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Research article

Catch-and-release regulations and paddlefish angler preferences

Wonkyu Cha [a], Richard T. Melstrom [b, *]

[a] Center for International Agricultural Partnership, Department of Global Cooperation Research, Korea Rural Economic Institute, Naju-Si, Jeollanam-Do, South Korea
[b] Institute of Environmental Sustainability, Loyola University Chicago, Chicago, IL 60660, USA

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ABSTRACT

This paper presents research on recreational paddlefish anglers' preferences for catch-and-release fishing. We used stated preference (SP) data from a choice experiment to identify the effect of a hypothetical catch-and-release regulation on fishing preferences, and revealed preference (RP) data to measure the desirability of actual paddlefish fishing locations. We then modeled the effects of catch-and-release regulations on location choice and participation in the Oklahoma fishery. Our results indicate that although anglers dislike catch-and-release, most directly affected by regulations will either continue fishing at their preferred site or switch to a site where harvesting is permitted. Our preferred model predicts two-thirds will continue to participate even if catch-and-release fishing is required statewide.

1. Introduction

Overharvest is an important fisheries management issue. The most recent study of the American Fisheries Society's Endangered Species Committee found that of 700 extant taxa, 230 were vulnerable, 190 were threatened, and 280 were endangered (Jelks et al., 2008). Many of these species are imperiled due to overharvest. Research has found that catch and harvest-induced mortality is one of the largest threats to sustainable fisheries (Jackson et al., 2001), including recreational fisheries (Coleman et al., 2004). Protecting fish stocks therefore relies on reserves, seasons, entry fees—either for particular areas or for an entire fishery—length limits and bag limits to control fishing effort (Hubert and Quist, 2010). How effective these policies are is often a critical knowledge gap, in particular because they depend on local cultural norms (Arlinghaus et al., 2007). Thus, protecting imperiled fish stocks requires information about the effect of management policies on local fishing effort.

This paper presents an analysis of the location and harvest preferences of recreational paddlefish anglers. The American paddlefish (*Polyodon spathula*) is a big game fish native to the Mississippi River basin that has been extirpated from several major tributaries due to overharvest. Recreational paddlefish fisheries are snag fisheries because the species is planktivorous (Paukert and Scholten, 2009). While some state fish and wildlife agencies have adopted strict harvest regulations to mitigate local extirpation risks, others have maintained generous harvest limits. In part due to overharvesting, the International Union for the Conservation of Nature (IUCN) classifies the species as Vulnerable (Gardy, 2004).[1] In our focus on the fishery in Oklahoma, knowledge of the location and harvest preferences of anglers is important because the population is fragmented by dams, and two areas receive over half of all fishing trips. Managers are considering catch-and-release regulations to protect the population in Oklahoma (Schooley et al., 2014). Temporarily limiting access to these sites could also ease harvest pressure. However, both actions would likely reduce recruitment and participation in the fishery.

Using data collected by the Oklahoma Department of Wildlife Conservation, we measured the preferences of paddlefish anglers for location attributes, including catch rates and catch-and-release regulations. Globally, fisheries managers make extensive use of harvest regulations to protect stocks (Arlinghaus and Cooke, 2009),

* Corresponding author.
E-mail addresses: wkcha@krei.re.kr (W. Cha), rmelstrom@luc.edu (R.T. Melstrom).

[1] The IUCN justification states that an "overall population size reduction of at least 30% may occur within the next 10 years or three generations due to actual or potential levels of exploitation and the effects of introduced taxa, pollutants, competitors or parasites."

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and the effect of regulations on fishing preferences and behaviors has become a major focus in human dimensions research (Aas et al., 2000; Sutton and Ditton, 2001; Sutton, 2003; Oh et al., 2005; Carlin et al., 2012). This paper contributes to this research by developing several participation and site choice models. We use these models to predict how the location choices of paddlefish anglers are affected by regulations that require catch-and-release fishing. The effect of these regulations on behavior is identified through stated preference (SP) data. SP-based methods are the only way to predict the effect of catch-and-release because current harvest regulations are applied uniformly across fishing areas in Oklahoma. Several papers in the recreational fisheries literature have developed site choice models from SP data (Aas et al., 2000; Lew and Larson, 2014, 2015; Knoche and Lupi, 2016). This paper also contributes research on combining actual and hypothetical choice data to predict fishing behavior (Adamowicz et al., 1994; Ready et al., 2005; Alberini et al., 2007). Combining choice data can result in a model that predicts actual behavior better than using hypothetical data alone (Von Haefen and Phaneuf, 2008). Our results demonstrate how analysts can use participation and site choice models to predict the effects of harvest management tools such as catch-and-release.

2. Methods

2.1. Discrete choice model

In this section we develop a discrete choice model to predict participation and site choice. Discrete choice models of recreational fishing explain observed trip patterns in terms of the attributes an angler would experience at different sites. These models can be generalized to include the decision to not go fishing, which is treated as an additional choice alternative, similar to a “no-purchase” option in demand models of consumer goods. On a given choice occasion t for angler i, assume there are A alternatives, including $A-1$ fishing sites plus the no-trip option. Each alternative is associated with a utility of U_{itj}, where $j = 1, \ldots, A$. The indirect utility from choosing alternative j has the form:

$$U_{itj} = \boldsymbol{x_{itj}}\boldsymbol{\beta} + (\lambda + \eta_i)\nu_j + \varepsilon_{itj}/\sigma_i \tag{1}$$

$$U_{itj} = V_{itj} + \varepsilon_{itj}/\sigma_i \tag{2}$$

where V_{itj} is the observable component of utility, σ_i is an individual scale factor, and ε_{itj} is the idiosyncratic portion of utility. Site attributes are measured by $\boldsymbol{x_{itj}}$ and the availability of the no-trip option by an alternative-specific constant ν_j. Preferences or tastes for different attributes are measured by parameters $\boldsymbol{\beta}$, λ and η_i.

More specifically, for the SP choice occasions the site attribute portion of utility includes

$$\boldsymbol{x_{itj}}\boldsymbol{\beta} = \beta_p p_{itj} + \beta_{catch} catch_{tj} + \beta_{river} river_{tj} + \beta_{c\&r} catch\&release_{tj} \tag{3}$$

where p_{itj} is angler i's travel cost to j, $catch_{tj}$ is the daily catch at j, $river_{tj} = 1$ if the fishing site is a river and $= 0$ otherwise, and $catch\&release_{tj} = 1$ if the site requires the release of all caught fish and $= 0$ otherwise. We expect that, other things equal, anglers like higher catch rates and rivers, dislike travel costs and prefer the opportunity to harvest versus catch-and-release. We expect a general preference for rivers over lakes because paddlefish are typically caught during their springtime spawning runs. When timed appropriately, snagging a paddlefish is easier when the fish become congested moving up river.

Individual preference heterogeneity is measured by the parameters η_i and σ_i. We also include interactions between the no-trip constant and years of fishing experience plus the square of years of fishing experience, to measure any association between experience and avidity. We found little evidence of other forms of observable preference heterogeneity.

Based on random utility maximization theory, an angler chooses their most preferred alternative (Haab and McConnell, 2002). This implies choosing alternative j where $U_{itj} > U_{itk}$ for all $j \neq k$. However, the researcher only observes the portion V_{itj} and out of sample cannot predict with certainty the preferred alternative (Melstrom and Jayasekera, 2017). Morey et al. (1993) recommend nesting non-participation separately from the participation alternatives to allow for a relatively greater degree of substitution across the participation alternatives. We therefore assume η_i is normally-distributed with mean zero and standard deviation ζ to control for heterogeneity in anglers' propensity to stay home rather than go fishing in a particular choice occasion. We further allow σ_i to be lognormally-distributed, which assures the scale factor is always positive, with mean $\overline{\sigma}$ and standard deviation τ (Fiebig et al., 2010). Assuming ε_{itj} is mean zero and independent and identically distributed extreme value yields the generalized multinomial logit (GMNL), where the probability of choosing j is

$$P_{it}(\text{choose } j) = \int \frac{e^{\sigma_i V_{itj}}}{\sum_{k=1}^{A} e^{\sigma_i V_{itk}}} f(\eta_i, \sigma_i | \zeta, \tau) d\eta_i d\sigma_i. \tag{4}$$

where $f()$ is the mixture of normal and lognormal density functions for η_i and σ_i, respectively. The GMNL is also known as a scaled mixed logit because it generalizes the mixed logit with the addition of the individual scale factor. See Melstrom et al. (2017) on the significance of scale factors in discrete choice models of recreational fishing. The parameters are estimated by simulated maximum likelihood. As with the mixed logit, simulation is required because the integral in equation (4) does not have a closed-form solution (Train, 1998). We also estimate a conditional logit (CL) as a check on the performance of the GMNL. The CL does not assume any form of unobserved heterogeneity ($\sigma_i = 0$ and $\tau_i = 0$) but may provide better in-sample predictions than the GMNL when one or more alternative specific constants are included in the model (Von Haefen and Phaneuf, 2008). We use the gmnl routine in Stata developed by Gu et al. (2013) to estimate the models. The log-likelihood function for the GMNL is simulated with 500 Halton draws.

Modeling fishing behavior using SP data has advantages and disadvantages. One advantage is that SP data can measure the desirability of products or site attributes that do not yet exist. Another advantage is that the effects of interest will be estimated without omitted variables bias, because the site attributes and attribute levels are chosen by the researcher—in other words, there is no risk of endogeneity or “contamination” from latent variables, which is an important concern in discrete choice models estimated from revealed preference (RP) data (Jennifer, 2006). A disadvantage of SP data is that hypothetical choices may not reflect true behaviors (Huang et al., 1997). Consequently, analysts may have difficulty using SP data to predict actual product shares, particularly for the opt-out option (the no-trip option in our application) (Von Haefen and Phaneuf, 2008).

We adopt a sequential modeling approach to overcome the limitations of SP data. First, we estimate the preference parameters using the SP data. Second, we fix the RP parameters for the site attributes equal to the SP preference parameters and use the RP data to estimate a set of alternative-specific constants (ASCs), along with a dummy in the scale function to control for SP-RP scale