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Improving confidence by embracing uncertainty: A meta-analysis of U.S. hunting values for benefit transfer☆

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ABSTRACT

Recreational hunting in the United States has traditional and cultural importance, and generates substantial economic benefits to individual hunters themselves. This paper conducts a meta-analysis of existing nonmarket valuation estimates for hunting in the United States to explore sources and implications of variation and uncertainty in these estimates. A multi-level meta-regression model is estimated to forecast point estimates for different hunting contexts, as well as to construct bounds of uncertainty around these estimates. The results and discussion provide insight to practitioners who need to conduct or understand benefit transfer, as well as those particularly interested in the value of hunting in the U.S.

1. Introduction

Recreational hunting in the United States (U.S.) has a long and rich tradition, maintaining cultural importance for many Americans, and serves as an economic driver for some local and state economies. In 2016 alone, 11.5 million people in the U.S. aged 16 and older participated in hunting, spending a total of $26.2 billion (DOI-DOC, 2017). However, comparing these numbers to the same analysis from 2011 shows that both participation and expenditures declined during this five-year period (DOI-DOC, 2017). In September 2017, the Secretary of the Interior signed Secretarial Order 3356 directing bureaus who manage Interior's lands and waters to: 1) expand hunting opportunities and access on public and private lands; 2) evaluate barriers to currently inaccessible managed lands; 3) engage underserved populations that traditionally have low participation in outdoor recreation; and 4) incorporate analysis of the impacts of management actions on hunting in planning and decision-making. One argument for expanding the base of hunters in the U.S. is the need to maintain excise taxes for conservation programs from the sale of licenses and sporting equipment. In addition to generating revenues for conservation programs, this Order is also designed to help support local economies through additional spending generated by hunters, and is presented as one component to an overall strategy of maintaining healthy wildlife and migratory bird populations. While true that hunting supports jobs and incomes from spending within local economies (DOI-DOC, 2017), another economic measure, and the focus of this article, is the consumer surplus that captures the economic value of the hunting experience to the individual hunter. This is measured by the amount of money an individual is willing to pay for a hunting experience above and beyond any costs paid (Loomis and Walsh, 1997).

Although there are various criteria for decisions regarding improved hunting access and wildlife populations, one may be based on economic efficiency and would include consumer surplus as the appropriate measure of benefits from changes to hunting access (OMB, 1992). There is growing demand for ecosystem service valuation research (Richardson et al., 2015), and U.S. federal agencies are increasingly being directed to incorporate such values into planning and decision-making (Executive Memorandum M-16-01, 2015; PCAST, 2011). By using sound scientific evidence and stakeholder input, consideration of consumer surplus values can improve agencies' ability to accurately account for the benefits of hunting to the public, aid in planning and decision-making involving resource tradeoffs, and provide critical inputs to damage assessments and regulatory analyses. Although the use of original data is generally the best approach for estimating nonmarket values (Johnston et al., 2015), public land management agencies may face time and funding constraints that make primary research infeasible (Rolfe et al., 2015). Thus, they frequently rely on existing data and the benefit transfer method (Bateman et al., 2011; Wainger and Mazzotta, 2011).

With this approach, a value or function estimated for an existing

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study site where a stated or revealed preference study has been conducted is transferred to a policy site of interest (see Rosenberger and Loomis (2017) for the historical context of the benefit transfer method). For example, the National Park Service used existing consumer surplus estimates to determine the economic value of hunting at Cape Cod National Seashore. In the final Environmental Impact Statement for the Seashore's hunting program, per-day consumer surplus values were multiplied by the estimated number of hunting days to determine the annual economic value of hunting in the baseline scenario and across the management alternatives considered. It is noted that "[t]hese economic losses must then be weighed against qualitative benefits related to the curtailment of hunting (e.g., improved recreation for non-hunters)" (NPS, 2007). The U.S. Fish and Wildlife Service also frequently includes existing estimates of the nonmarket value of hunting in their planning efforts for national wildlife refuges (FWS, 1999; 2000; 2005).

Considerable guidance has been issued on how to apply the benefit transfer method while adhering to economic theory (Boyle and Bergstrom, 1992). One benefit transfer approach a practitioner could rely on is to use a single consumer surplus estimate from an existing study, or simply estimate an average value or range based on several studies. However, this approach may raise some questions: not all studies are the same, so are observed differences in results simply an artifact of different empirical methods used in the original study? What if studies from similar, yet slightly different contexts are available; how can those be incorporated into the understanding of the unstudied policy site? Meta-regression analyses help address these challenges, and can be useful if there are no individual studies that provide a close enough match to the new policy site. Previous research has found that a unit value transfer may be more appropriate for transfer between relatively similar sites, whereas function transfers generally yield lower errors for transfer between less similar sites (Bateman et al., 2011). In a review of studies that included reliability testing, Rosenberger (2015) finds evidence that function transfers generally outperform unit value transfers in minimizing transfer errors. By statistically controlling for methodological and resource attributes, a meta-regression model can be constructed to aid in predicting consumer surplus estimates needed in an unstudied policy-relevant site (Nelson, 2015). As such, meta-regression models can reduce the level of uncertainty when conducting a benefit transfer since they leverage information from the full body of literature and control for study level differences (Loomis and Rosenberger, 2006). There are many examples of meta-regression analyses focused on the nonmarket value of ecosystem services, including the preservation of threatened, endangered, and rare species (Richardson and Loomis, 2009), water quality (Johnston et al., 2016; Johnston and Thomassin, 2010), salmon preservation (Weber, 2015), river restoration improvements (Bergstrom and Loomis, 2017), and outdoor recreation (Rosenberger et al., 2017). However, to our knowledge, none have focused specifically on recreational hunting.

There are errors and uncertainties in all models. In the context of using benefit transfer for ecosystem service valuation, it is important to include confidence intervals for both ecological and economic models given the complexity of these respective systems (Ferrini, Schaafsma, and Bateman, 2015). Estimating confidence intervals from meta-regression model output is not a groundbreaking exercise. Examples include Brander et al. (2015), who estimate confidence intervals for losses in economic benefits due to coral reef degradation in Southeast Asia, and León and Araña (2015), who predict benefit estimates with confidence intervals for air quality improvements in European countries. However, there are cases where forecasted confidence intervals have not been used; for example, Sen et al. (2014) estimated a meta-analysis of recreation use values for Great Britain to assess the outcome of several policy implementations, but did not include uncertainty into the transfer of benefit estimates in their analysis. There are no hard rules to know when a transferred estimate is sufficiently valid (Boyle and Parmeter, 2017), but there has been a great amount of effort dedicated to understanding benefit transfer validity and to mitigating transfer errors through best-practice guidance (Rosenberger, 2015). In real-world applications, it is important to demonstrate this uncertainty using a range of estimates with upper and lower bounds so as to not give policy-makers a false sense of precision with transferred values (Boyle and Parmeter, 2017; Rosenberger and Loomis, 2017). Building routine uncertainty measures into prediction tools, like the meta-analysis presented here, can help speak to that issue. In this analysis, uncertainty bounds are estimated around forecasted consumer surplus measures for hunting, which represents an improvement in the ability to conduct benefit transfers in practice. To demonstrate, this article presents the results of multiple approaches to benefit transfer for estimating the benefits of hunting. We show how meta-regression models can be advantageous in filling in some of the deficiencies of benefit transfers that rely on single point estimates, average values, or a range of values from one or more studies. We also demonstrate the advantage of meta-regression models in controlling for study-level differences, thus reducing the overall uncertainty of transferred value estimates in many contexts.

The purpose of this paper is to demonstrate how meta-regression models can incorporate uncertainty with modeled output. We begin by discussing the existing literature on consumer surplus values per day of hunting in the U.S. Next, using this existing data we estimate a meta-regression model to test for methodological and other factors that systematically influence existing consumer surplus estimates per day of hunting. We then calculate model forecast estimates and uncertainty bounds from our preferred meta-regression model. The paper concludes with a discussion of how the use of meta-regression models – and the practice of considering uncertainty through confidence intervals – is often an improvement over more simplistic benefit transfer methods, such as relying on average values and simple ranges of estimates.

2. Materials and methods

2.1. Hunting valuation data

Data for the meta-regression model are drawn from Oregon State University's *Recreation Use Values Database* (RUVD) (Rosenberger, 2016). This database builds upon prior reviews of the economics literature on recreation use values, including Sorg and Loomis (1984), Walsh et al. (1988), MacNair (1993), Boyle et al. (1998), Loomis et al. (1999), Kaval and Loomis (2003), and Loomis (2005). The current RUVD is the result of an extensive literature review of studies that have estimated use values for a wide range of recreation activities in the U.S. and Canada from 1958 to 2015 (Rosenberger, 2016). The RUVD is restricted to studies that report a recreation value in per person per activity day units or a value that could be converted to these units using information provided in the study. Detailed information about each study is coded into a Microsoft Excel[1] spreadsheet, and includes the study reference, study location, details about the recreation activity, site characteristics, methodology, and the economic benefit estimate. For studies where hunting was the primary recreation activity being valued, the RUVD includes 73 original studies comprising 721 value estimates for big game hunting, small game hunting, and waterfowl hunting. Multiple studies provide value estimates for more than one type of hunting; for instance, Martin et al. (1974) report twelve values for big game hunting, thirteen for small game hunting, and four for waterfowl hunting. Data drawn from the RUVD are restricted to studies conducted in the U.S., resulting in a dataset of 66 studies and 626 estimates of consumer surplus inflated to 2016 dollars using the Consumer Price Index. It should be noted that additional hunting valuation studies exist that are not included in this present analysis due to their inability of being converted to the necessary per person per day value

[1] Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.