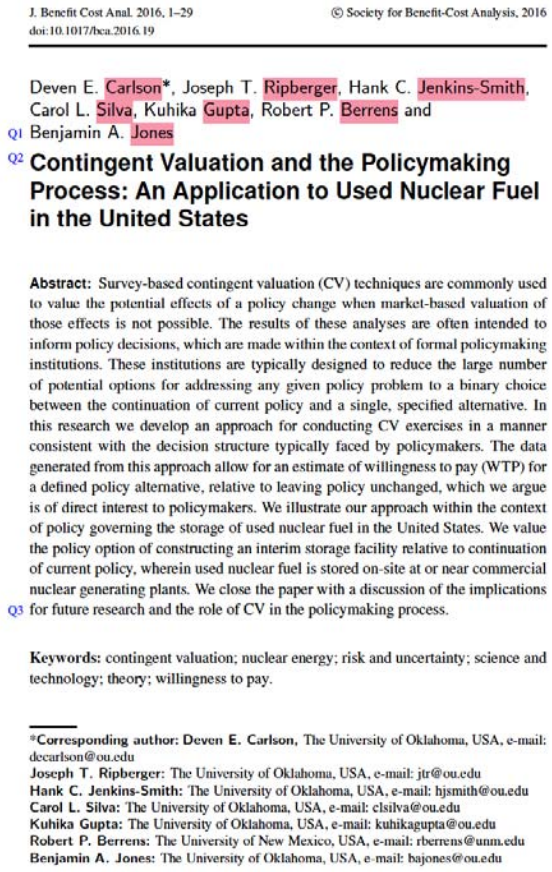
Estimating Non-Use Values for Alternative Operations of the Glen Canyon Dam: An Inclusive Value Approach

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



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Contingent Valuation and the Policymaking Process: An Application to Used Nuclear Fuel in the United States

Abstract: Survey-based contingent valuation (CV) techniques are commonly used to value the potential effects of a policy change when market-based valuation of those effects is not possible. The results of these analyses are often intended to inform policy decisions, which are made within the context of formal policymaking institutions. These institutions are typically designed to reduce the large number of potential options for addressing any given policy problem to a binary choice between the continuation of current policy and a single, specified alternative. In this research we develop an approach for conducting CV exercises in a manner consistent with the decision structure typically faced by policymakers. The data generated from this approach allow for an estimate of willingness to pay (WTP) for a defined policy alternative, relative to leaving policy unchanged, which we argue is of direct interest to policymakers. We illustrate our approach within the context of policy governing the storage of used nuclear fuel in the United States. We value the policy option of constructing an interim storage facility relative to continuation of current policy, wherein used nuclear fuel is stored on-site at or near commercial nuclear generating plants. We close the paper with a discussion of the implications for future research and the role of CV in the policymaking process.

Keywords: contingent valuation; nuclear energy; risk and uncertainty; science and technology; theory; willingness to pay.

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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)

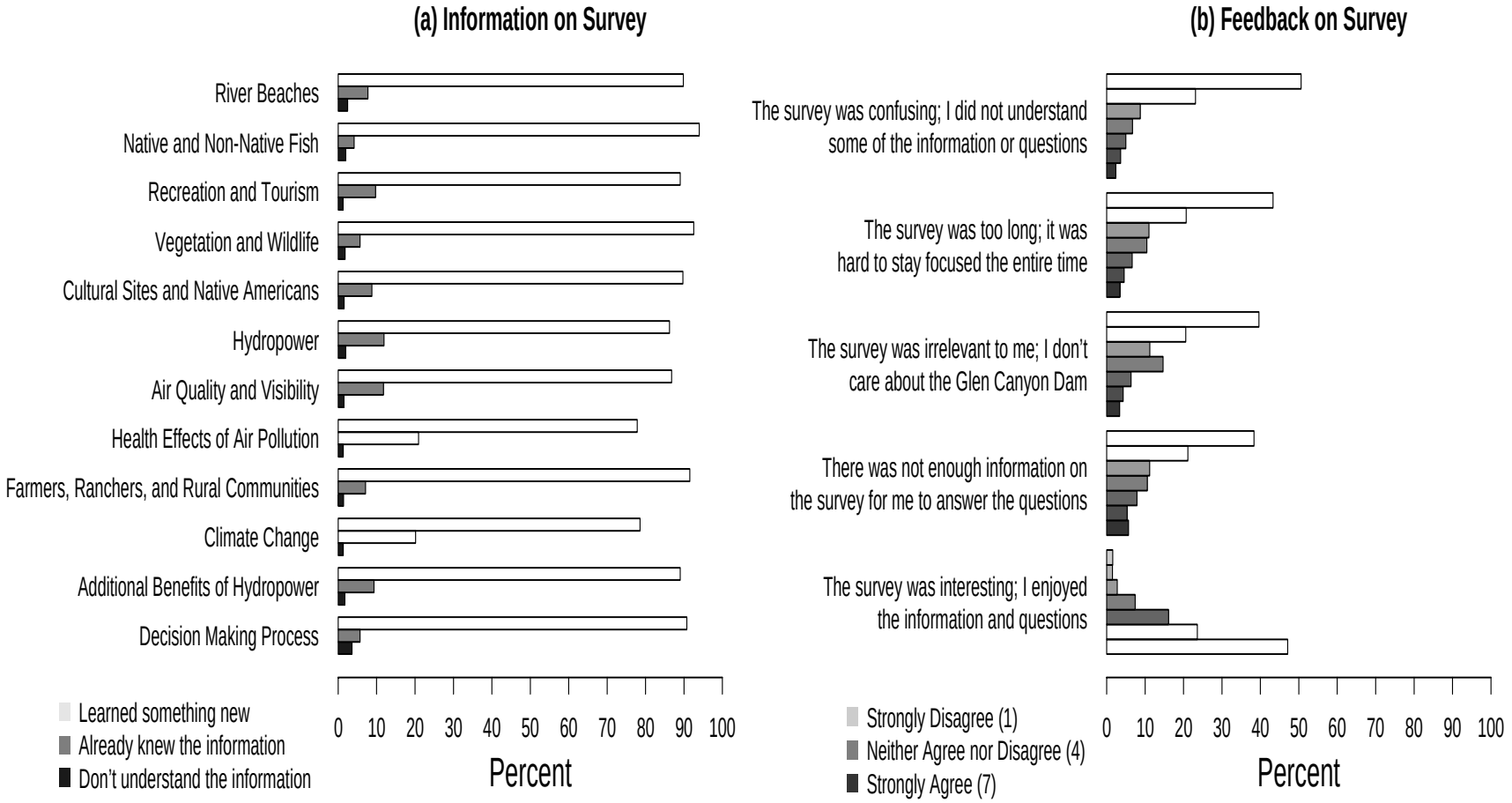
Dimensions of Value by Source of Identification and Characterization

Dimension of Value	Source(s) of Identification	Source(s) of Characterization
River Beaches	Lit review, public hearings, stakeholder interviews	DEIS
Native and Non-Native Fish	Lit review, public hearings, stakeholder interviews	DEIS
Vegetation and Wildlife	Lit review, public hearings, stakeholder interviews	DEIS
Recreation and Tourism	Lit review, public hearings, stakeholder interviews	DEIS
Cultural Sites and Native Americans	Lit review, public hearings, stakeholder interviews	DEIS
Hydropower	Lit review, public hearings, stakeholder interviews	DEIS
Air Quality and Visibility	Lit review, public hearings, stakeholder interviews	DEIS
Greenhouse gas emissions	Lit review, public hearings, stakeholder interviews	DEIS
Health Effects of Air Pollution	Lit review, stakeholder interviews	Lit review
Farmer/Rancher/Rural Communities	Lit review, public hearings, stakeholder interviews	Lit review
GCC Impacts of Hydropower	Lit review, stakeholder interviews	Lit review
Ancillary Hydropower Benefits	Lit review, public hearings	Lit review
Governance/Process	Public hearings, stakeholder interviews	Lit review

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



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

	Number of respondents	Percentage of sample
Vote to Change Operations	**175**	**17.4%**
Would pay >$0 payment amount	*54*	*5.2%*
Would not pay >$0 payment amount	*56*	*5.7%*
Not sure if would pay >$0 payment amount	*65*	*6.5%*
Vote to Continue Operations	**669**	**65.4%**
Would pay >$0 payment amount	*218*	*21.7%*
Would not pay >$0 payment amount	*217*	*20.4%*
Not sure if would pay >$0 payment amount	*234*	*23.4%*
Would Not Vote	**155**	**17.2%**

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)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Change				Continue			
	Payment Only	Payment Only (80%)	All Controls	All Controls (80%)	Payment Only	Payment Only (80%)	All Controls	All Controls (80%)
Median WTP	$9.32 (7.88)	$0.35 (1.04)	$10.14 (8.02)	$0.43 (1.23)	$89.13 (21.55)	$22.43 (9.57)	$87.40 (21.36)	$20.19 (8.20)

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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Supplemental Slides

Experimental Treatments

	Value Definition Survey [Track]							Value Elicitation Survey [Track]		
Resource	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**
River Beaches	X	X	X	X	X	X	X	X	X	X
Native and Non-Native Fish	X	X	X	X	X	X	X	X	X	X
Vegetation and Wildlife	X	X	X	X	X	X	X	X	X	X
Recreation and Tourism	X	X	X	X	X	X	X		X	X
Cultural Sites and Native Americans	X	X	X	X	X	X	X		X	X
Hydropower	X	X	X	X	X	X	X		X	X
Air Quality and Visibility	X	X	X	X	X	X	X		X	X
Health Effects of Air Pollution		X					X			X
Farmers, Ranchers, and Associated Rural Communities			X				X			X
Climate Change				X			X			X
Additional Benefits of Hydropower					X		X			X
Decision Making Process						X	X			X