Individualized Geocoding in Stated Preference Questionnaires: Implications for Survey Design and Welfare Estimation

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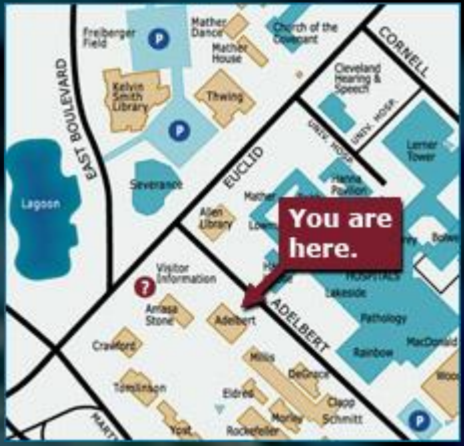


Australian Agricultural and Resource Economics Society 60th Annual Conference. Canberra, Australia, February 2-5, 2016.

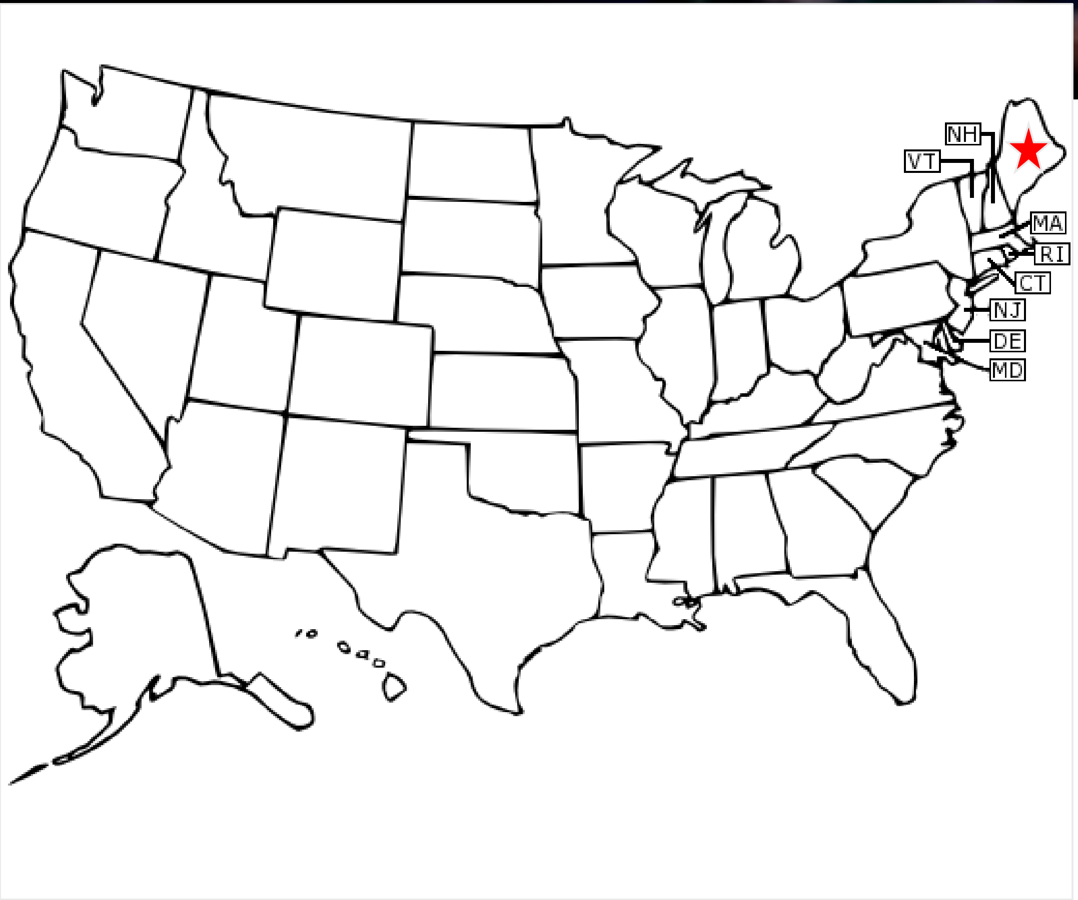
Spatial Information and Maps in Stated Preference Surveys

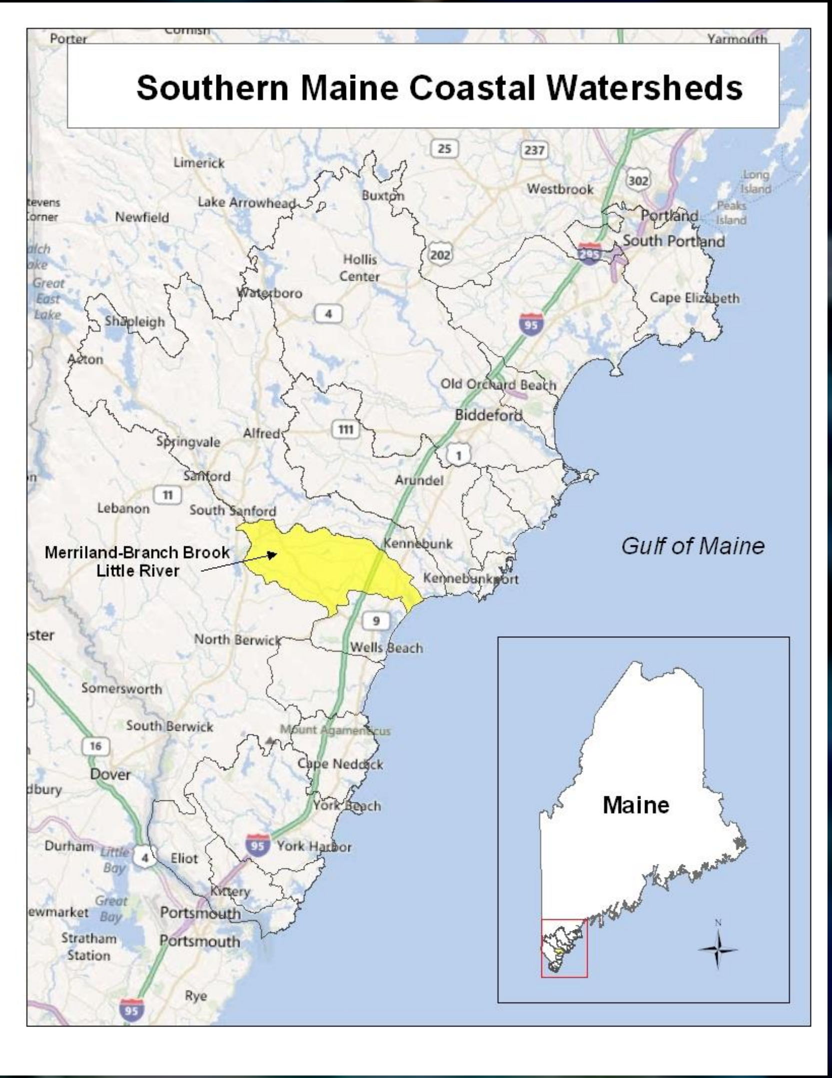
- If willingness to pay (WTP) is conditional on spatial aspects of policy scenarios, accurate welfare elicitation requires respondents to have correct understanding of these aspects.
- Stated preference surveys often include maps to convey potentially relevant spatial characteristics.
- For any given policy scenario, these maps are almost universally *generic*: they provide the same information to all respondents, with no individual detail.
- It is assumed that these maps provide sufficient information to support well-informed WTP elicitation.
- The geography literature implies that this may not be true.

Individualized Geocoding in Stated Preference Questionnaires

- This paper evaluates the standard practice of generic mapping in stated preference valuation, in which identical policy area maps are shown to all respondents.
- Compared to a more information-intensive alternative in which individually geocoded maps identify the location of each respondent's home relative to policy effects.
- The evaluation is grounded in a theoretical model clarifying the impact of individualized spatial information on preferences for non-market outcomes.
- Case study focused on ecosystem services from changes to riparian land in the Merriland, Branch Brook, and Little River (MBLR)Watershed in Maine, USA.

Study Location





Intuitive Summary of the Theoretical Model

- Individualized spatial information is not expected to influence preferences and WTP for all attributes.
- Utility theoretic model clarifies when individualized spatial information should be welfare-relevant.
- Two characteristics must hold:
  - Spatial conditions perceived by respondents without individualized spatial information <u>must diverge from actual conditions</u>.
  - Spatial conditions <u>must influence welfare</u>.
- Contrary examples: WTP for recreational fishing versus WTP for enhanced vegetation on riparian land.

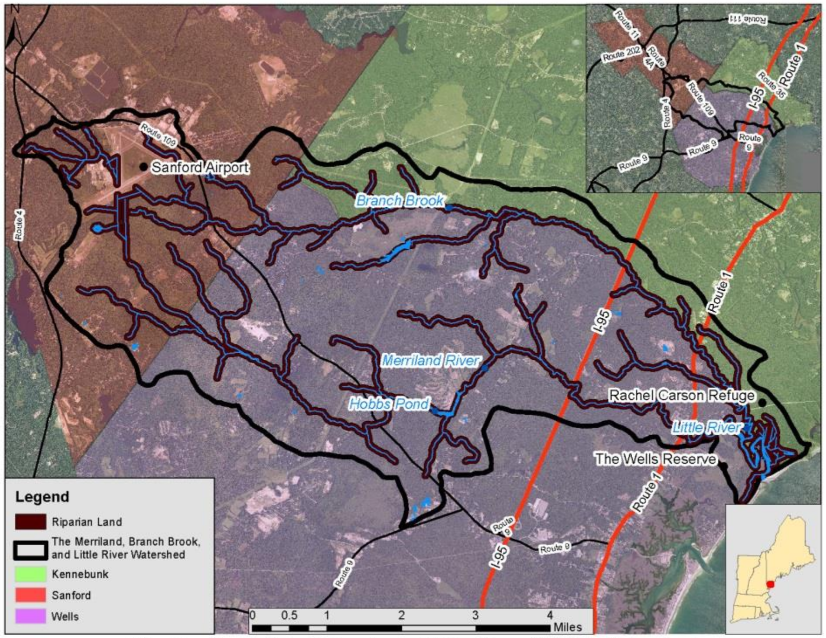
Choice Experiment Design and Testing

- Choice experiment developed over three years in an extensive process involving scientists, stakeholders, policymakers and the public.
- Testing and revision including 9 focus groups plus cognitive interviews.
- Experimental design minimized D-error for choice model covariance with main effects and two-way interactions.
- Split sample: Identical choice experiments with one group given a traditional generic survey map and another given the same map showing their household location.
- Automated ArcGIS python script used to generate individual maps from respondents' physical addresses, leading to a unique printed survey for each respondent.

Alternative Maps

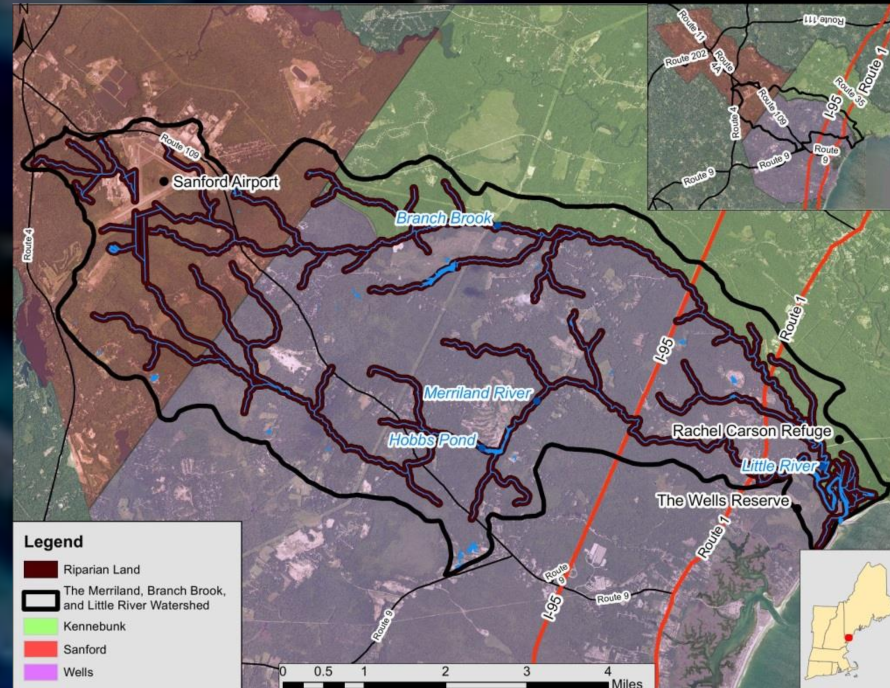
RIPARIAN LAND IN KENNEBUNK, SANFORD AND WELLS

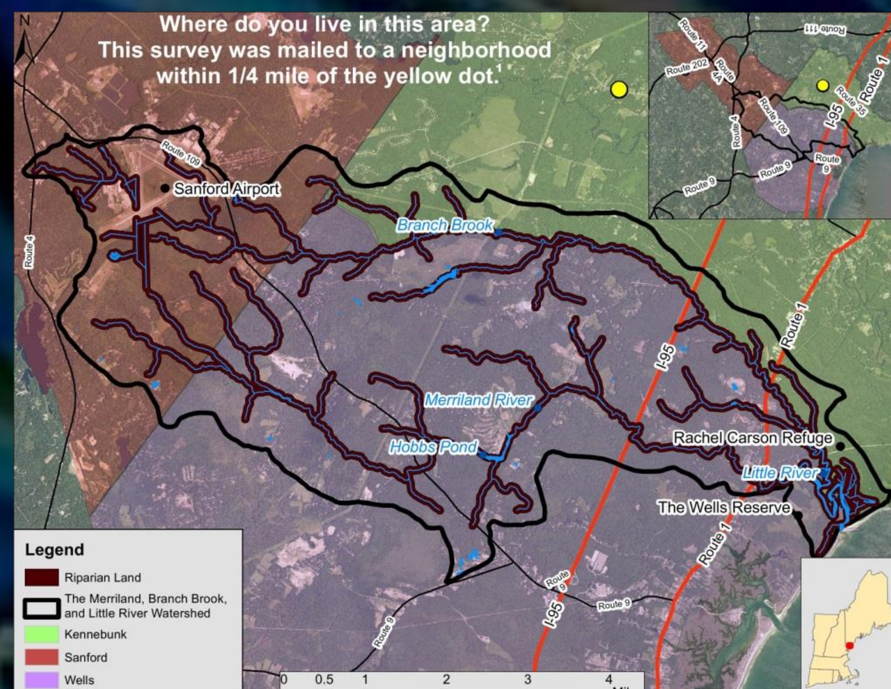
The map below shows the area addressed by this survey. This includes all land that drains into the **Merriland, Branch Brook**, and **Little Rivers** within Kennebunk, Sanford and Wells.



The Merriland, Branch Brook, and Little River (MBLR) Watershed

Across this area there are about **4,700 acres** of land within 300 feet of a river or stream. This area is shown as Riparian Land on the map. **4,300 acres** of this riparian land are covered by trees and natural vegetation. The remaining 400 acres have been developed or cleared.

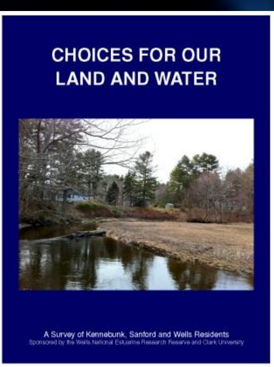


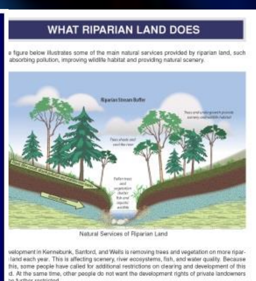


COMPARING PROTECTION OPTIONS

The upcoming questions will ask you to compare different ways of protecting riparian land in Kennebunk, Sanford and Wells, and vote for the ones you prefer. You may also vote to reject the proposed programs and retain the status quo. **Effects of each option will be described by the following effects, as estimated by scientists:**

Effect	What it Means
Natural Riparian Land	The amount of riparian land covered by natural vegetation. Currently about 91% of the land is in natural condition. With no action **85%** of riparian land in the area (4000 acres) will remain in natural condition in 5-10 years.
River Ecology	Average ecological condition of area rivers, measured by the diversity of small organisms (dragonflies, mayflies, etc.) that live there. A score of 100% is the best possible condition in the area. A score of 0% means nothing lives in the water. With no action, the ecological condition in area rivers will be **55%** in 5-10 years. The score today is about 60%.
Recreational Fish	The number of recreational fish in area rivers, measured by scientific sampling of brook trout. A score of 100% would mean that area rivers contain the maximum number of trout possible (30 trout per 1000 sq. feet). Today there are about 19 trout per 1000 sq. feet. With no action, scientists predict there will be an average of 17 trout per 1000 sq. feet (**55%** of the most possible) in 5-10 years.
Safe Swimming	The percentage of days in which government tests show that area beaches (Laudholm, Drakes Island, Crescent Surf, and Parson) are safe for swimming. 100% means that all tests show water safe for swimming. With no action, scientists predict **85%** of tests will show water safe for swimming in 5-10 years.
Development Setback	The minimum width of the riparian area where development is restricted. Currently development and clearing is restricted within a minimum distance of **100 feet from rivers** and **25 feet from streams**. This distance is larger in some areas and for some types of development. Existing (legal) development would be grandfathered if setbacks change.
Enforcement	Whether enforcement is increased to prevent illegal development or clearing on riparian land. This could include inspections on private land if violations are suspected. Currently, inspections can only occur when a violation has been reported or as part of permitting.
$ Cost to your Household per Year	How much the policy will cost your household in unavoidable annual taxes and fees. These are guaranteed to only be spent on the protection option that is indicated.





YOU WILL BE ASKED TO VOTE

After considering the current situation and possible protection effects and methods, which do you prefer? You will be given choices and asked to vote for the option you prefer by checking the appropriate box. **Questions will look similar to the sample below.**

SAMPLE QUESTION:

Method or Effect of Protection	In 5-10 years under the Current Situation	In 5-10 years under Option A	In 5-10 years under Option B
Riparian Land Condition	**85%** 4000 out of 4700 riparian acres covered by natural vegetation	**87%** 4100 out of 4700 riparian acres covered by natural vegetation	**95%** 4500 out of 4700 riparian acres covered by natural vegetation
River Ecology	**55%** of best possible (100%) ecological condition	**85%** of best possible (100%) ecological condition	**85%** of best possible (100%) ecological condition
Recreational Fish	**55%** 17 out of 30 possible fish per 1000 sq. feet	**75%** 23 out of 30 possible fish per 1000 sq. feet	**55%** 17 out of 30 possible fish per 1000 sq. feet
Safe Swimming	**85%** of beach tests meet safe swimming guidelines	**95%** of beach tests meet safe swimming guidelines	**85%** of beach tests meet safe swimming guidelines
Development Setback	**100 feet** required between development and rivers; 25 feet for streams	**150 feet** required between development and rivers; 75 feet for streams	**100 feet** required between development and rivers; 25 feet for streams
Enforcement	**No Change** in enforcement and inspections	**No Change** in enforcement and inspections	**Increased** enforcement and inspections
$ Cost to your Household per Year	**$0** Increase in Annual Taxes or Fees	**$45** Increase in Annual Taxes or Fees	**$5** Increase in Annual Taxes or Fees
HOW WOULD YOU VOTE? (CHOOSE ONLY ONE) I vote for	X NO NEW PROTECTION	X I vote for OPTION A	X I vote for OPTION B
	If you prefer **No New Action** Check Here	If you prefer **Option A** Check Here	If you prefer **Option B** Check Here

Implementation and Modeling

- Surveys implemented December 2013 – January 2014, with multiple wave mailings to maximize response.
- Surveys mailed to 2,544 random households in the three towns (1,272 per version; physical addresses only).
- Of deliverable surveys, 366 and 368 surveys were returned for the generic and individually geocoded versions. Response rate of 34.5%.
- Mixed logit model estimated in WTP-space (Scarpa et al. 2008; Train and Weeks 2005) to ameliorate challenges for WTP estimation using preference-space models.
- All ecological attributes included in percentage form, relative to the ecological reference condition (best possible) for the watershed (100%).

WTP-Space Mixed Logit Model

- Pooled model allows systematically varying implicit prices (WTP) and scale across the two split-samples.
- $U_{ph}(\cdot) = \tilde{\lambda}_h(-C_{ph} + \boldsymbol{\omega}'_{\boldsymbol{h}} \boldsymbol{X}_{\boldsymbol{ph}} + (I_h \boldsymbol{\rho}_{\boldsymbol{h}})' \boldsymbol{X}_{\boldsymbol{ph}}) + \varepsilon_{ph}$
- $I_h = 1$ if household h is provided with an individually geocoded survey map, and $I_h = 0$ otherwise.
- $\boldsymbol{X}_{\boldsymbol{ph}}$ = policy outcomes from policy *p*.
- C_{ph} = cost of policy *p*.
- $\tilde{\lambda}_h = -e^{(v_h + I_h \tau_h)}$ = lognormal cost coefficient.
- WTP coefficients assumed normally distributed.
- Estimation using BIOGEME (Bierlaire, 2003) with CFSQP optimization (Lawrence et al., 1997) and Modified Latin Hypercube Sampling (Hess et al., 2006)

WTP Space Results

Attribute	Generic Map $[\hat{\omega}_h]$ (Std. Error)	Std. Dev. $\hat{\omega}_h$ (Std. Error)	Difference between Generic and Geocoded $[\hat{\rho}_h]$ (Std. Error)	Std. Dev. $\hat{\rho}_h$ (Std. Error)
WTP Coefficients				
ASC	-71.8672*** (14.9012)	123.1220*** (16.5306)	**11.6407 (15.1087)**	14.4597 (12.8406)
Riparian Land Condition	1.0889*** (0.4189)	1.7879*** (0.6432)	**-1.7688** (0.7264)**	4.4366*** (0.9998)
River Condition	0.9141*** (0.1732)	1.3169*** (0.4221)	**-0.1253 (0.2788)**	1.0040* (0.5781)
Recreational Fishing	0.6825*** (0.1556)	1.0951*** (0.3186)	**0.0726 (0.2938)**	1.7801*** (0.6465)
Safe Swimming	1.9008*** (0.5084)	0.2327 (0.5835)	**-0.1508 (0.8256)**	1.3899* (0.8386)
Development Setbacks	0.1020* (0.0521)	0.4942*** (0.0772)	**0.0830 (0.0875)**	0.4238*** (0.1217)
Enforcement	14.6832*** (3.0515)	9.6454 (9.6484)	**9.3817* (5.1206)**	8.2733 (14.8040)
Implied Cost Coefficient				
ln(λ_h)	-2.7411*** (0.2247)	-0.6436** (0.2628)	-0.3284* (0.1976)	0.1374*** (0.0365)
Observations (N)	2136			
Pseudo R^2	0.22			
Log-Likelihood	-1800.60	**Prob. > χ^2**	0.0001	

Effects of Individual Geocoding

- Results are consistent with theory and expectations.
- Imply that respondents receiving generic map speculate closer proximity to riparian land than is actually the case (people *think* they live near affected rivers but do not).
- Correcting this misperception reduces WTP for *Riparian Land Condition* and increases WTP for *Enforcement*.
- We do not expect WTP for other attributes to be affected.
  - Respondents already know where they swim and fish, and whether their property is subject to development setbacks. Relevant spatial information already known.
  - WTP for *River Condition* motivated primarily by nonuse value. Micro-level proximity not relevant.

Summary

- The traditional assumption in stated preference survey design is that generic maps provide sufficient information to support well-informed, unbiased preference elicitation.
- Paper compares stated preference results informed by individual cartographic information to results from otherwise identical surveys using generic maps.
- Results conform to theoretical expectations and provide evidence that generic maps may provide insufficient information to support well-informed welfare elicitation.
- Effects vary across different types of policy outcomes.
- Researchers must balance the difficulty of developing individually geocoded surveys against the risk of misinformed welfare estimates from generic maps.

Questions?

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