Aquatic Resource Improvements and Benefit Transfer: What Can We Learn From Meta-Analysis?

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WTP for Aquatic Resource Improvements

- Researchers increasingly considering benefit transfer approaches that allow welfare measures to be adjusted for attributes of the policy context.
- Validity & reliability of such adjustments depend on systematic variation in underlying WTP
- Two meta-analyses conducted to identify systematic components of WTP for aquatic resource improvements.

Research Emphasis

- Comparison of results for distinct and independent meta-models.
- What does this tell us about underlying WTP?
- Implications for benefit transfer and applied welfare evaluation.
- Upshot—findings from meta-analysis promising with regard to systematic aspects of WTP, but also reveal challenges for benefit transfer.

Meta-Analysis

- "…the statistical analysis of a large collection of results for individual studies for the purposes of integrating the findings..." (Glass 1976)
- May provide a superior alternative to unadjusted WTP transfer, as it allows adjustment for systematic influences of policy context.
- Allows exploration of patterns in WTP across studies.
- But, little (and mixed) guidance in literature.

Study #1: Meta-Analysis of WTP for Water Quality in Aquatic Habitats

- Drawn from studies that estimate WTP for water quality changes noted to affect aquatic life.
- From 300+ surface water valuation studies addressing such resources, 33 found suitable.
- 78 observations drawn from these studies.
- Multiple observations/study due to variations in extent of amenity change, elicitation method, water body type, number of water bodies, recreational activities, and species affected.

Study #1: Meta-Data

- Criteria for Inclusion:
  - Estimate total (use and nonuse) WTP,
  - Water quality change affects aquatic life or habitat in water supporting recreational use,
  - Conducted in the U.S.,
  - Apply generally accepted methods
  - Provide sufficient information regarding study, economic, and resource attributes.
- Studies published between 1981-2001.
- All involve stated preference methods (including revealed/stated combinations).
- Majority derived from peer-reviewed literature.

Study #1: Econometric Model

- Dependent variable: natural log of household WTP for water quality improvements in aquatic habitat.
- Water quality change measured on RFF Ladder.
- 31 independent variables characterizing: 1] methodology, 2] populations, 3] geographic region/scale, 4] resource condition and change.
- Multilevel model, robust variance estimation, non-weighted, semi-log and trans-log functional forms.

Study #2: Meta-Analysis of Per-Fish WTP for Increases in Recreational Catch

- Data drawn from studies estimating marginal WTP that anglers place on catching an additional fish (or that allow such a value to be calculated).
- From 450+ studies addressing such resources, 48 found suitable.
- 391 observations drawn from these studies.
- Multiple WTP estimates from single studies available due to in-study variations in baseline catch rate, species, fishing location, fishing method, and methodology.

Study #2: Meta-Data

- Criteria for Inclusion:
  - Estimate marginal per-fish WTP or allow this value to be calculated,
  - Studies conducted in the U.S. or Canada,
  - Apply generally accepted methods
  - Provide sufficient information regarding study, economic, and resource attributes.
- Studies published between 1977-2001.
- Studies include stated preference, travel cost, RUM, and revealed/stated methods.
- Majority derived from peer-reviewed literature.

Study #2: Econometric Model

- Dependent variable: natural log of WTP per fish.
- 45 independent variables characterizing: 1] methodology, 2] anglers, 3] geographic region, 4] species attributes, 5] catch rates.
- Multilevel model, robust variance estimation, non-weighted, semi-log functional form.

Study #1: Model Results

- Likelihood ratio test: model variables are jointly significant at $p<0.0001$ ($\chi 2=101.8$, df 31).
- Of 31 independent variables, 26 are statistically significant; most significant at $p<0.01$.
- Random effects not statistically significant.
- Considerable systematic component of WTP variation.
- Signs of significant parameter estimates generally correspond with intuition.

Primary Findings

- Wide range of systematic effects influencing WTP. Strong statistical results. Most effects intuitive.
- WTP sensitive to:
  - Survey and elicitation methods,
  - Scope in various dimensions
    - Magnitude of water quality change
    - Baseline water quality
    - Number of water bodies affected

Primary Findings

- WTP also sensitive to:
  - Type of habitat
  - Type of population sampled
    - General Population vs. Nonuser
  - Other attributes of the resource and region.
    - WTP varies by geographical region

Example: Resource Attributes

Table A. Results for Selected Resource Condition and Change Variables

Variable	Parameter Estimate	Standard Error	t-statistic	Prob>|t|
wq_ladder	-0.3617	0.1795	-2.01	0.05
WQ_fish	0.2095	0.0809	2.59	0.01
WQ_shell	0.2610	0.0984	2.65	0.01
WQ_many	0.2400	0.0977	2.46	0.02
WQ_non	0.4808	0.1947	2.47	0.02
fishplus	0.7964	0.1719	4.63	0.00
baseline	-0.1240	0.0407	-3.04	0.00

Systematic Effects: Methodology

Table D. Results for Selected Methodology (Study) Attributes

Variable	Parameter Estimate	Standard Error	t-statistic	Prob>|t|
intercept	6.0043	0.6078	9.88	0.00
year_indx	-0.1058	0.0185	-5.72	0.00
discrete_ch	0.3713	0.3306	1.12	0.26
voluntary	-1.6422	0.2255	-7.28	0.00
interview	1.3030	0.1700	7.66	0.00
mail	0.5627	0.1753	3.21	0.00
lump_sum	0.6180	0.1710	3.61	0.00
nonparam	-0.4650	0.1756	-2.65	0.01
protest_bids	0.9390	0.1325	7.09	0.00
outlier_bids	-0.8814	0.1103	-7.99	0.00
median_WTP	0.2193	0.1625	1.35	0.19
hi_response	-0.8020	0.1190	-6.74	0.00

Study #2: Model Results

- Likelihood ratio test: model variables are jointly significant at $p<0.0001$ ($\chi 2=236.5$, df 45).
- Of 45 independent variables, 33 are statistically significant; most significant at $p<0.01$.
- Random effects significant at $p<0.10$.
- Considerable systematic component of WTP variation.
- Signs of significant parameter estimates generally correspond with intuition.

Primary Findings

- Wide range of systematic and statistically significant effects influencing WTP.
- WTP sensitive to:
  - Research methods
  - Species and region
  - Angler attributes
  - Baseline catch rates
- Findings match intuition.
  - Examples: Higher WTP for marginal fish associated with nonlocal anglers, lower baseline catch rates, well-known “trophy” and popular game fish, etc.

Systematic Effects: Resource Type

Table 7. Selected Results for Multilevel Model

Variable	Model One (Unrestricted) Parameter[a] (Std. Err.)	Variable	Model One (Unrestricted) Parameter[a] (Std. Err.)
nonlocal	3.5950*** (0.3596)	*pike_walleye*	1.2546*** (0.3209)
big_game_natl	1.2285** (0.5032)	*bass_fw*	1.7142*** (0.4805)
big_game_satl	2.1601*** (0.5926)	*trout_east*	0.7173* (0.3862)
big_game_pac	2.0546*** (0.4799)	*trout_GL*	1.7802*** (0.3524)
small_game_atl	1.0587 (0.7399)	*trout_west*	0.6358 (0.3918)
small_game_pac	1.4371*** (0.4330)	*trout_other*	-0.7200 (0.4633)
flatfish_atl	1.1088*** (0.3709)	*salmon_atlantic*	5.3450*** (0.4700)
flatfish_pac	1.6171*** (0.5258)	*salmon_GL*	2.2583*** (0.2957)
other_sw	0.4498 (0.4339)	*salmon_pacific*	2.3844*** (0.7000)
musky	3.5631*** (0.3281)	*steelhead_GL*	2.2701*** (0.5331)
steelhead_pac	2.4655*** (0.2526)		2.3529*** (0.2888)

Study #2: Sample Findings

Figure 1. Parameter Estimates: Trout and Salmon Species/Region Groups

The Devil is in the Details…

- Both meta-analyses suggest robust, systematic and intuitive patterns influencing WTP for aquatic resource improvements.
- Attributes of methodology are also significant.
- Functional form, use of weighted regression, etc. can influence WTP forecasts from meta-analysis—but little evidence of such problems here—*are such issues overstated in the literature*?
- Choices not well informed by theory or empirical fit; literature provides mixed or missing guidance.

Example #1: Functional Form and Methodology

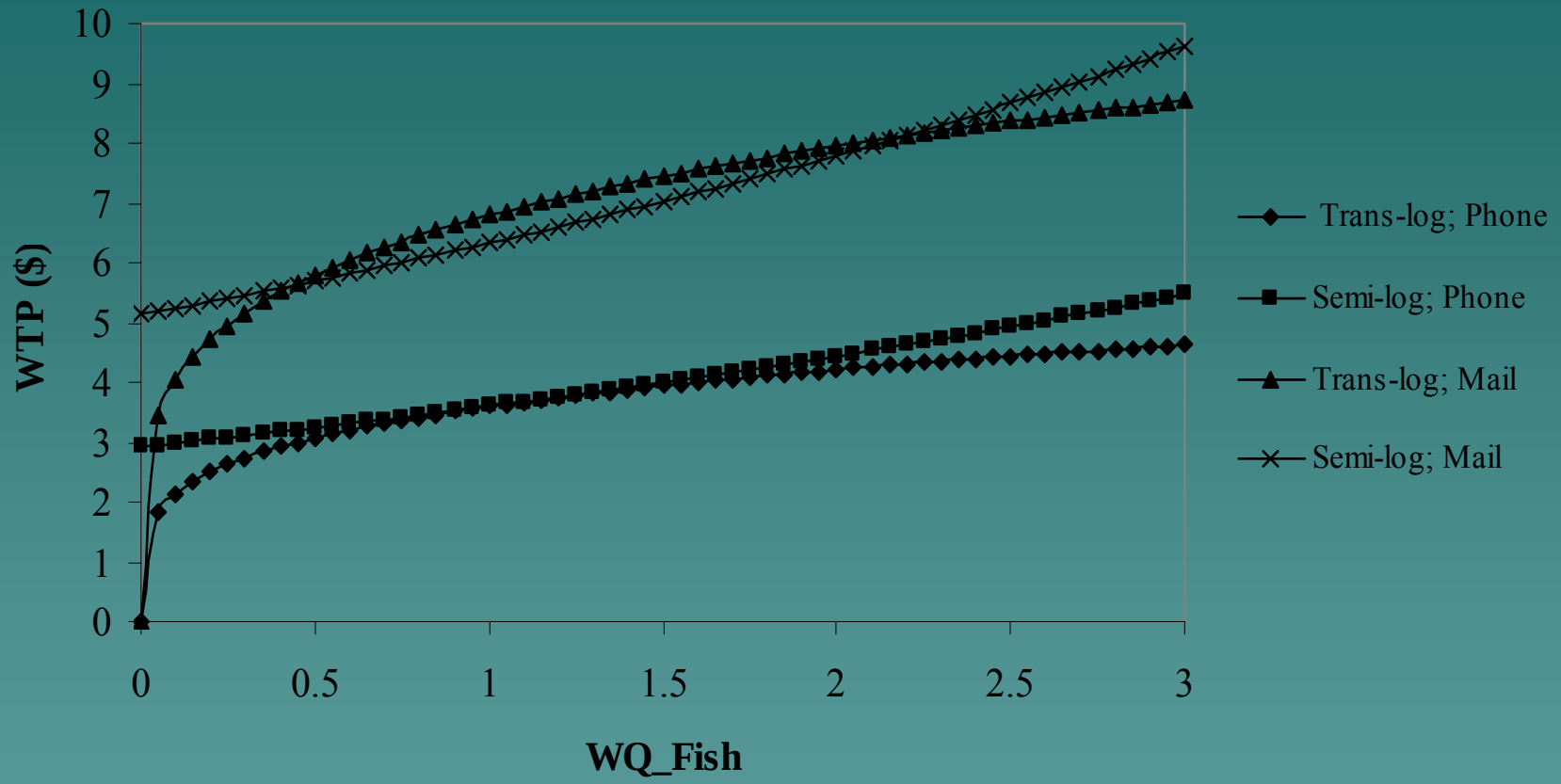

Figure 2. Estimated Nonuser Willingness to Pay for Improvements in Water Quality for Fish Habitat (*WQ_Fish*): Four Specifications

Example #2: Methodology and Per-Fish WTP

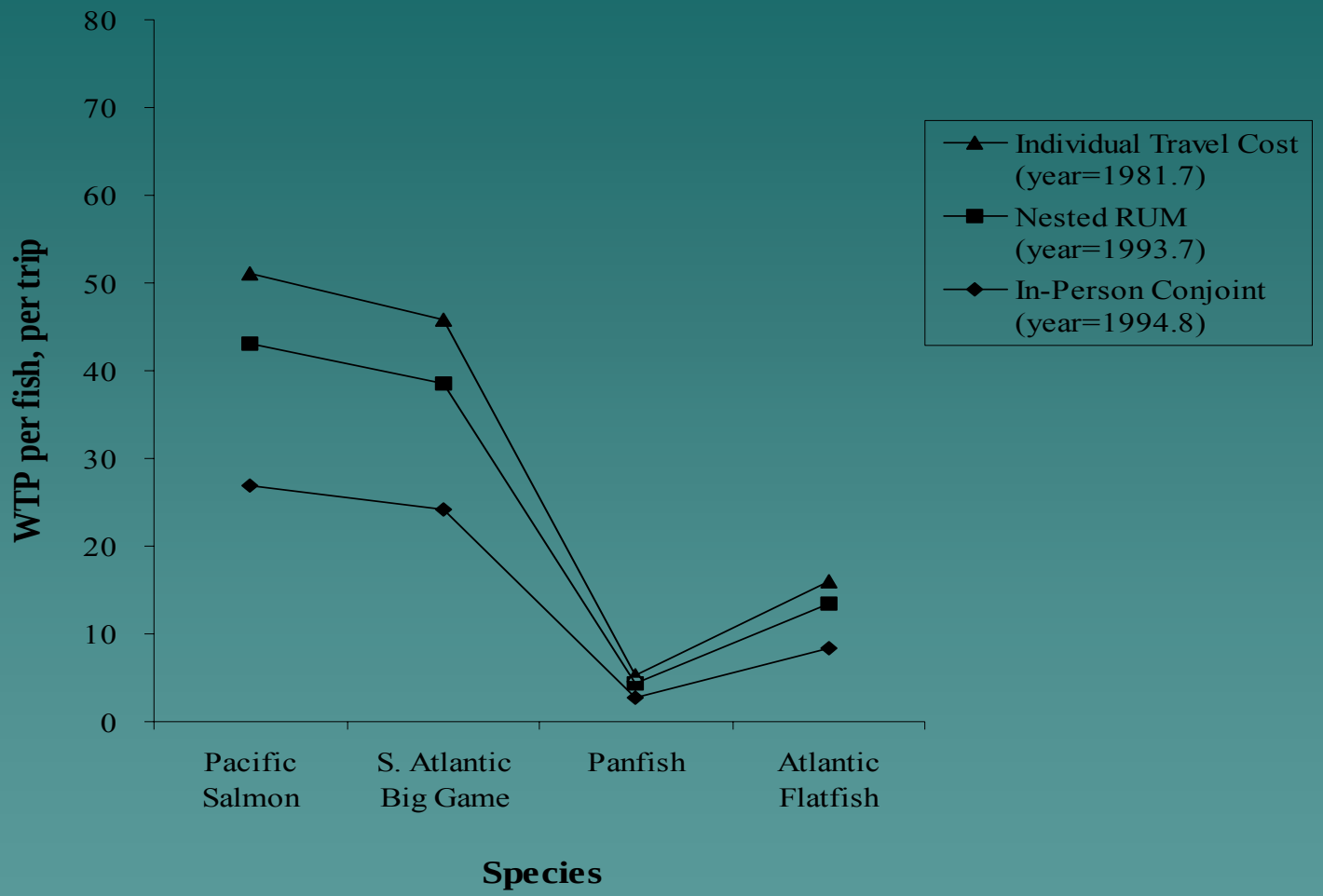

Figure 3. Per Fish WTP as a Function of Research Methodology: An Illustration Assuming Mean Year for Included Study Methodologies.

Example #3: Methodology and Per-Fish WTP

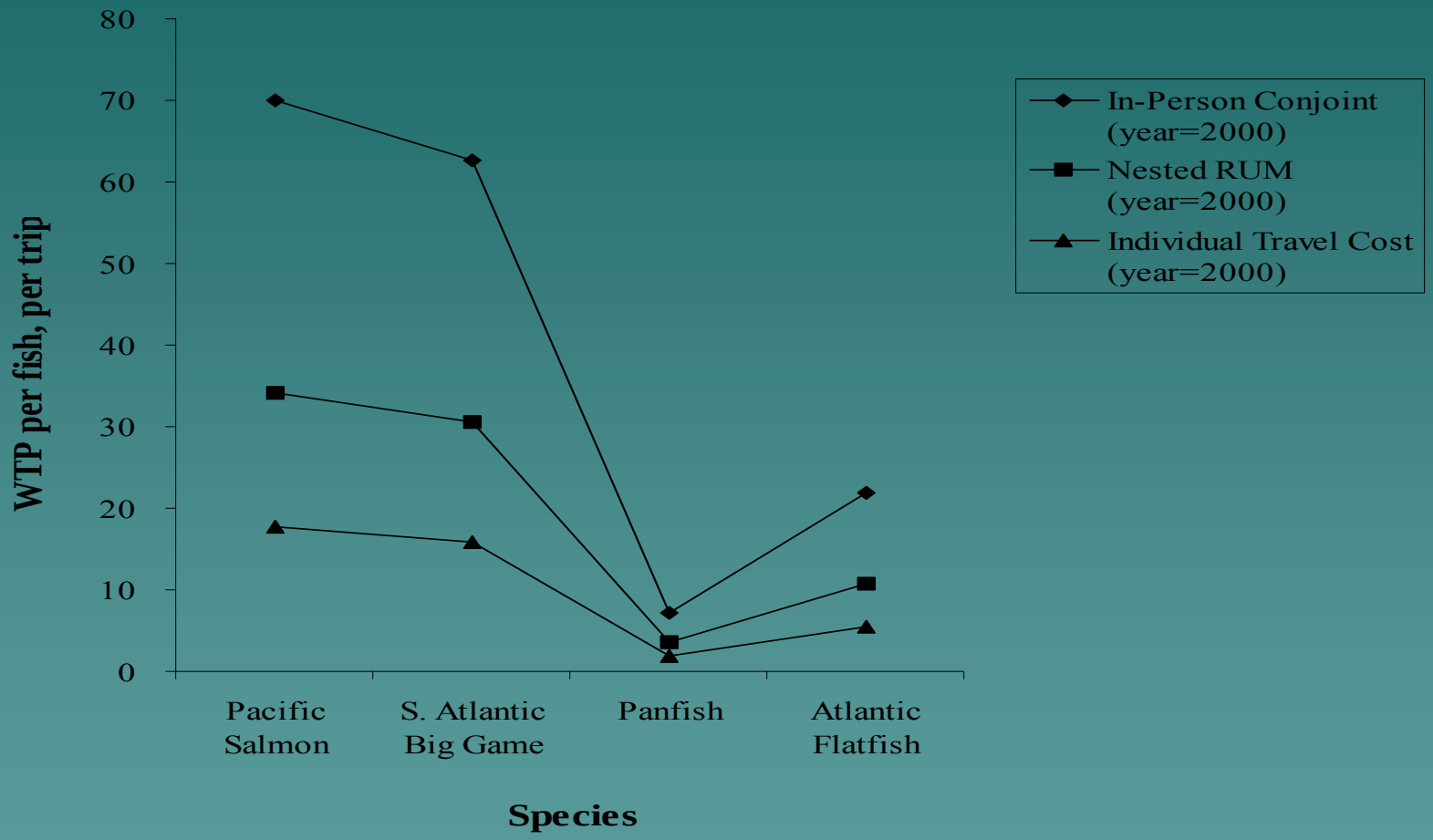

Figure 4. Per Fish WTP as a Function of Research Methodology: An Illustration Assuming Equivalent Study Years (2000).

Questions and Implications

- Results suggest systematic variation in values—WTP not entirely constructed, stochastic, or methodologically-determined.
- But, meta-analyses show that methodology influences WTP—how do we address this in a benefit transfer?
- Methodological effects robust within models, but not always consistent across different meta-models
  - Example: In-person CVM surveys associated with *increases* in WTP for water quality improvements, and *decreases* in WTP for increased recreational catch.

Conclusions

- Results promising with regard to the ability of meta-analysis to identify systematic components of WTP.
- Results also expose challenges in use of meta-models for benefit transfer.
- Availability of guidance for meta-analysis may have significant implications for its future role in applied welfare analysis.