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A Hedonic Price Analysis of the Outfitter Market for Trout Fishing in the Rocky Mountain West

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Trout is the most popular sport fish in Montana, Wyoming, Colorado, and New Mexico where fishing outfitters bring revenues to many rural economies. This article uses the hedonic pricing method on a monopolistically competitive outfitter market in those four states to examine angler values for trout fishing characteristics. A total of 1,685 fishing trip observations were collected from 198 outfitter websites during the 2009 fishing season. Vectors of variables describe states, trip characteristics, trout species, and river destinations. Descriptions were used to estimate marginal implicit prices for fishing characteristics. Anglers highly valued fishing in Montana, Wyoming, and Colorado relative to New Mexico and fishing for only cutthroat trout as compared to brown, rainbow, and cutthroat trout together. Anglers also preferred quality indicators such as trophy-size trout opportunities, blue ribbon stream designation, and private land access. Results are related to cutthroat trout conservation strategies and recent state legislative bills regarding stream access.

Keywords Rocky Mountain West, trout, fishing, hedonic analysis, cutthroat, private land, cutthroat conservation, stream access laws

Introduction

Trout are a freshwater fish that prefer cold water mountain streams and lakes. In 2006, between 74% and 92% of freshwater anglers chose to fish for trout in the Rocky Mountain states of Montana, Wyoming, Colorado, and New Mexico, making trout the most popular freshwater sport fish and a significant source of revenue to local, and primarily rural, economies (Harris, 2010; Hussain, Munn, Grado, & Henderson, 2008; Nickerson, Oschell, Rademaker, & Dvorak, 2007). Past research has used travel cost and stated preference survey methods to value various characteristics of trout fishing such as: increased catch rates (Dalton, Bastian, Jacobs, & Wesche, 1998; Johnson, Behnke, Harpman, & Walsh, 1995; Kerkvliet & Nowell, 2000; Morey, Breffle, Rowe, & Waldman, 2002), the availability of trophy-size trout (Dalton et al., 1998; Kerkvliet, Nowell, & Lowe, 2002), fishing site

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selection (Kerkvliet & Nowell, 2000; Morey et al., 2002), and specific fisheries (Kerkvliet et al., 2002). However, Rocky Mountain anglers have also been shown to value other fishing characteristics, such as the ability to catch wild trout (Allen, 1988). Previous research has not valued trout fishing access based on trip characteristics offered by outfitters. This article attempts to fill this gap. Understanding angler values for the range of fishing characteristics that comprise a fishing experience has important policy implications. For example, in a government experiment with charter forest management, information on anglers' valuations of fishing characteristics would have been helpful in setting feasible revenue goals for the angling recreation program (Little, Berrens, & Champ, 2005).

Combinations of trout species, environmental characteristics, quality indicators, and public/private characteristics are present in all trout fishing opportunities; any angler who purchases a state angling permit and selects a fishing site for their own solo trip implicitly values the package of characteristics available at their selected site. It is difficult to infer these anglers' values for trout fishing characteristics from a state's public permit prices alone, which range from $9 for a single day in Colorado to $92 for an annual Wyoming permit (CDOW, 2010; MFWP, 2010; NMGF, 2010; WGFC, 2010). However, outfitters offer access to similar fishing opportunities as those enjoyed by the solo angler. The outfitter market in Montana, Wyoming, Colorado, and New Mexico offers heterogeneous trout fishing opportunities where price differences reflect varying amenity levels in trip characteristics. A hedonic pricing analysis can decompose observed price variation for trout fishing access into estimated marginal implicit prices for the varying trip characteristics. This article analyzes the private outfitter market for trout fishing opportunities to estimate angler values for a range of fishing trip characteristics.

The data consist of 1,685 observations of varying prices and outfitter trip characteristics collected for the 2009 fishing season from 198 outfitter websites. Results from three semi-log models suggest that outfitter access to trout fishing was most highly valued in Montana, followed by Wyoming and Colorado relative to New Mexico. Quality indicators were highly valued as was fishing access on privately owned land. Compared to fishing in streams with opportunities for three trout species, fishing where only cutthroat trout were predominant added value. The Flathead, Lower Missouri, Beaverhead, and Clark Fork Rivers in Montana and Yellowstone National Park (YNP) were among the river systems with the highest estimated values.

This information is potentially useful to rural and state policymakers in decision-making over fishing resources and habitats as the fishing industry contributes economically to rural counties in the Rocky Mountains; in Colorado, five of the eight counties with the heaviest fishing activity are rural (McCollum, Haefele, & Rosenberger, 1999). Cutthroat trout restoration efforts and state stream access laws are discussed as examples of how these results might be applied, as statistically significant results indicate that anglers valued fishing for cutthroat trout ($21.16) as well as on privately owned land ($85.91).

Fishing and the Outfitter Market

The market for trout fishing and the prices for fishing access are influenced by a variety of characteristics. Overall, natural resources such as rivers, fish, and fish habitat are quasi-public goods that are regarded as part of the public trust doctrine. This implies the public's right to use and the state's ability to regulate these resources. Anglers are legally required to purchase the necessary stamps and permits from a state's regulating agency. Trout fishing as a quasi-public good is non-rival only up to the point where large numbers of anglers exhaust a stream, and non-excludable except for limitations on fishing publicly owned waters during

spawning. States also regulate fishing limits, catch-and-release rules for certain species, and float fishing restrictions (CDOW, 2010; MFWP, 2010; NMGF, 2010; WGFC, 2010). When public fishing stretches are surrounded by private lands, access is regulated by a state's stream access laws (Stauffer, 2006).

Outfitters are a key supplier of access to state fishing resources. While residents fish their states in greater numbers (Harris, 2010), non-residents disproportionately hire outfitters (Nickerson et al., 2007). In 2005 Montana outfitters reported 63,800 fishing outfitter clients of which, approximately 87% were non-residents and 33% came to Montana specifically for their outfitter trip (Nickerson et al., 2007).[1] In 2008, Montana sold almost 390,000 permits (39% to non-residents). For the same year, Wyoming, Colorado, and New Mexico report figures of 317,000 (63%), 676,000 (22%), and 195,000 (16%), respectively. Considering Nickerson et al. (2007), it can be extrapolated that approximately 14% of the total permitted anglers in Montana in 2008 subsequently hired an outfitter.

Anglers and outfitters represent the demand and supply sides, respectively, of the market for trout fishing access. The Internet has facilitated the ability of these primarily non-resident clients to locate local fishing outfitters. Increased Internet marketing has thickened a previously thin market by better connecting outfitters with angling clients (Mozumder, Starbuck, Berrens, & Alexander, 2007). Outfitters use website advertising to post prices and differentiate their services through varying amenity levels desired by anglers; these include fishing instruction, river knowledge, quality indicators, boats, and service amenity levels. Through exclusive fishing access contracts with private landowners, outfitters can offer access opportunities beyond what is publicly available to anglers. For large-volume rivers, the outfitter provides boat equipment and can row while the angler fishes. These heterogeneous service levels are often bundled with other services (e.g., lodging) and are reflected in varying prices for a fishing trip, creating a monopolistically competitive private market for trout fishing access.

Most outfitters are located in the rural regions of the Rocky Mountain West, where expenditures in the fishing and outfitter markets can be a considerable revenue source to local and regional economies (Harris, 2010). While the full economic impact of the outfitter industry is difficult to estimate, a 2005 economic impact analysis on the outfitter industry in Montana provides some insight. Nickerson et al. (2007) reported that angling outfitters guided 63,800 clients for 120,100 client days and estimated a direct economic impact of $34.2 million. It is important for local policymakers to understand how and which fishing trip characteristics advertised by outfitters influence the market prices in their local economies.

Model and Data

Theoretic Model

This analysis uses a hedonic price model (Rosen, 1974) to estimate the implicit marginal prices for the characteristics of an outfitter-led trout fishing trip. Taylor (2003) provides an excellent theoretical background and discussion of potential issues in estimating a hedonic model. Hedonic analysis can be used in a market for a heterogeneous good where variation in levels of the good's characteristics results in observed market price differences. Typically, the supply of trout on public lands is not responsive to the marginal price of trout fishing; it is exogenous so variations in fishing opportunities result from differences in site and outfitter characteristics (Livengood, 1983). By estimating a hedonic price function, researchers can uncover anglers' underlying preferences for individual trout fishing

characteristics (Taylor, 2003). Hedonic analysis has not been used in the fishing literature, but it has been used to value hunting leases in Mississippi (Rhyne, Munn, & Hussain, 2009), deer hunting leases and permits (Livengood, 1983; Taylor & Marsh, 2003), and elk hunting permits (Little & Berrens, 2008).

In a first-stage hedonic analysis, the hedonic model assumes that an angler *i* gains utility from the purchase of a single trout fishing trip, *Z*, with differing state **(S)**, fishing trip **(F)**, trout species **(T)**, and river-specific **(R)** characteristics. The heterogeneity of fishing trip options is reflected in the presence of characteristics such as the ability to fish in blue-ribbon trout streams, for wild trout, for different trout species, or on privately owned land. The angler selects from a menu of trip characteristics with varying prices for a trout fishing trip, P_Z. Market prices reflect changes in levels of fishing trip characteristics, a researcher can estimate marginal implicit prices for individual trip characteristics while holding the other characteristics constant (Taylor, 2003).

The basic hedonic function states that angler *i* gains utility, subject to his budget constraint, as a function of the good's characteristic levels plus the consumption of a composite good, X, whose price is normalized to \$1 (Taylor, 2003). The respective general utility and price functions are:

$$U^i(\mathbf{S_j}, \mathbf{F_k}, \mathbf{T_l}, \mathbf{R_m}; X) \quad \text{subject to :} \quad P_Z + X = Y \tag{1}$$

$$P_Z = f(\mathbf{S_j}, \mathbf{F_k}, \mathbf{T_l}, \mathbf{R_m}) \tag{2}$$

where $P_X = 1$ is the price of composite good, X, and Y represents angler *i*'s entire budget. The price of a trout fishing trip is a function of the characteristic levels. Angler *i* exhausts his budget on the fishing trip and the composite good.

To value any individual characteristic, such as fishing on private land, F_1, angler *i* is assumed to purchase a single trout fishing trip at the point where the tradeoff in market prices for a fishing trip on private land, P_{F1}, against the price for the composite commodity, X, equals the marginal rate of substitution between the two. In other words, the utility tradeoff between a fishing trip on private land and the change in consumption of the composite good must equal the rate at which the two can be traded at market prices. This is given as:

$$\partial P_Z / \partial F_1 = [\partial U / \partial F_1] / [\partial U / \partial X] \tag{3}$$

In general, Equation 3 represents the angler's marginal willingness-to-pay or implicit price for any specific trout fishing characteristic (Taylor, 2003).

Data

The dataset for this analysis was created using information collected from trout outfitter websites during the period of December 2008 through March 2010, reflecting the 2009 fishing season. The data collection approach was similar to research by Little and Berrens (2008) on big-game hunting permits in the Southwestern United States. For this research an outfitter was defined as an outfitter, angling club, or fishing lodge offering access to a trout fishing opportunity. Data were collected by identifying outfitters with an online presence that at least advertised prices with fishing trip destinations.[2] Only Montana and Colorado license both outfitters and guides. Guides are more numerous than outfitters and must work

for or contract with a licensed outfitter. They may guide for multiple outfitters. Two-thirds of outfitters in this dataset identify at least a percentage of their guides on their websites.[3] For that subset, region-wide the mean number of guides per outfitter is 6.6, ranging from 1 to 42 guides; the median is 5 guides per outfitter. By state, the mean ratio of guides per outfitter is approximately 6.5 (MT), 6.1 (WY), 7.9 (CO), and 3.4 (NM). Nickerson et al. (2007) reported an average of 4.86 guides per outfitter industry-wide in Montana, ranging from 0 to 50 guides per outfitter. Overall 55% of outfitters are based in local fly shops, where visiting anglers acquire information and equipment for local waters. Fly shop staff work with the outfitter as guides, taking reservations, providing trip information, and they reduce the need for a separate physical store. By state, the percentage of outfitters associated with fly shops ranges from 41% (MT) and 43% (NM) to 67% (CO). The data represent only outfitters with a website. A hedonic price analysis requires characteristics, such as those used in advertising, whose varying amenity levels are observable by potential clients.

There are three issues or assumptions in using online price data. The first is that the Internet-advertised price reflects the on-site retail price. In two studies using Internet data, the researchers compared Internet and in-store prices and found no differences between the two (Brynjolfsson & Smith, 2000; Little & Berrens, 2008). The second is that each advertised trip represents at least one sale transaction. Following the approach of Little and Berrens (2008), approximately 8% of outfitters were contacted; during a short interview, these outfitters confirmed both that there was no difference between online prices and in-store prices as well as that they booked at least one of every trip advertised. Third, trips are unweighted; an observation for a one day fishing trip counts as much as an observation for a multiple day fishing trip with lodging, nor is there weighting for each outfitter's most popular fishing trips.

Internet advertising involves asymmetric information regarding online river and trout species descriptions; the angler must trust the accuracy of the outfitter's descriptions (Grabner-Kräuter & Kaluscha, 2003). Kim, Ferrin, and Rao (2008) found that a perception of high quality, current information, and positive reputation tend to increase trust in online sellers. Many outfitters provide past client testimonials and fish photos or provide links to outside websites such as the U.S. Geological Survey or the Orvis® Web page "Fly Fishing Reports and Conditions, United States." These websites are an independent source of daily river-specific information and may increase the perception that the outfitter provides accurate, quality information.

Hedonic price analyses depend on correct identification of exogenous product characteristics that influence price, as price differences result from varying characteristic levels (Taylor, 2003). The fishing literature was reviewed to help identify relevant variables and the region for analysis. While hedonic studies have not been used in empirical work on fishing, non-market valuation methods have been used, primarily on the Rocky Mountain West, analyzing specific rivers or angling behavior in Montana (Allen, 1988; Kerkvliet & Nowell, 2000; Kerkvliet et al., 2002; Morey et al., 2002), Wyoming (Dalton et al., 1998), and Colorado (Johnson et al., 1995; McCollum et al., 1999). The selected region of interest included those three states plus New Mexico for a regional market; Utah and Idaho were omitted.

Two hedonic studies on big game permits helped to identify relevant characteristics (Little & Berrens, 2008; Livengood, 1983). Influential characteristics selected were those observable to anglers through the website advertising: price, trip and river descriptions, trout species available, any lodging, and contact information. Table 1 defines all variables used.

Table 1
Variable definitions

TROUTPRICE *(dep var)*	Per angler price for a trout fishing opportunity for two anglers sharing outfitter services plus rod fee and lodging if applicable
State Indicators (S)	
MT	Trout fishing opportunity is in Montana; yes = 1, no = 0
WY	Trout fishing opportunity is in Wyoming; yes = 1, no = 0
CO	Trout fishing opportunity is in Colorado; yes = 1, no = 0
NM	Trout fishing opportunity is in New Mexico *(omitted variable);* yes = 1, no = 0
Fishing Trip Indicators (F)	
HALF	Fishing trip lasts 4 hours or less, a half day *(omitted variable);* yes = 1, no = 0
FULL	Fishing trip lasts 6 to 10 hours, a full day (approx. one day); yes = 1, no = 0
MULTI	Fishing trip lasts 1.5 days to 10 days, multi-days; yes = 1, no = 0
DISTANCE	Distance in miles (Mapquest) from regional airport to outfitter headquarters or private ranch
LODGING	Fishing included a combination of lodging, food, amenities; yes = 1, no = 0
LODGE-STREAM	Lodging includes a stream flowing through the property; yes = 1, no = 0
PRIV	Fishing opportunity accessed from privately owned land; yes = 1, no = 0
WADE	Fishing opportunity was a wade trip only; yes = 1, no = 0
ORVIS	Orvis-endorsed guide, expedition, or lodge; yes = 1, no = 0
WILD	Outfitter advertised fishing for wild trout; yes = 1, no = 0
TROPHY	Outfitter advertised fishing for trophy size trout or trout 14″ plus; yes = 1, no = 0
BLUE	Outfitter advertised fishing on Blue Ribbon, Gold Medal, or Quality Trout Waters; yes = 1, no = 0
Trout Species Indicators (T)	
CUTT	Almost all the fish in the stream are cutthroat trout; yes = 1, no = 0
BROWN	Almost all the fish in the stream are brown trout; yes = 1, no = 0
RAIN	Almost all the fish in the stream are rainbow trout; yes = 1, no = 0
TWO	Stream has a strong population of two trout species; yes = 1, no = 0
THREE	Stream has a strong population of all three trout species or available species were not mentioned *(omitted variable);* yes = 1, no = 0

(*Continued*)

Table 1
(Continued)

TROUTPRICE *(dep var)*	Per angler price for a trout fishing opportunity for two anglers sharing outfitter services plus rod fee and lodging if applicable
River Indicators (R)	
MT-FLATHEAD	Northwest MT—Flathead and South, Middle and North Forks of Flathead
MT-YELLOWSTONE	Southwest MT—YNP to Big Timber; Boulder, Stillwater, and Paradise Valley Spring Creeks
MT-CLARK FORK	Western MT—Clark Fork, Rock Creek, Blackfoot, Bitterroot
MT-BEAVERHEAD	Southwest MT—Beaverhead, Big Hole, Upper and Lower Ruby (they form the Jefferson)
MT-GALLATIN	Southwest MT—Gallatin River (forms the Missouri with Jefferson and Madison)
MT-LOWER MISSOURI	Central MT—Missouri (Hauser/Holter Dams to Cascade, MT) and Dearborn, Marias, and Smith Rivers
YNP	Rivers, streams and lakes inside Yellowstone National Park
WY-NORTH PLATTE	N. Central CO/S. Central WY—North Fork, Michigan, North Platte, Encampment, Sweetwater, Laramie
CO-COLORADO	North/West CO—Upper/Lower Colorado, Williams Fork, Blue, Fraser, Piney, Eagle and Gore Creek
CO/NM-RIOGRANDE	Southern CO/North Central NM—Rio Grande, South Fork, Red, Chama, Hondo, Jemez Rivers
NM-SAN JUAN	Southwest CO/Northwest NM—Upper/Lower San Juan, San Juan Quality Waters, Pine and Piedra Rivers

The dependent variable in this dataset represents the TROUTPRICE for an outfitter to provide full-service fishing access to fishing waters on public or private land with fly-fishing instruction included. Observations that did not include fly-fishing instruction were dropped; they were considered a separate, more experienced class of clients and comprised only 3% to 8% of trips in each state. Each TROUTPRICE$_{a,b}$ observation has a unique identifier comprised of a guide number, *a,* and trip number, *b.* Most outfitters offer multiple trips reflecting their river permits and varying fishing quality over the year due to river level fluctuations, trout spawning seasons, and insect hatches. The mean and median number of trips is 6.2 and 5, respectively, with a standard deviation of 4.6. Outfitters' summer or full-season prices were used.

The dependent variable, TROUTPRICE, indicates the per angler rate, conditional on two anglers sharing the outfitter and any included lodging. Half day and full day rates were commonly listed as one guide per two anglers and multiple anglers confirmed that this was typical; rates were divided in half to calculate TROUTPRICE. Package rates were typically advertised as per angler based on double occupancy. Rod fees were advertised as per angler.

Independent variables selected describe website-advertised state, trip, species, and river characteristics. State characteristics indicate fishing in Montana (MT), Wyoming (WY), Colorado (CO), or New Mexico (NM), with New Mexico as the omitted variable.

Trip characteristics include binary variables describing any lodging combination with meals and services (LODGING), plus possible on-site stream access (LODGE-STREAM);

fishing access on privately owned land (PRIV); a fishing method that was strictly on foot (WADE). Interval categorical variables describing trip lengths from 2 to 4 fishing hours (HALF), 6 to 10 fishing hours (FULL), and 1.5 days up to 10 days (MULTI) were coded as binary response variables with HALF as the omitted variable. The continuous variable, DISTANCE, indicates remoteness. Mapquest was used to measure the distance in miles between the nearest major state airport and the outfitter's headquarters or the private ranch fishing destination. ORVIS, WILD, TROPHY, and BLUE are binary variables that measure fishing quality. ORVIS indicates a high quality outfitter endorsed by the Orvis® fly-fishing and hunting specialty sporting goods store for providing great fishing and service by experienced outfitters. The variable WILD indicates an opportunity to catch wild trout that have lived their whole life cycle in the stream, which has been shown to influence fishing site selection (Allen, 1998). TROPHY and BLUE are subjective quality indicators that were coded one if the outfitter specifically used either term. TROPHY was also considered the mention of a 14-inch-plus fish. No specific size indicates a trophy-size fish; fish size depends on many factors such as food availability and stream temperature. TROPHY does not indicate a guarantee or even a higher probability of catching a trophy-size fish; it is simply a signal of the outfitter's subjective measure of river quality. BLUE represents a high quality fishing river. Not all states have precise definitions for a high quality fishing stretch; thus BLUE is a subjective quality indicator.

Species characteristics indicate which trout species are predominantly available. The variables CUTT, BROWN, and RAIN indicate fishing in streams where cutthroat/cutbows (a cutthroat/rainbow hybrid trout), brown, or rainbow trout, respectively, were predominant; thus, the probability of catching the targeted species would be extremely high. Since CUTT represents streams where there were strictly cutthroats or an extremely high percentage of cutthroats, it is assumed those streams do not contain many, if any, rainbows with which to mate. So CUTT is assumed to represent a high probability of catching a cutthroat, not a cutbow. TWO indicated a more even probability of catching two trout species. THREE (the omitted variable) indicated either all three species appeared equally probable or no species were advertised.

River indicator variables represent specific rivers on which fishing trips are available. Smaller tributaries and shorter river segments were combined into larger river systems (Table 1). Most fishing trips have one destination river; however, for a multi-day fishing trip with several possible river destinations, then all the rivers were coded for that single observation.

A total of 1789 unique trips were gathered. Trips that did not include guided fishing instruction were dropped, leaving 1,685 usable observations. Trout fishing trip opportunities are heterogeneous across states, as shown in Table 2, which provides the descriptive statistics.

Econometric Model

Hedonic models require selection of a functional form. In general, trout fishing characteristics cannot be costlessly packaged together simply based on the angler's ideal fishing trip. The price of a trout fishing trip is unlikely to be the sum of its marginal implicit characteristic prices, as suggested by the linear OLS model. Non-constant marginal implicit pricing is more intuitive (Taylor, 2003). The dependent variable, TROUTPRICE, had a positive skewness where the mean ($434) was greater than the median ($210), indicating the presence of heteroskedasticity (Greene, 2003). Thus a nonlinear functional form seemed likely. The majority of the exogenous variables are binary indicators so dependent

Table 2
Descriptive statistics on trout fishing trips by state and region

VARIABLE	MONTANA	WYOMING	COLORADO	NEW MEXICO	REGION
Dependent, median					
TROUTPRICE	$233	$216	$180	$175	$210
Independent, mean					
FULL	54%	62%	65%	63%	61%
MULTI	35%	13%	5%	16%	16%
DISTANCE	167	197	157	167	168
LODGING	36%	19%	6%	16%	18%
LODGE-STREAM	13%	14%	3%	8%	8%
WADE	25%	51%	74%	74%	56%
PRIV	6%	21%	22%	17%	17%
ORVIS	24%	21%	15%	17%	19%
WILD	38%	38%	25%	32%	31%
TROPHY	40%	43%	35%	40%	38%
BLUE	30%	21%	22%	30%	25%
CUTT	4%	19%	2%	10%	6%
BROWN	10%	10%	12%	8%	11%
RAIN	4%	8%	6%	12%	7%
TWO	28%	23%	28%	37%	28%
NUMBER OF OBS	487	286	768	145	1,685
% OF TOTAL OBS	29%	17%	46%	9%	100%

variable transformations were compared against a standard OLS regression. A Box Cox specification test indicated a semi-log functional form might be appropriate (Box & Cox, 1964). Taylor (2003) notes that simpler forms such as the semi-log or double-log are more accurate if there are unobservable influential variables or measurement errors. A general semi-log model was used:

$$\ln \text{TROUTPRICE}_{a,b} = \beta_0 + \mathbf{\beta_j S_j} + \mathbf{\beta_k F_k} + \mathbf{\beta_l T_l} + \mathbf{\beta_m R_m} + \varepsilon_{a,b} \quad (4)$$

Equation 4 indicates the price of a trout fishing trip_b offered by outfitter_a is a function of a vector of state-level characteristics **(S)**, a vector of fishing trip characteristics **(F)**, a vector of trout species characteristics **(T)**, and a vector of river-specific characteristics **(R)**, plus an error term, ε. The estimated constant, β_0, represents the value of the baseline transaction, while the other β's represent conformable vectors of estimated coefficients.

The R^2 values supported the goodness-of-fit of the semi-log functional form as the preferred model with linear-in-parameters independent variables. Robust standard errors were used to allow for remaining heteroskedasticity. For a semi-log model, the estimated implicit price of any characteristic, Z_f, is calculated $(\partial P_Z / \partial Z_f) = \beta_f P$, where P is evaluated at the median (Taylor, 2003). For a continuous variable such as DISTANCE, the estimated β_f coefficient can be interpreted as the relative effect on the price of a trout fishing trip due to a small change in the variable; this β_f is used to calculate marginal implicit prices (Taylor, 2003). For a dummy variable, the β_f only approximates the relative change to

the price (Halvorsen & Palmquist, 1980). It must be corrected by evaluating the change in price when the dummy variable is present and when it is not. Marginal implicit prices are calculated as $(e^{\beta f} - 1)P$, where P is evaluated at the median (Halvorsen & Palmquist, 1980).

Due to the positive skewness of the dependent variable, the median price is used in calculating marginal implicit prices to provide a more conservative estimate of implicit prices (Taylor, 2003). To correct for correlations among the variables, confidence intervals were calculated using standard errors estimated with the bootstrap method of re-sampling with replacement. One thousand repetitions were used (Efron & Tibshirani, 1986).

Results

Three semi-log model specifications were considered. Model 1 is a trimmed specification that only includes the vectors of state-level and fishing trip characteristics. Model 2 used the Model 1 plus the vector of trout species characteristics. Model 3 replaced the vector of state indicator variables from Model 2 with the vector of river indicator variables.

Results with estimated coefficients for all three models are reported in Tables 3 and 4.[4] Marginal implicit prices from Model 2 are reported followed by a short discussion of rivers from Model 3. Overall, estimated coefficients were relatively stable in sign and significance across all three models. The constant represented the baseline transaction: a half-day float fishing trip on public land in New Mexico (Model 2) or on a representative river (Model 3) for all three trout species with no lodging, no quality indicators, and no wild or trophy-size trout.

As compared to New Mexico, fishing in Montana, Wyoming, and Colorado added value with implicit prices of $46.49, $16.35, and $8.35 respectively; the confidence interval for Colorado included a potential $0 price. Results likely represent state heterogeneity in fishing opportunities (Table 2) and management of fishing resources. Fishing pressure was greater in the Southern Rockies with almost twice as many trout anglers as compared to the Northern Rockies in 2006 (Harris, 2010). This may negatively affect trout and their habitat while increasing the probability of angler crowding. State policies toward wild trout exemplify heterogeneous natural resource management styles. Montana manages all its streams for wild trout. Colorado manages only portions of certain streams for wild trout; New Mexico and Wyoming have no wild trout management policy.

Most fishing trip variables were significant with the expected signs. Additional time above 2 to 4 fishing hours (HALF) was valued, with estimated marginal implicit prices of $62.62 for 6 to 10 fishing hours (FULL) and $447.20 for 1.5 days to 10 days (MULTI). The variable DISTANCE had an estimated implicit price of $0.06 per mile. With a mean regional distance of 168 miles (standard deviation is 97 miles), $10.08 was the average estimated value. Outfitters provide knowledge of local rivers, fishing seasons, and local entomology, and tend to be located in towns relatively close to their most commonly guided fishing spots. Increased distance may improve access to less crowded sites, which adds value as angler crowding negatively impacts the fishing experience (Kerkvliet et al., 2002; McCollum et al., 1999). A combination of lodging, meals, and services (LODGING) added value with an estimated marginal implicit price of $276.39. An on-site stream (LODGE-STREAM) running through a lodge's property added $33.74 in value. Easy fishing access and additional fishing time may explain the value. Private (PRIV) land access added $85.91 in value, perhaps due to quality fishing habitat resulting from stream access laws or in comparison to crowded public lands (Mozumder et al., 2007). Private land also added value to big-game hunting (Little & Berrens, 2008).

Table 3
Semi-log model results, models 1 and 2 ($N = 1{,}685$)

	Model 1: Basic		Model 2: Basic + Trout			
Variable	Coefficient[a]	(S.E.)	Coefficient[a]	(S.E.)	Implicit Price	(95% C.I.)[b]
MT[c]	0.204***	(.024)	0.200***	(.024)	$46.49	($33.98, $59.37)
WY	0.089***	(.025)	0.075***	(.025)	$16.35	($5.10, $27.96)
CO	0.037*	(.020)	0.039*	(.021)	$8.35	(−$0.42, $17.72)
FULL	0.258***	(.013)	0.261***	(.013)	$62.62	($55.62, $69.52)
MULTI	1.143***	(.065)	1.141***	(.064)	$447.20	($366.52, $539.18)
DISTANCE	0.0003***	(.0001)	0.0003***	(.0001)	$0.06	($0.02, $0.08)
LODGING	0.846***	(.071)	0.840***	(.071)	$276.39	($210.75, $352.85)
LODGE-STREAM	0.149**	(.060)	0.149**	(.060)	$33.74	($6.61, $63.99)
WADE	−0.114***	(.015)	−0.123***	(.015)	−$24.30	(−$29.61, −$18.84)
PRIV	0.337***	(.022)	0.343***	(.022)	$85.91	($73.75, $98.61)
ORVIS	0.091***	(.019)	0.090***	(.019)	$19.77	($11.21, $28.67)
WILD	0.008	(.015)	0.012	(.015)		
TROPHY	0.044***	(.015)	0.056***	(.015)	$12.09	($5.32, $18.86)
BLUE	0.019	(.016)	0.027*	(.016)	$5.75	(−$1.05, $12.54)
CUTT[d]			0.096***	(.031)	$21.16	($7.48, $35.70)
BROWN			−0.045**	(.018)	−$9.24	(−$15.95, −$2.09)
RAIN			−0.080***	(.025)	−$16.14	(−$25.41, −$6.21)
TWO			−0.022	(.017)		
CONSTANT	4.910***	(.028)	4.923***	(.029)	—	
R^2	.883		.884			

Dependent variable: LnTroutPrice
[a]Significance levels: *.10; **.05; ***.01
[b]C.I. estimated with bootstrap procedure, 1,000 repetitions
[c]Omitted state variable is NM
[d]Omitted trout species is THREE

The estimated marginal implicit price of a WADE trip was −$24.30, indicating that WADE trips were less valued than float trips. Approximately 72% of WADE trips occurred in the Southern Rockies. The negative value may reflect a less valued fishing experience overall in the Southern Rockies. The outfitter quality indicator, ORVIS, had a positive coefficient; the estimated implicit price was $19.77. An ORVIS® endorsement of quality may increase the value of a fishing trip by reducing the inherent risk in hiring an unknown outfitter. The estimated coefficient for WILD showed mixed results. It was not significant in Model 2, although it was at the 10% level in Model 3, however the confidence interval included a $0 value. The estimated coefficient on TROPHY was positive and significant with an estimated marginal implicit price of $12.09. Anglers value the possibility of catching large fish. Dalton et al. (1998) also reported a positive net willingness-to-pay and consumer surplus for a doubling of possibility of catching large trout. The river quality indicator, BLUE, varied in significance from 10% (Model 2) to 1% (Model 3); however the sign was stable across models. Estimated marginal implicit prices were $5.75 (Model 2) and $10.55 (Model 3). Anglers and outfitters consider it an indication of high quality

Table 4
Semi-log model results: Model 3 ($N = 1{,}685$)

	Model 3: Basic + Trout and Rivers			
Variable	Coefficient[a]	(S.E.)	Implicit price	(95% C.I.)[b]
MT-FLATHEAD	0.296***	(.099)	$72.33	($21.62, $134.49)
MT-YELLOWSTONE	−0.014	(.031)		
MT-CLARK FORK	0.174***	(.030)	$39.91	($25.83, $54.56)
MT-BEAVERHEAD	0.266***	(.051)	$63.99	($38.16, $92.19)
MT-GALLATIN	0.122*	(.047)	$27.25	($6.61, $50.10)
MT-LOWER MISSOURI	0.327***	(.055)	$81.22	($51.41, $114.43)
YELLOWSTONE NP	0.221***	(.052)	$51.93	($24.42, $82.68)
WY-NORTH PLATTE	−0.037	(.027)		
CO-COLORADO	0.071***	(.019)	$15.45	($7.04, $23.95)
CONM-RIOGRANDE	−0.015	(.027)		
NM-SAN JUAN	−0.113***	(.032)	−$22.44	(−$33.71, −$10.64)
FULL	0.265***	(.013)	$63.71	($56.96, $70.92)
MULTI	1.102***	(.064)	$422.07	($346.69, $507.65)
DISTANCE	0.0005***	(.0001)	$0.11	($0.06, $0.13)
LODGING	0.809***	(.069)	$261.55	($200.77, $331.86)
LODGE-STREAM	0.191***	(.057)	$44.19	($16.81, $75.17)
WADE	−0.132***	(.014)	−$25.97	(−$31.05, −$20.93)
PRIV	0.360***	(.022)	$90.99	($78.90, $103.90)
ORVIS	0.093***	(.018)	$20.46	($12.54, $28.43)
WILD	0.025*	(.014)	$5.32	(−$0.84, $11.86)
TROPHY	0.056***	(.015)	$12.09	($5.75, $18.63)
BLUE	0.049***	(.016)	$10.55	($3.81, $17.49)
CUTT[c]	0.088***	(.029)	$19.32	($6.39, $33.01)
BROWN	−0.046**	(.019)	−$9.44	(−$16.53, −$1.88)
RAIN	−0.062**	(.026)	−$12.62	(−$22.62, −$2.30)
TWO	−0.022	(.016)		
CONSTANT	4.932***	(.025)	—	
R^2	0.893			

Dependent variable: LnTroutPrice
[a]Significance levels: *.10; **.05; ***.01
[b]C.I. estimated with bootstrap procedure, 1,000 repetitions
[c]Omitted trout species is THREE

fishing; however, there was a lack of consensus as to its importance. The positive sign may be the main implication; anglers positively valued a signal of high quality fishing and blue ribbon was interpreted as an indication of few substitute rivers (Kerkvliet & Nowell, 2000).

Individual trout species variables were significant; compared to a fishing opportunity for all three trout species, fishing for only cutthroat trout (CUTT) added value, while fishing for brown (BROWN) or rainbow (RAIN) only decreased value; marginal estimated prices were $21.16, −$9.24, and −$16.14, respectively. The added value from cutthroat may reflect its rarity, headwater stream habitats, or appreciation programs (WGFC, 2010).

Negative estimated values of rainbow and brown trout may reflect anglers' values of their most common habitats.

In Model 3, rivers represent location. Combinations of rivers with tributaries or several regional rivers were created for analysis purposes. Alternative lumping could be considered; for this analysis, 10 rivers systems and one national park, approximately half of fishing trips, were used. The omitted rivers formed a baseline river.[5] Relative to the baseline, the following rivers were positively valued: Flathead, Clark Fork, Beaverhead, Gallatin, Lower Missouri (MT); Colorado (CO); and YNP. Morey et al. (2002) found several of these Montana rivers to be popular fishing sites and YNP was highly valued in Kerkvliet et al. (2002). Fishing was less valued on the San Juan River (NM). Values could reflect overall angling experiences. One example is the San Juan River, which features thousands of trophy-size rainbow trout on the blue ribbon section but has heavy angling pressure and is less scenic.

Policy Implications and Conclusion

Hedonic pricing analyses can improve the understanding of a market by decomposing the observed price variation for a heterogeneous good into estimated marginal implicit prices for its characteristics. To estimate values for a range of fishing characteristics, this analysis considered the private outfitter market which offers access to heterogeneous trout fishing opportunities. Local and state policymakers can use these results as one information source for policies that affect public use and enjoyment of natural resources such as riverine fisheries.

Rural economies with high quality fishing habitats could attract more non-resident anglers who often fish for multiple days, require lodging services, and typically spend more per trip (Dalton et al., 1998; Hussain et al., 2008; Morey et al., 2002) than residents. Results suggest that anglers significantly valued multi-day trips ($447.20) and lodging ($276.39) while fishing. Nickerson et al. (2007) reported mean length of fishing trips and days spent in Montana of 2.91 and 6.71 nights, respectively. Non-resident anglers comprised large percentages at some fishing sites. Several Montana fishing site surveys had a range of 31% to 88% of non-resident respondents (Allen, 1988; Kerkvliet et al., 2002; Morey et al., 2002). Policies improving habitat quality or fishing access may increase revenues from expenditures by non-resident anglers.

The estimated marginal prices presented in this article are relevant in the context of two current policy issues: cutthroat trout preservation strategies and stream access laws. Results indicated that anglers had a relatively higher willingness-to-pay to fish for cutthroat trout and for the benefits of fishing on private land. A brief discussion of each issue follows.

The first policy issue involves the region's native cutthroat trout. Fourteen different subspecies of cutthroat are found throughout the Rockies (Quist & Hubert, 2004). Non-native trout species have had a significant negative impact on native cutthroat trout (Koel, Bigelow, Doepke, Ertel, & Mahony, 2005; Quist & Hubert, 2004). Interactions with non-native trout species will likely influence declines in future cutthroat populations (Wenger et al., 2011). Various western states and the National Park System have worked to restore and protect cutthroat trout populations (CDOW, 2010; Dauwalter, Sanderson, Williams, & Sedell, 2011; MFWP, 2010; NMGF, 2010; UDWR, 2000; WGFC, 2010).

Game and Fish Departments in the western U.S. have recognized that management strategies for preserving the native cutthroat trout population must acknowledge that they are a popular sportfish (UDWR, 2000). One strategy suggested for preserving genetically pure cutthroat trout populations is to remove non-native competitors (UDWR, 2000). This strategy has been implemented in several ways in YNP where the U.S. Geological Survey

and National Park System have tried to remove lake trout from Yellowstone Lake in order to protect the Yellowstone cutthroat (Johnson, 2011; Koel et al., 2005).

Results indicated that anglers were willing to pay approximately $20 extra for fishing in riverine habitats where cutthroat trout were predominant, relative to a multi-species alternative. For any cost–benefit analysis of a preservation strategy, this would help value angler benefits.

The second policy issue, stream access, is related to the ownership of riparian lands and their streambeds. Private land ownership is interspersed with public lands and rivers flow between them. Interpretations of the public trust doctrine (Simmons, 2007; Stauffer, 2006) argue that the public has the right to the recreational use of surface waters, but access is not guaranteed with privately owned streambeds. Unless a boat can float over a streambed without touching it, anglers must obtain landowner permission and often pay a rod fee.[6]

Stream access laws may be seen as either a protection of, or hindrance to, the property rights of riparian landowners (Watson, 2009). Colorado and Montana, respectively, have the most restrictive and the most liberal stream access laws in the West (Watson, 2009). Montana's current law allows easier recreational access on privately owned streambeds, which may decrease riparian landowners' incentives to improve stream habitat on their property, reducing their ability to charge rod fees for a quality private fishing habitat. One view is Colorado's law provides greater protection of riparian property rights, resulting in higher landowner investments in fishing habitats and a superior angling experience. Recent legislative bills in Utah, Colorado, and Montana have considered the issue of recreational access on non-navigable streams flowing through privately held land versus the landowner's property rights and the incentives provided by secure property rights. Utah and Montana's bills restricted access, while Colorado's bill increased recreational access. Utah's bill passed; Colorado and Montana's bills were tabled.[7]

The results from this study show that anglers highly valued fishing access on private lands; marginal implicit prices range from $86 to $91. Possible explanations include: (a) improved fishing quality resulting from riparian property rights protection; and (b) an improved experience as compared to the degraded or overcrowded public lands (Mozumder et al., 2007).

This analysis extends previous research on the economics of fishing by using the hedonic pricing method to investigate the outfitter market for trout fishing access in the Rocky Mountain West. A wide range of characteristics were considered and marginal implicit prices estimated for characteristics of trout fishing trips in Montana, Wyoming, Colorado, and New Mexico. There was evidence that anglers value fishing for cutthroat trout as well as fishing quality indicators, such as trophy-size trout, blue ribbon streams, and private land fishing access. Obtaining price data from subsequent years would facilitate further research, such as considering public and private lands as distinct angling markets. This is an area of increasing interest as population growth will likely increase pressure on public land natural resources. Anglers appear to be willing to pay a premium for quality fishing experiences on private land that provide increased solitude or improved fishing habitat. Better understanding of access opportunities, markets, and regional implications for rural economies will be the focus of future research.

Notes

1. This is supported by informal interviews by the lead author with outfitters across all four states who estimated 70% to 95% of their clientele as non-residents.

2. Outfitters were identified through: (i) Google searches using angling key words; (ii) fishing enthusiast sites with outfitter lists such as Orvis, Trout Conservancy, Jackson Hole Fly Fishing Guides; (iii) chamber of commerce websites; and (iv) outfitter organizations.
3. These outfitters provided a combination of guide information, such as names, photos, and biographies that highlight their guides' love of fly fishing and fishing expertise.
4. Several alternate specifications were considered to test for robustness. One alternative removed the top and bottom 2.5% price points ($n = 1{,}618$). A second alternative used only day trips or shorter with no lodging ($n = 1{,}368$). Overall results were qualitatively quite similar.
5. Rivers include: the Jefferson, Kootenai, Madison (MT); the Snake, Green, Bighorn, Tongue (WY); the Yampa, South Platte, Arkansas, Gunnison, Roaring Fork, Animas, Dolores, Conejos, Cache La Poudre, Big Thompson (CO); the Cimarron, and Pecos (NM).
6. For rivers non-navigable by the federal definition, state law governs recreational access. In most western states, stream access laws allow the landowner control over the streambed.
7. In 2010 Utah restricted access to non-navigable water flowing through private land with House Bill (HB) 141 (Recreational access to Utah waters on private land, available at UDWR website, http://tinyurl.com/y8egz59, January 15 2011); Colorado's House of Representatives (HOR) passed HB1188 to improve commercial outfitter access only (Williams, D.O., Curry to float bill aimed at ending rafter-landowner rights disputes, available at The Colorado Independent (http://tinyurl.com/y8drjke), January 17, 2011). In 2011, Montana's HOR passed HB309, to restrict access on waterways that have water diverted into them (e.g., irrigation ditches).

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