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Scale heterogeneity in recreationists' decision making: Evidence from a site choice model of sport fishing

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ABSTRACT

Recreation managers and planners recognize the importance of individual preferences and analysts have responded by incorporating individual and group-level heterogeneity in models of recreation behavior. We present a site choice model of recreational fishing that incorporates unobserved heterogeneity through a scale effect. By testing for scale heterogeneity, the model more accurately measures variation in site preferences compared with a conditional logit model, and demonstrates that site quality can affect fishing behavior unevenly across individuals. This result has important implications when using the model to predict fishing behavior and to value site quality and site access. We used the results to simulate the welfare impacts of several hypothetical improvements in fish abundance and find that ignoring scale heterogeneity can lead to inflated economic benefit estimates.

Management implications: The information in this study can be used by fisheries managers to economically substantiate and motivate actions to enhance the benefits of recreational fishing. The analysis demonstrates that diversity of preferences means some anglers choose fishing sites based on information about catch and accessibility, while others care less about these characteristics. Nevertheless, in general, we find that anglers in the U.S. southwest value increases in bass and walleye abundance as well as state programs to improve public fishing access.

1. Introduction

Site choice models of recreational fishing provide lake, reservoir and fisheries managers useful insights into the demand for fishing. These models are widely used in recreation research because they can measure the influence of fishing quality and other site characteristics on the behavior of anglers (Hunt, 2005). In doing so, site choice models can predict changes in fishing pressure across a landscape due to changes in the quality or accessibility of one or more sites. Site choice models are also the preferred methodology to value recreational fisheries; by quantifying the tradeoff between site quality, accessibility and travel costs, researchers and managers can use these models to estimate the economic value of fishing sites and changes in fishing quality.

This paper presents the results of a site choice model of recreational fishing developed from a fall 2014 survey of license-holders in the U.S. state of Oklahoma. Recreational fishing is one of the most popular outdoor activities in Oklahoma, totaling 730 thousand anglers out of a population of about 3.8 million, according to the National Survey of Fishing, Hunting and Wildlife-Associated Recreation (2011). Our work adds to existing research on recreation demand in two ways. First, the model characterizes the locational preferences of anglers in a part of the U.S. Southwest. The insights are therefore likely to be more generalizable to the region than those from more dated studies in other regions. Second, we use the model to examine whether observed site characteristics affect choice behavior in the same way across anglers. This is done by estimating the model as a scale heterogeneity logit, which allows the model to recognize that the site choices of some anglers are attributable to observable site characteristics but that the choices of others may be influenced relatively more by latent characteristics (Breffle & Morey, 2000; Fiebig, Keane, Louviere, & Wasi, 2010).

Site choice models are widely used, but the geographical focus of existing applications to anglers is concentrated on fisheries in the northeast United States, the North American Great Lakes, and coastal regions (see the literature reviews in Hunt (2005), Johnston, Ranson, Besedin, and Helm (2006) and Melstrom, Lupi, Esselman, and Stevenson (2015)). There is a relative paucity of research examining

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the site choices of anglers living in the North American interior, despite a long history of fisheries management there (Nielsen, 1999). Published site choice models of fisheries in this region include Jakus, Downing, Bevelhimer, and Fly (1997), Jakus, Dowell, and Murray (2000) and Parsons, Jakus, and Tomasi (1999), who studied reservoir anglers in Tennessee; Adamowicz, Louviere and Williams (1994) and Peters, Adamowicz, and Boxall (1995), who studied stream and lake anglers in Alberta; and Train (1998) and Morey, Breffle, Rowe, and Waldman (2002), who studied stream anglers in Montana. Existing models could be used to describe behavior and to value fisheries in regions that currently lack studies, but this is undesirable if the preferences of anglers differ between regions (Johnston et al. (2006) reports several differences). Thus, there is a critical need to learn about the site preferences of anglers in understudied regions like the southwest United States.

Fisheries managers need information about angler heterogeneity, which recreation researchers have tackled by developing models that account for observable and unobservable heterogeneity in fishing preferences. The simplest site choice model is estimated as a conditional logit, which assumes an attribute observed by all decision makers has a homogenous effect on choice. Individual-level heterogeneity can be incorporated into these models by interacting site quality with demographic variables (Breffle & Morey, 2000; Hunt, 2008). Mixed logit models generalize the conditional logit to allow for unobserved heterogeneity in the effects of observed attributes. Conditional and mixed logits are widely used in recreation demand modeling (Train, 1998, Alvarez, Larkin, Whitehead & Haab, 2014). We build on existing work by estimating the site choice model as a scale heterogeneity logit, which generalizes a conditional logit to measure heterogeneity in the stochastic component. By including a scale effect, the model can measure whether observed site quality affects behavior consistently across anglers or, put differently, if site choice is driven more by unobserved attributes (from the analyst's perspective) for some anglers than for others. In comparing the estimates from conditional and scale heterogeneity logits, we find restricting the scale factor to be equivalent across individuals in the conditional logit can lead to significant differences in the predicted value of site quality changes, which can have important implications for managing recreational fishing sites.

2. Scale and taste heterogeneity in choice models

Fishing site choice models are a way of explaining the variety of behaviors observed in a population of anglers. To the analyst, variation in choice can be described by forms of heterogeneity in terms of differing site attributes and angler characteristics. Analysts also regularly distinguish between observable and unobservable heterogeneity, which refer to the influences of observed and unobserved variables, respectively.

Scale heterogeneity is different from taste heterogeneity in choice analysis. With taste heterogeneity, the attributes that describe a choice alternative may be influential to some decision makers but not others. For example, if bass anglers but not trout anglers care about bass catch rates, then there is taste heterogeneity in catch rates. In site choice modeling, taste heterogeneity allows for sources of variation in the effects of observable site attributes, which in turn may be due to observable or latent characteristics of the decision makers. Continuing with the catch rate example, if the analyst can distinguish between bass and trout anglers in the data, then observed taste heterogeneity in catch rates can be incorporated into the model by fixing the effect of bass catch rates to zero for anglers who do not fish for bass. In contrast, scale heterogeneity refers to variation in the idiosyncratic error of the choice model. The choices of some decision makers may be well explained by the attributes of the alternatives, in which case the model error for them is small, but for others choice may be poorly explained by the observed attributes and for them the error is large. Therefore, scale heterogeneity accounts for the relative influence of the unobservable characteristics as a whole. If there were no scale or taste heterogeneity, then decision makers would be affected identically by all the characteristics that describe a choice alternative. When this is not true, accounting for scale heterogeneity, taste heterogeneity, or both will improve the predictive power of the choice model. Furthermore, measuring scale and taste heterogeneity provides managers information about preference diversity across anglers.

3. Methods

3.1. Site choice model

Based on random utility maximization (RUM) theory, the demand for recreational fishing sites can be characterized by relative differences in site attributes. RUM-based site choice models assume individuals pick the site with the highest utility. For an individual angler i, let A denote the number of sites in the model and U_{ij} denote the utility level associated with site j=1,…,A. The indirect utility from choosing site j can be written as:

$$U_{ij} = x_j\beta + x_j z_i \gamma + p_{ij}\rho + \varepsilon_{ij}/\sigma_i \quad (1)$$

where x_j includes the site attributes that vary across sites and relevant for all anglers, the term $x_j z_i$ interacts site attributes with angler characteristics to measure observable taste heterogeneity, p_{ij} is the travel cost to angler i of fishing at site j, σ_i measure the scale effect specific to angler i and ε_{ij} is idiosyncratic error. The model allows anglers to be different in the importance they place on known site attributes relative to unknown (from the analyst's perspective) attributes. An angler whose choice is more influenced by unobserved site quality will have a smaller σ than an angler whose choice is more affected by observed site quality (Breffle & Morey, 2000).

Trips are taken to site j where $U_{ij} > U_{ik}$, although the researcher only observes the portion $V_{ij} = x_j\beta + x_j z_i\gamma + p_{ij}\rho$ and out of sample cannot predict with certainty the preferred fishing site for a given trip. Assuming ε_{ij} has mean zero and is distributed extreme value yields the conditional logit model, with the probability of visiting site j

$$prob_i(\text{choose}j) = e^{\sigma_i V_{ij}} / \sum_{k=1}^{A} e^{\sigma_i V_{ik}}, \quad (3)$$

where it is usually assumed σ_i =1 or at least σ_i =σ so that the error variance is constant across decision makers and the coefficient estimates correspond to σβ, σγ and σρ (Greene, 2003). Although it is not possible to identify σ from the other parameters, it plays an important role in the probabilities predicted from the model. As σ approaches zero the error variance approaches infinity and the model predicts equal choice probabilities for all sites (Ben-Akiva & Lerman, 1985). In other words, the model is less able to predict deterministically the site with the highest utility when variability in the error is large relative to the observed component V_{ij}. This result is intuitive. However, ignoring scale heterogeneity in the case $\sigma_i \neq \sigma$ can cause the model to make misleading predictions, similar to how ignoring scale differences in combined choice data can bias coefficient estimates (Swait & Louviere, 1993; Whitehead, Pattanayak, Van Houtven, & Gelso, 2008).

The scale heterogeneity logit allows scale to vary across individuals by assuming σ_i is distributed lognormal, which assures the scale is always positive, with mean θ and standard deviation τ (Fiebig et al., 2010). The probability of visiting site j is then

$$prob_i(\text{choose}j) = \int e^{\sigma_i V_{ij}} / \sum_{k=1}^{A} e^{\sigma_i V_{ik}} f(\sigma_i|\tau) d\sigma_i. \quad (4)$$

where f() is the lognormal density. Note that this model has gone by different names in the literature, including the random scale logit (Breffle & Morey, 2000) and the scale heterogeneity multinomial logit (s-MNL) (Fiebig et al., 2010). While the mean parameter θ is normalized for the purposes of identification, τ can be interpreted as a