fishing in west coast Federal waters is extremely important for the region
- About 60% of respondents think that fishing should be allowed in protected areas as long as gear does not damage habitat



- About 50% of respondents are willing to pay higher prices for seafood to establish protected areas
- About 30% of respondents think that businesses and industries should be compensated for their costs due to protected area restrictions