Marine protected area designations off the U.S. west coast: size/use designs to optimize public economic value

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MPA Values Sensitive to System Changes

- Well-documented that divers value quality improvements (increased coral cover, species diversity, visibility, etc…) within MPAs (Kenter et al 2013, Bhat 2003, Weilgus et al. 2003)
- Kenter et al. (2013) show anglers value quality improvements within MPAs
- McVittie & Moran (2010), Wallmo & Edwards (2008) show public value changes with size and/or use of MPAs

As an indicator that can change in response to management/policy, potential for MPA values to complement existing HD indicators?

Public Value of MPAs off the U.S. West Coast

Objective: estimate the value of different MPA size/use designations for households on the U.S. west coast

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?

Study Methods: Stated Preference Choice Experiment Survey

Willingness-to-Pay value for goods not traded in traditional market.

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.

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 every year for three years	$0	$25	$15
Q6e. Which option do you **most** prefer for West Coast Federal Waters? (check only one box)	Option 1 ❒	Option 2 ❒	Option 3 ❒
Q6f. Which option do you **least** prefer for West Coast Federal Waters? (check only one box)	Option 1 ❒	Option 2 ❒	Option 3 ❒

Choice Model and Willingness-to-Pay

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

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

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

- Estimate willingness-to-pay

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

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

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 MPAs as long as gear does not damage habitat

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

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 $p < 0.01$

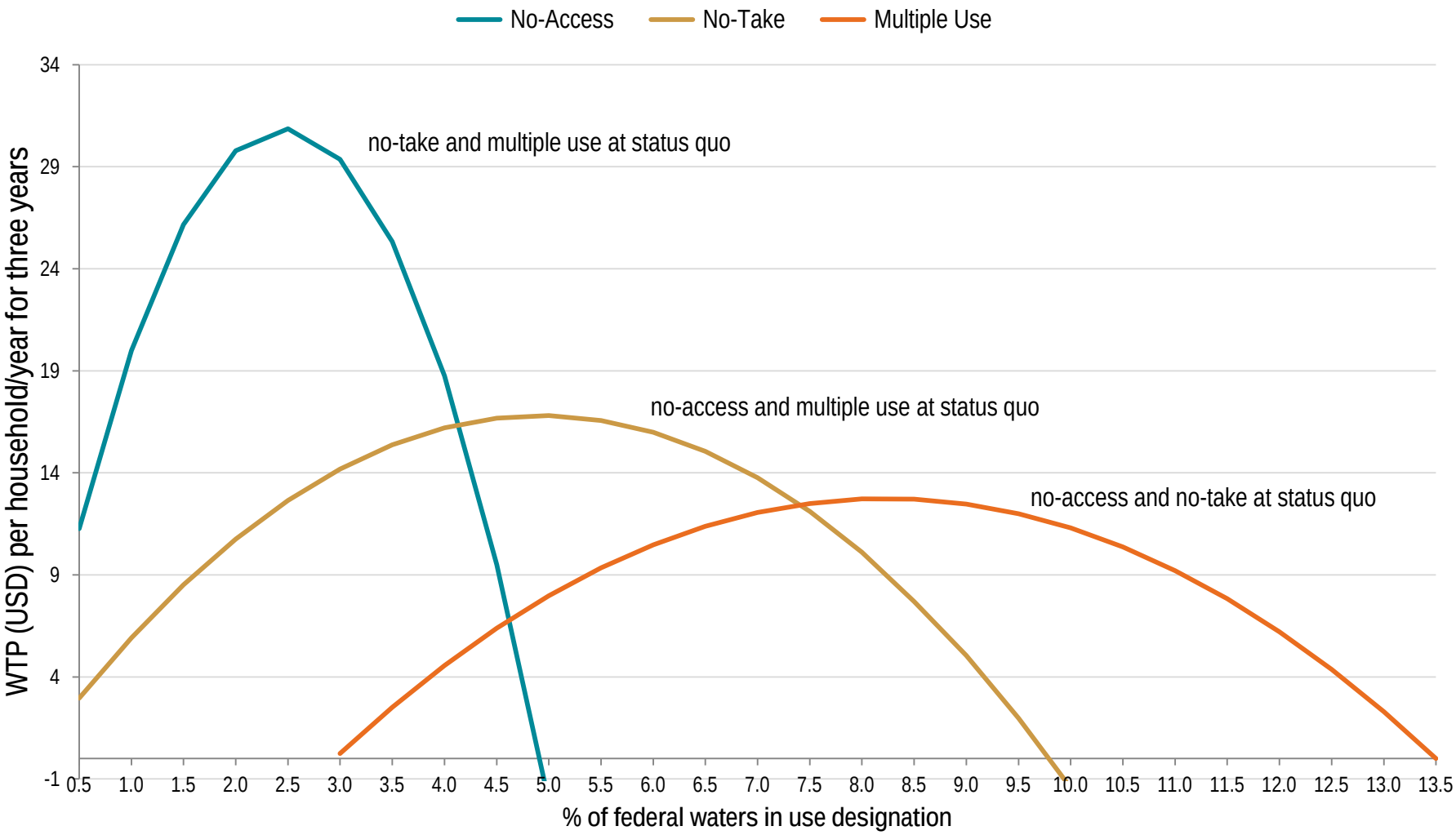
Maximum Size of each Use Type

Maximum size

- 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…

- Small MPAs (< ~ 4.2% of Federal waters) will yield the highest value designated as no-access
- Medium MPAs (~4.2% to 7.5%) will yield the highest value if designated as no-take
- Large MPAs (> ~ 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 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 net benefits be estimated?
  - Opportunity costs, other costs
  - Potential as an HD indicator?