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Visitors' Preferences for Freshwater Amenity Characteristics: Implications from the U.S. Household Survey

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We employed spectral analysis of completely ranked U.S. household survey data on freshwater recreation to understand visitors' preferences for freshwater amenity characteristics—closeness, water quality, wildlife, and size—and used rank-ordered and multinomial logit models to identify factors affecting their ranking choices. Spectral analysis of amenity characteristics reveals that closeness is the most preferred amenity characteristic and that the combination of closeness and size is the most preferred combination of amenity characteristics in freshwater recreation. Results from the rank-ordered and multinomial logit models suggest that amenity characteristics choices vary significantly among visitors based on their activity choices and socioeconomic and demographic characteristics.

Key words: complete ranking, outdoor recreation, rank-ordered model, multinomial logit model, site amenities, spectral analysis

Introduction

Socioeconomic and demographic characteristics are considered reliable predictors of demand for outdoor recreation participation (Ghimire et al., 2016; Paudel, Caffey, and Devkota, 2011). Amenity characteristics at a recreation site—such as water quality, wildlife, natural beauty, size, travel distance or closeness, etc.—are also believed to influence visitors' demand for outdoor recreation participation (De Valck et al., 2015; Dvarskas, 2007; Hanley, Bell, and Alvarez-Farizo, 2003; Murray, Sohngen, and Pendleton, 2001; Parsons, Massey, and Tomasi, 1999; Weber, Mozumder, and Berrens, 2012). Extensive studies have analyzed the importance of amenity characteristics on outdoor recreation participation (e.g., Acharya, Hatch, and Clonts, 2003; Adamowicz, Jennings, and Coyne, 1990; Cutter, Pendleton, and DeShazo, 2007; Eiswerth et al., 2000; Ghimire et al., 2016; Paudel, Caffey, and Devkota, 2011).

Heterogeneity in activity choices and socioeconomic and demographic characteristics may lead visitors to have different preferences for site amenity characteristics. For instance, some visitors may place more importance on water quality but less importance on wildlife, while other visitors may place more importance on wildlife and less importance on water quality. However, previous studies have not analyzed which site amenity characteristics are the most preferred and the factors determining these ranking choices. We analyze visitors' ranking of freshwater amenity

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characteristics to identify the most preferred site amenity characteristic in freshwater recreation and the factors affecting these ranking choices in the United States.

We use data from the National Survey on Recreation and the Environment (NSRE), which asked visitors to rank four site amenity characteristics—closeness (closeness of the site to your home), water quality (cleanliness of the water at the site), wildlife (number of fish, birds, or other wildlife at the site), and size (size, depth, and overall amount of water at the site)—from most to least important to them in relation to freshwater recreation (Interagency National Survey Consortium, USDA Forest Service, and Human Dimensions Research Laboratory, 2010). We use spectral analysis of completely ranked data to understand the most preferred site amenity characteristics in freshwater recreation. We also apply rank-ordered and multinomial logit models to infer the factors affecting those ranking choices.

Analyzing visitors' preferences for site amenity characteristics is relevant for multiple reasons. Each year, millions of people spend billions of dollars to participate in fresh water-based recreation activities in the United States. In 2011, a total of 33.1 million people went fishing and 71.8 million people went wildlife watching (e.g., observing, feeding, or photographing wildlife), spending $41.8 and $54.9 billion, respectively (U.S. Fish & Wildlife Service, 2011).[1] These numbers could increase if these bodies of water are managed with attention to the needs and expectations of user groups. Because of heterogeneity in activity choices and socioeconomic and demographic characteristics, freshwater resource managers might struggle to manage their limited resources to meet the needs and expectations of their user groups. For instance, a variety of recreation activities are possible in some bodies of water, but visitors who swim or fish may have different preferences for amenity characteristics from visitors who view wildlife or go boating. In this regard, this study could help natural resource managers better understand the needs and expectations of their user groups and manage amenity characteristics accordingly.

Literature Review

If a group of respondents ranks all available items in a survey, this is referred to as "complete ranking" or "full ranking." These types of preference-ranking data are often coded as consecutive integers from one to the number of categories reflecting their degree of preference, but the integer does not indicate their distance. There are several approaches to analyzing the rank-ordered preferences, including a distance-based model (Critchlow, 1985; Mallows, 1957), a multi-stage ranking model (Benter, 1994),[2] a completely randomized factorial design (an extension of the Kruskal-Wallis ranks test that allows interaction effects and linear contrasts to be calculated, Scheirer, Ray, and Hare, 1976), and a Markov Chain Monte Carlo technique (Eriksson, 2006). While these methods are computationally efficient for analyzing rank-ordered preferences, they are difficult to conceptualize in different dimensions (Paudel, Pandit, and Dunn, 2013). Thompson (1993) employed a generalized permutation polytopes and exploratory graphical method, which is extremely efficient for analyzing a small sample but ineffective for a large sample (Kidwell, Lebanon, and Cleveland, 2008). To overcome this problem, Kidwell, Lebanon, and Cleveland (2008) extended permutation polytopes for visualizing rank-ordered data for large samples in way that is both easy to conceptualize and computationally efficient. Gormley and Murphy (2008, 2010) developed a mixture model for rank-ordered data using clusters of homogeneous groups to identify the preference-ranking pattern. Lee and Yu (2010) developed a distance-based tree model to

[1] In 2011, 37.4 million people went fishing and/or hunting, including 33.1 million people who fished, 13.7 million people who hunted and 9.4 million people who fished and hunted. These recreationists spent a total of $89.8 billion, of which $41.8 billion was spent on fishing, $33.7 billion on hunting, and $14.3 billion on activities such as membership dues, contributions, land leasing and ownership, and licenses, stamps, tags, and permits (U.S. Fish & Wildlife Service, 2011).

[2] See Marden (1996) and Greene and Hensher (2010) for details on many rank-ordered analysis methods used in the literature.

analyze ranked preferences that relaxes the assumption of a homogeneous population and effectively incorporates covariates (Paudel, Pandit, and Dunn, 2013).

In economics, rank-ordered data are analyzed using ordered probit or exploded logit methods (Chapman and Staelin, 1982; McFadden, 1974a,b; Paudel et al., 2007). Despite the fact that spectral decomposition is very useful for analyzing fully ranked preference data, its application to economic analysis and natural resource management is relatively new and very limited. For instance, Lawson and Orrison (2002) employed generalized spectral analysis to detect the hidden coalition in the voting of nine judges of the U.S. Supreme Court. Likewise, Pedrotti, Rensi, and Zaninotto (2006) used these methods to analyze individuals' preferences for cars in Italy. Most recently, Paudel, Pandit, and Dunn (2013) employed generalized spectral decomposition methods to identify the most preferred choice of termite control treatments among households in Louisiana and supplemented the information using an inference-based multinomial logit analysis. Like these authors, we use first and second-order spectral analysis to identify the most preferred site amenity characteristics. Like Paudel, Pandit, and Dunn (2013), we supplement this information with inference-based rank-ordered and multinomial logit analyses.

Method

Spectral Analysis

Spectral analysis is similar to classical two-way analysis of variance (ANOVA), and ANOVA is a special case of spectral analysis (Diaconis, 1988, p. 153). However, unlike ANOVA, generalized spectral analysis considers the order of preference or ranking and captures natural symmetries that are generally hidden in the existence of a symmetric group (Pedrotti, Rensi, and Zaninotto, 2006). Stated differently, generalized spectral analysis is used to decompose data on order preference into first- and second-order effects (Diaconis, 1989). The first-order effect measures the average attraction that a single feature has when coupled with a second feature, while the second-order effect detects the positive (or negative) power of combination of two coupled attributes (Pedrotti, Rensi, and Zaninotto, 2006).[3]

Suppose there are $k = 1, \ldots, K$ site amenity characteristics that $i = 1, \ldots, N$ visitors are asked to rank. Let $y_i(k) \in \{1, \ldots, K\}$ denote the ranking that visitor i gives to the kth characteristic. For example, if $y_i(k) = 1$, then the visitor most prefers alternative k. This type of rank-ordered data can be represented as permutations. In fact, a permutation, y, is a bijective function: $y : \{1, \ldots, K\} \rightarrow \{1, \ldots, K\}$ associated with each item $k \in \{1, \ldots, K\}$ and rank $y(k) \in \{1, \ldots, K\}$ (Critchlow, 1985).

When K items are ranked, the permutation of the number of items provides the sample size of the data for complete ranking (Paudel, Pandit, and Dunn, 2013). Since $K = 4$ characteristics were provided to visitors for ranking, there will be 4! (=24) complete ranking combinations. Table 1 shows possible ranking patterns (twenty-four different combinations indexed by $j = 1, \ldots, 24$) and the number of visitors choosing these ranking patterns. A visitor's choice problem can be regarded as selecting one of the twenty-four available ranking combinations. Let z_{ij} be a binary variable equal to 1 if visitor i selects ranking combination j and 0 otherwise. The number of visitors selecting combination j is then $N_k = \sum_{i=1}^{N} z_{ij}$, which are the values in the last column of table 1. See Appendix A for details on decomposition and Appendices B and C for details on computation of the first- and second-order analyses. Further details on the use of rank-ordered data analysis using spectral analysis can be found in Diaconis (1988, 1989), Paudel, Pandit, and Dunn (2013), and Pedrotti, Rensi, and Zaninotto (2006).

Although spectral analysis is very useful for understanding the ranking of freshwater amenity characteristics, it doesn't reveal how visitors' activity choices and socioeconomic and demographic

[3] Positive power means that two characteristics interact positively, resulting in positive values, and negative power means that two characteristics interact oppositely, resulting in negative values.

Table 1. Visitors' Preference for Freshwater Amenity Characteristics, Complete Ranking

	Rank				Respondents	
Combinations	**1**	**2**	**3**	**4**	**Frequency**	**Percentage**
1	1	2	3	4	108	13.45
2	1	2	4	3	69	8.59
3	1	3	2	4	64	7.97
4	1	3	4	2	34	4.23
5	1	4	2	3	33	4.11
6	1	4	3	2	16	1.99
7	2	1	3	4	74	9.22
8	2	1	4	3	41	5.11
9	2	3	1	4	72	8.97
10	2	3	4	1	29	3.61
11	2	4	1	3	18	2.24
12	2	4	3	1	16	1.99
13	3	1	2	4	73	9.09
14	3	1	4	2	14	1.74
15	3	2	1	4	50	6.23
16	3	2	4	1	32	3.99
17	3	4	1	2	5	0.62
18	3	4	2	1	14	1.74
19	4	1	2	3	11	1.37
20	4	1	3	2	5	0.62
21	4	2	1	3	8	1.00
22	4	2	3	1	10	1.25
23	4	3	1	2	1	0.12
24	4	3	2	1	6	0.75
Total					803	100

Notes: 1 – closeness, 2 – water quality, 3 – wildlife, 4 – size.

characteristics affect these ranking patterns. We use rank-ordered and multinomial logit models to analyze the determinants of these ranking patterns.

Rank-Ordered and Multinomial Logit Models

The basic analytical framework for the rank-ordered and multinomial logit models comes from the random utility model. The random utilities for individual i are a set of latent variables, $U_{i1}, \ldots, U_{iJ}$, defined as

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \tag{1}$$

where $i = 1, \ldots, N$ indexes individuals and $j = 1, \ldots, J$ indexes alternatives. In our case, the alternatives to be evaluated are the $J = 24$ ranking combinations of amenity characteristics in table 1. Equation (4) consists of two parts: V_{ij} is the deterministic component of the utility and ε_{ij} is the random component, which represents the researcher's ignorance about the consumer utility function. The deterministic part of the utility is modeled as

$$V_{ij} = \boldsymbol{x}_i' \boldsymbol{\beta}_j, \tag{2}$$

where $\boldsymbol{x}_i$ is an m-dimensional vector of individual i's socioeconomic and demographic characteristics and $\boldsymbol{\beta}_j$ is an m-dimensional parameter vector specific to alternative j (Van Dijk, Fok, and Paap, 2007).

In the rank-ordered setup, respondents are asked to rank items (under the assumption of complete ranking) rather than select their most preferred option. Here, respondents rank the $K = 4$ site characteristics. Recalling that $y_i(k)$ denotes the rank that individual i gives to characteristic k, let the vector $\boldsymbol{y}_i = [y_i(1), \ldots, y_i(K)]'$ denote the full ranking of individual i. For notational convenience, let us use the equivalent notation $\boldsymbol{r}_i = [r_{i1}, \ldots, r_{iK}]'$, where r_{ik} denotes the characteristic number that received rank k from individual i. The relation between $y_i(k)$ and r_{ik} is given by

(3) $$y_i(k) = k' \Rightarrow r_{ik'} = k$$

for $k, ' = 1, \ldots, K$.

An individual prefers an amenity characteristic with a higher utility over an amenity characteristic with a lower utility. If we observe a full ranking, then

(4) $$U_{ir_{i1}} > U_{ir_{i2}} > \ldots > U_{ir_{iK}}.$$

Under utility assumption (4) and the assumption of the type I extreme value distribution of the random component (ε) in equation (4), we obtain the rank-ordered logit model (Beggs, Cardell, and Hausman, 1981; Van Dijk, Fok, and Paap, 2007), where the probability of observing a particular ranking $\boldsymbol{r}_i$ is equal to

(5) $$Pr[r_{1;}\beta] = Pr[U_{ir_{i1}} > U_{ir_{i2}} > \ldots, > U_{ir_{iK}}] = \prod_{k=1}^{K-1} \frac{\exp(V_{ir_{ik}})}{\sum_{l=k}^{K} \exp(V_{ir_{il}})}.$$

In the multinomial setup, respondents are asked to choose their most preferred option out of the complete set of J alternatives. Hence, the choice set includes 4! = 24 combinations. Recalling that $z_{ij} = 1$ indicates that respondent i chose ranking combination j, the utility of alternative j for respondent i is larger than all other alternatives; that is,

(6) $$U_{ij} \geq \max\{U_{i1}, \ldots, U_{iJ}\}.$$

Under utility assumption (4) and the assumption of the type I extreme value distribution of the random component (ε) in equation (4), we have a setup of a multinomial logit model (see McFadden, 1974a,b), where the probability of individual i selecting alternative j is given by

(7) $$Pr[y_{ij} = 1; \boldsymbol{\beta}] = Pr[U_{ij} \geq \max\{U_{i1}, \ldots, U_{iJ}\}] = \frac{\exp(V_{ij})}{\sum_{l=1}^{J} \exp(V_{il})},$$

where $\boldsymbol{\beta} = \{\beta_1, \ldots, \beta_J\}$ and β_J is kept equal to 0 for identification (Van Dijk, Fok, and Paap, 2007).

In both multinomial and rank-ordered logit models, the vector of regressors includes indicator variables for freshwater recreation participation (swimming, boating, fishing, viewing, and picnicking) and socioeconomic and demographic characteristics (age, gender, income, education, ethnicity, residency location, number of family members under sixteen years in a household, and number of freshwater trips made by visitor) as suggested by the outdoor recreation participation literature (Floyd, 1998; Kelly, 1996; Payne, Mowen, and Orsega-Smith, 2002; Scott and Jackson, 1996; Scott and Munson, 1994). The residency location vector also includes region fixed effects to account for the differences in climate, topography, culture, and outdoor recreation resources across geographic regions that could affect visitors' preferences for site amenity characterisitcs (Ghimire et al., 2014b).[4] Stata 13.1 was used to estimate the coefficients of the rank-ordered and multinomial logit models and Mathematica to estimate the spectral analysis model.

[4] The region fixed effects include a set of indicator variables to control for urban residency and geographic location of respondents. The geographic classification is based on the USDA Forest Service RPA map (http://www.fs.fed.us/research/rpa/regions.php). The regions are *North* (CT, DC, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WI, and WV), *Pacific* (AK, CA, HI, OR, and WA), *Rocky Mountain* (AZ, CO, ID, KS, MT, NV, NM, ND, NE, SD, UT, and WY), and *South* (AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA).

Data and Hypotheses

This study uses outdoor recreation participation data from the 2010 NSRE (Interagency National Survey Consortium, USDA Forest Service, and Human Dimensions Research Laboratory, 2010). The NSRE is a long-term data collection project of the U.S. Forest Service, Southern Research Station, and is conducted periodically to collect information on a number of outdoor recreation and environmental topics, including outdoor recreation participation, environmental attitudes, natural resources values, attitudes toward natural resource management policies, and demographic and lifestyle characteristics of households. Using a computer-assisted telephone interviewing (CATI) system, the NSRE conducts a random-digit-dialed telephone survey of approximately 5,000 people age sixteen years or older, living in U.S. households (it does not collect responses from people in retirement facilities, hospitals, or military camps).[5] The CATI system randomly selects a telephone number; the interviewer, upon hearing someone answer, inquires how many people in the household are sixteen years or older. The person with the most recent birthday is selected for interviewing (Link and Oldendick, 1998; Oldendick et al., 1988)

In addition to questions about outdoor recreation participation, the 2010 NSRE included a freshwater recreation module, which asked people who indicated that they had participated in freshwater recreation in the past twelve months to rank four amenity characterisitcs—closeness, water quality, wildlife, and size—from most to least important while participating in these recreation activities (Interagency National Survey Consortium, USDA Forest Service, and Human Dimensions Research Laboratory, 2010).[6] In the survey, 803 respondents indicated that they had participated in five types of freshwater recreation activities—swimming, boating, fishing, viewing, and/or picnicking—during the past twelve months; Respondents were also asked to rank these amenity characteristics. Based on their activity participation, we create binary indicator variables to represent participation in the five activities. The survey also collected socioeconomic and demographic characteristics (age, gender, income, education, ethnicity, residency location, and number of family members under sixteen in a household) and the number of freshwater trips made by the respondents who ranked these amenity characterisitcs. Because of missing values in one covariate or the other, a total of 644 observations were used in the rank-ordered and multinominal logit analyses. Since visitors were asked to rank four amenity characteristics (closeness, water quality, wildlife, and size), there are four regression equations in the rank-ordered analysis and a number of regression equations based on the ranking patterns associated with the four choices in the multinominal analysis. Table 2 provides brief descriptions and summary statistics of the variables used.

Some recreation activities require a greater use of certain amenity characteristics compared to other activities. Accordingly, we expect a certain relationship between visitors' ranking of freshwater amenity characteristics and activity choices. For instance, swimming requires greater contact with water compared to fishing or viewing and, accordingly, swimmers are expected to place greater importance on water quality. Hence, we expect to find that the *Swimming* variable contributes positively to the probability that water quality is ranked highly. But swimmers in general do not want to swim in bodies of water where large fish, alligators, or other reptiles are found, so Swimming is expected to decrease the probability that wildlife will be a highly ranked characterstic. Similarly, boating may partly depend on water body size, so *Boating* is expected to increase the probability that size will be a highly ranked characteristic. The number of fish, birds, or other wildlife at the site could be an important amenity for fishers or nature viewers, so the *Viewing* is

[5] Each version of the survey consists of modules of questions and each version is tested to ensure an average time of fifteen minutes to complete. The survey employs a stratified random sample based on urban/rural/near-urban geographic locations. Each version surveys approximately 5,000 people, but some over-sampling is done to ensure a minimum sample size of 500 per state (across all versions) or for some modules that focus on rural outdoor recreation use (e.g., over-sampling people living in rural areas). The U.S. Department of Commerce, Bureau of the Census, and 2000 Census data are used to construct post-sample weights. Both English and Spanish versions of the questionnaires are used and interviews are conducted bilingually to overcome language barriers. The NSRE survey can be found at http://www.srs.fs.usda.gov/trends/nsre-directory/index.html.

[6] See Appendix D for the freshwater amenity characteristics ranking question asked in the survey.

Table 2. Description and Summary Statistics of Variables

Variable	Description	Mean	Min.	Max.
Freshwater amenity characteristics (N = 803)[a]				
Closeness	Importance placed on closeness of recreation site	2.05	1	4
Water quality	Importance placed on water quality at the recreation site	2.12	1	4
Size	Importance placed on size of recreation site	2.50	1	4
Wildlife	Importance placed on wildlife at the recreation site	3.32	1	4
Freshwater-based recreation (N = 644)				
Swimming	A binary indicator variable that equals 1 if respondent participated in outdoor swimming over the last twelve months and 0 otherwise	0.65	0	1
Boating	A binary indicator variable that equals 1 if respondent participated in boating over the last twelve months and 0 otherwise	0.63	0	1
Fishing	A binary indicator variable that equals 1 if respondent participated in fishing over the last twelve months and 0 otherwise	0.58	0	1
Viewing	A binary indicator variable that equals 1 if respondent participated in bird/nature viewing over the last twelve months and 0 otherwise	0.57	0	1
Picnicking	A binary indicator variable that equals 1 if the respondent participated in picnicking over the last twelve months and 0 otherwise	0.74	0	1
Respondents' characteristics (N = 644)				
Age	Age of respondent, in years	49	16	90
Female	A binary indicator variable that equals 1 if respondent was female, and 0 otherwise	0.46	0	1
Income $\geq$ 50,000	A binary indicator variable that equals 1 if annual household income was greater or equal to $50,000 and 0 otherwise	0.68	0	1
College degree	A binary indicator variable that equals 1 if respondent had a four-year college or higher degree and 0 otherwise	0.48	0	1
White	A binary indicator variable that equals 1 if respondent was white and 0 otherwise	0.91	0	1
No. of trips	Number of freshwater-based trips made by respondent over the last twelve months	9	1	200
Members under 16	Number of household members under the age of sixteen	0.89	0	6
Residency location (N = 644)				
Urban	A binary indicator variable that equals 1 if the respondent was from an urban area and 0 otherwise	0.78	0	1
South	A binary indicator variable that equals 1 if respondent was from the Southern region and 0 otherwise	0.27	0	1
North	A binary indicator variable that equals one if respondent was from the Northern region,and 0 otherwise1	0.43	0	1
Pacific	A binary indicator variable that equals 1 if respondent was from the Pacific region and 0 otherwise	0.16	0	1
Rocky Mountain	A binary indicator variable that equals 1 if respondent was from the Rocky Mountain region and 0 otherwise	0.14	0	1

Notes: [a] Importance placed on the freshwater amenity characteristics was measured on a scale of 1 to 4, with 1 being "most important" and 4 being "least important."

expected to contribute positively to the probability that wildlife will be a highly ranked characterstic. Closeness may be important for various recreation activities, as it is often associated with travel costs. However, literature on outdoor recreation participation and site selection is unclear about which of the freshwater recreation activities place greatest importance on closeness.

We expect socioeconomic and demographic controls to have different signs based on amenity characteristic ranking. For instance, closeness could be important for many people, but it could

Table 3. Percentage of Respondents Ranking Amenity Characteristics *k* in Position *y*

Freshwater Amenity	Rank			
Characteristics (N = 803)	**1**	**2**	**3**	**4**
Closeness	41	27	19	13
Water quality	31	35	25	9
Wildlife	23	25	29	23
Size	5	13	27	55

Table 4. First-Order Effects, Complete Ranking

Freshwater Amenity	Rank			
Characteristics (N = 803)	**1**	**2**	**3**	**4**
Closeness	123	17	-47	-94
Water quality	49	76	0	-126
Wildlife	-13	5	28	-21
Size	-158	-99	18	240

be more important for older people and people with children because of economic or physical constraints. Accordingly, we expect that the variables *Age* and *Members under 16* will contribute positively to the probability that closeness will be highly ranked. As females and people with higher incomes or education levels tend to be pro-environment on many issues (Stern, Dietz, and Kalof, 1993; Straughan and Roberts, 1999), we expect the variables *Female*, *Income* $\geq$ *50,000*, and *College Degree* to increase the probability that water quality will be highly ranked. Because of a psychological fear of wild animals (Agee, 2008; Røskaft et al., 2003), we expect that older people, females, and people with little children will tend to place less importance on wildlife. Accordingly, we expect the variables *Age*, *Female*, and *Members under 16* to contribute negatively to the probability that wildlife will be highly ranked. People with higher incomes are expected to place importance on wildlife, as higher income tends to allow participation in wildlife-related adventures, which are often costly (Poudyal, Cho, and Bowker, 2008). Hence, the variable *Income* $\geq$ *50,000* is expected to increase the probability that wildlife will be highly ranked. Anecdotally, we expect people with children to place importance on size, as they tend to require bigger sites for safety reasons, to have space to themselves, and to get their members engaged in activities. Accordingly, the variable *Members under 16* is expected to contribute positively to the probability that size will be highly ranked.

Results

Results from Spectral Analysis

Table 3 shows the percentage of respondents ranking characteristic *k* in position *y*. The largest percentage of respondents (40.4%) selected closeness as their first choice; 34.5% of respondents voted water quality as their second choice, 28.5% voted wildlife as their third choice, and 55% voted size as their fourth choice in freshwater recreation. Results of the first-order spectral analysis are summarized in table 4. The first-order analysis shows the importance placed by visitors on a single characteristic. The table has an entry *k*, *y*, the number of respondents ranking choice *k* in position *y* minus the sample size over four, so rows and columns sum to zero. The entries are rounded to integers and the table is based on counts, not on proportions. Table 4 is an affine function of table 1 and it thus has the same structure as table 1. The largest numbers in the first and second columns (123 and 76) indicate that respondents chose closeness as the most perferred and water quality as the second preferred amenity characteristics in freshwater recreation. Size is ranked as the least preferred amenity characteristic.

Table 5. Second-Order, Unordered Effects

Freshwater Amenity Characteristics (N = 803)	Rank 1,2	1,3	1,4	2,3	2,4	3,4
{Closeness, water quality}	−10	11	−1	−1	11	−10
{Water quality, wildlife}	25	−10	−15	−15	−10	25
{Water quality, size}	−15	−1	16	16	−1	−15
{Closeness, wildlife}	−15	−1	16	16	−1	−15
{Closeness, size}	25	−10	−15	−15	−10	25
{Wildlife, size}	−10	11	−1	−1	11	−10

Notes: Freshwater amenity characteristics are analyzed in combination. For example, closeness, size indicates how these two characteristics are ranked in combination. {1,2} under rank indicates first and second ranking. The highest value under the rank in column {1,2} indicates that the two characteristics are preferred in first and second place in combination based on the second-order unordered effects. These values are obtained from inner products of characteristics and rankings.

Table 5 summarizes the results of the second-order analysis.[7] The second-order analysis shows the importance (score) visitors placed on a combination of two choice options at a time. The analysis identified six distinct combinations (unordered pairs) of amenity characteristics that respondents could rank. Geometrically, the function projects to thirty-six points in a four-dimensional space. That is, there are only four independent values in the table consisting of thirty-six entries. It is relatively straightforward to interpret the second-order unordered effects when there are more choices (greater than four, see Diaconis, 1989). Because of the four choice options in the second-order decomposition, there are some equal values in table 5 (for example see values associated with {1,2} and {3,4} are −11).[8] The entries in the table are rounded to integers. Two choice options—water quality, wildlife} and {closeness, size}—have the largest value (25) in the first column, indicating a substantial effect for ranking these choice options in position {first, second}.[9] For choice options pairs {closeness, wildlife}, {water quality, size}, {wildlife, size}, and {water quality, closeness}, there is an opposite effect: each visitor likes both or dislikes both choice options because the row entry begins and ends with the same value (Diaconis, 1989).

Two choice options—closeness, size} and {water quality, wildlife}—have the largest value in the first column in table 5. However, the first-order analysis (table 4) indicates that closeness is the most prefereed amenity characterisitc in freshwater recreation. Hence, based on the largest value of the closeness option in the first-order analysis, it can be inferred that the combination of closeness and size is the most prefered combination of amenity characterisitics in freshwater recreation. It is worth nothing that the first-order analysis alone would not have given this insight, as size itself was a low-ranked characteristic in table 4.

Results from the Rank-Ordered Logit Model

Table 6 summarizes the findings of the rank-ordered logit model. The table shows the estimated coefficients of the rank-ordered logit regression equations, as shown by the column headings.[10] The regression equations are statistically significant, as indicated by the log likelihood and likelihood ratio chi-squared statistics. The decision criterion for hypothesis testing is based on $p < 0.10$.

All of the activity variables have explanatory power for the ranking of different attributes, as expected. The variables *Swimming* and *Boating* both increase the probability that water quality is ranked first. *Boating* also has a positive impact on the probability that size is ranked first and a

[7] See Paudel, Pandit, and Dunn (2013) or Diaconis (1989) for the calculation details.

[8] When there are less than five amenity characteristics from which to choose, one observes the row symmetry as shown in table 5 (see Paudel, Pandit, and Dunn, 2013; Diaconis, 1989).

[9] Substantial effect means the inner products of choice options {water quality, wildlife} and {closeness, size} in position 1 and 2, i.e., {1,2} are high. The higher the positive value, the more are these two choice options preferred in that particular ranking set.

[10] To ease interpretation of the regression results, we reversed the order of preferences with 1 indicating least important and 4 indicating most important.

Table 6. Freshwater Amenity Characteristics, Freshwater-Based Recreation Activities, and Socioeconomic/Demographic Characteristics (Rank-Ordered Logit Estimates) (N=644)

	Freshwater Amenity Characteristics			
	Closeness	**Water Quality**	**Wildlife**	**Size**
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Swimming	−0.082	0.289***	−0.044	−0.200
	(0.100)	(0.102)	(0.107)	(0.138)
Boating	−0.132	0.144*	−0.196*	0.318**
	(0.104)	(0.090)	(0.111)	(0.143)
Fishing	−0.115	−0.145	0.580***	−0.545***
	(0.100)	(0.096)	(0.101)	(0.133)
Viewing	−0.282***	0.148	0.399***	−0.333***
	(0.093)	(0.092)	(0.097)	(0.127)
Picnicking	0.152	0.134	0.112	−0.357**
	(0.104)	(0.100)	(0.108)	(0.138)
Age	0.008**	−0.000	−0.008*	−0.002
	(0.004)	(0.004)	(0.004)	(0.005)
Female	0.049	0.151*	−0.188**	−0.050
	(0.095)	(0.091)	(0.096)	(0.129)
Income $\geq$ 50,000	0.034	0.126	0.278***	−0.548***
	(0.103)	(0.102)	(0.106)	(0.156)
College degree	0.217**	−0.148	−0.069	0.003
	(0.095)	(0.094)	(0.098)	(0.132)
White	0.420**	0.137	0.097	−0.551**
	(0.175)	(0.173)	(0.180)	(0.215)
No. of trips	−0.001	0.004	−0.005	0.001
	(0.003)	(0.003)	(0.003)	(0.004)
Members under 16	0.115***	0.014	−0.168***	0.089*
	(0.041)	(0.041)	(0.045)	(0.054)
Urban	−0.255***	−0.012	0.022	0.234***
	(0.056)	(0.055)	(0.058)	(0.085)
South	−0.046	0.183*	−0.094	−0.007
	(0.105)	(0.103)	(0.113)	(0.142)
Pacific	0.060	0.024	0.032	−0.235
	(0.125)	(0.125)	(0.132)	(0.178)
Rocky Mountain	−0.294**	0.237*	0.237	−0.040
	(0.146)	(0.143)	(0.147)	(0.199)
Log likelihood	−1,046.66	−1,042.15	−1,010.70	−749.54
LR chi^2	60.45	32.56	93.78	65.87
Prob. > chi^2	0.00	0.00	0.00	0.00

Notes: Rank-ordered logit estimates. Dependent variable is the probability that each of the amenity charactersitics indicated by column headings is ranked first. Standard errors are shown in parentheses. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.

negative impact on the probability that wildlife is ranked first. *Fishing* has a positive impact on the probability that wildlife is ranked first but a negative impact on the probability that size is ranked first. *Viewing* increases the probability that wildlife is ranked first but decreases the probability that closeness and size are ranked first. Finally, *Picnicking* has a negative impact on the probability that size is ranked first.

Regarding controls, the variables *Age*, *College Degree*, *White*, and *Members under 16* are all positive and significant to explain the probability that closeness is ranked first (column 1). *Female* is positive and significant to explain the probability that water quality is ranked first (column 2). The variables *Age*, *Female*, and *Members under 16* are all negative and significant to explain the porbability that wildlife is ranked first, but *Income* $\geq$ *50,000* is positive and significant to explain the probability that wildlife is ranked first (column 3). The variables *Income* $\geq$ *50,000* and *White* are negative and significant, but the variable *Members under 16* is positive and significant to explain the probability that size is ranked first (column 4). Regarding residency location, the variable *Urban* is negative and significant to explain the probability that closeness is ranked first (column 1), but it is positive and significant to explain the probability that size is ranked first (column 4). The *Rocky Mountain* variable is negative and significant to explain the probability that closeness is ranked first (column 1), but it is positive and significant to explain the probability that water quality is ranked first (column 2).

Results from the Multinomial Logit Model

As indicated in table 1, there are twenty-four possible ranking patterns associated with the four choices. Since not all ranking patterns occurred with the same frequency, we chose ten categories of the ranking patterns with greater than 4% frequency, per Paudel, Pandit, and Dunn (2013). Categories with less than 4% frequency were merged and labeled “Other Categories.” As we are interested in analyzing the determinants of the most perfered site amenity characteristics (e.g., ranking patterns with closeness as the first choice), we choose 3 > 1 > 2 > 4 (wildlife > closeness > water quality > size) as the base category.[11] Before reporting the findings, we tested for the independence of irrelevant alternative (IIA). The Hausman test indicated we could not reject the null hypothesis; hence the IIA assumption held.[12] Table 7 reports the multinomial logit coefficients and relative risk ratios (odds ratios) (see Appendix E for the marginal effects).[13] Coefficient significance held in most cases between the multinomial logit coefficients and relative risk ratios, although the same was not true for marginal effects.[14] In what follows we base our interpretations on the relative risk ratios.

Results indicate that visitors who participate in swimming are more likely by a factor of between 1.5 and 1.6 to choose categories 1 > 2 > 3 > 4, 2 > 1 > 3 > 4, 2 > 3 > 1 > 4, 1 > 2 > 4 > 3, and 3 > 2 > 1 > 4 compared to the base category (3 > 1 > 2 > 4). Hence, visitors who participate in swimming are, in general, more likely to choose {closeness, water quality} and {water quality, wildlife}.

Visitors who participate in boating are more likely by a factor of between 1.6 and 2.6 to choose categories 2 > 3 > 1 > 4, 1 > 2 > 4 > 3, and 2 > 1 > 4 > 3 but less likely by a factor of 0.6 to choose category 1 > 3 > 2 > 4 compared to the base category. Hence, visitors who participate in boating, in general, are more likely to choose {water quality, wildlife} and {closeness, water quality}, but they are less likely to choose {closeness, wildlife}.

The table also indicates that visitors who participate in fishing are less likely by a factor of between 0.1 and 0.4 to choose categories 1 > 2 > 3 > 4, 2 > 1 > 3 > 4, 2 > 3 > 1 > 4, 1 > 2 > 4 > 3, 1 > 3 > 2 > 4, 2 > 1 > 4 > 3, 1 > 4 > 2 > 3, and Other Categories compared to the base category. Hence, visitors who participate in fishing are, in general, less likely to choose {closeness, water quality}, {water quality, wildlife}, {closeness, wildlife}, and {closeness, size}.

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[11] However, results are identical when we use other combinations of less-preferred amenity characteristics (e.g., 3 > 2 > 1 > 4). The combination 3 > 2 > 1 > 4 (wildlife, water quality, closeness, size) indicates an individual who ranked wildlife first, water quality second, closeness third, and size fourth.

[12] The IIA assumption states that by removing any categories from the choice set, the probability of ranking the remaining categories stays unchanged.

[13] The ratio of the probability of choosing one outcome category over the probability of choosing the baseline category is referred to as relative risk or odds. Relative risk can be obtained by exponentiation of the linear equations, yielding regression coefficients that are relative risk ratios for a unit change in predictor variable. The relative risk ratio is always a positive value by construction but measures a decrease in the relative risk when the coefficient is negative (Bruin, 2006).

[14] To interpret the multinomial logit results, Powers and Xie (2000) recommend using the odd ratios since the marginals may not have the same sign as the coefficients.

Table 7. Freshwater Amenity Characteristics, Freshwater-Based Recreation Activities, and Socioeconomic/Demographic Characteristics (Multinomial Logit Estimates) (Base Category: 3 > 1 > 2 > 4)

	1 > 2 > 3 > 4		2 > 1 > 3 > 4		2 > 3 > 1 > 4	
	Coeff.	**RR**	**Coeff.**	**RR**	**Coeff.**	**RR**
Variables	**(1)**	**(1)**	**(2)**	**(2)**	**(3)**	**(3)**
Swimming	0.486**	1.626**	0.510**	1.665**	0.468**	1.597**
	(0.206)	(0.335)	(0.226)	(0.377)	(0.225)	(0.360)
Boating	0.104	1.110	−0.129	0.879	0.471**	1.601**
	(0.210)	(0.233)	(0.228)	(0.200)	(0.232)	(0.372)
Fishing	−1.034***	0.356***	−0.830**	0.436***	−0.731***	0.482***
	(0.209)	(0.074)	(0.225)	(0.098)	(0.227)	(0.109)
Viewing	−0.963***	0.382***	−0.040	0.961	−0.893***	0.410***
	(0.195)	(0.074)	(0.222)	(0.213)	(0.208)	(0.085)
Picnicking	0.381*	1.464***	0.210	1.234	0.092	1.096
	(0.208)	(0.304)	(0.230)	(0.284)	(0.221)	(0.242)
Age	−0.002	0.998	−0.000	1.000	−0.024***	0.977***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.007)
Female	0.156	1.169	0.230	1.259	0.133	1.142
	(0.185)	(0.216)	(0.203)	(0.256)	(0.200)	(0.228)
Income $\geq$ 50,000	0.171	1.187	0.603***	1.827***	0.803***	2.232***
	(0.210)	(0.249)	(0.223)	(0.407)	(0.218)	(0.487)
College degree	−0.145	0.865	0.128	1.136	0.180	1.198
	(0.187)	(0.162)	(0.207)	(0.235)	(0.204)	(0.244)
White	0.778**	2.177**	0.247	1.280	0.181	1.199
	(0.408)	(0.889)	(0.385)	(0.492)	(0.372)	(0.446)
No. of trips	−0.015***	0.985***	−0.005	0.995	−0.016***	0.984***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)
Members under 16	0.227**	1.255**	0.324***	1.383***	0.097	1.101
	(0.093)	(0.116)	(0.098)	(0.136)	(0.098)	(0.108)
Urban	−0.182*	0.834***	0.079	1.082	0.117	1.124
	(0.099)	(0.083)	(0.114)	(0.123)	(0.116)	(0.130)
South	0.519**	1.680**	0.393*	1.481*	0.388	1.474
	(0.214)	(0.360)	(0.240)	(0.356)	(0.243)	(0.357)
Pacific	−0.159	0.853	0.149	1.161	0.608**	1.837**
	(0.259)	(0.221)	(0.270)	(0.313)	(0.260)	(0.477)
Rocky Mountain	−0.213	0.808	0.372	1.451	0.578*	1.782*
	(0.301)	(0.243)	(0.313)	(0.454)	(0.303)	(0.540)
Constant	0.706	2.026	−0.984	0.374	0.476	1.609
	(0.671)	(1.359)	(0.722)	(0.270)	(0.690)	(1.111)
N	103		69		65	

Notes: Multinominal logit estimates (log likelihood = $-5,142.42$, LR chi^2 = 827.17, and prob. > chi^2 = 0.00). Dependent variable is the probability of observing a particular ranking patterns, as indicated by column headings (1 – closeness, 2 – water quality, 3 – wildlife, 4 – size). Standard errors are in parentheses. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level. Coeff. and RR stand for multinomial logit regressions coefficients and relative risk ratio, respectively.

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Table 7 (continued). Freshwater Amenity Characteristics, Freshwater-Based Recreation Activities, and Socioeconomic/Demographic Characteristics (Multinomial Logit Estimates) (Base Category: 3 > 1 > 2 > 4)

	1 > 2 > 4 >3		1 > 3 > 2 > 4		3 > 2 > 1 > 4	
	Coeff.	**RR**	**Coeff.**	**RR**	**Coeff.**	**RR**
Variables	**(4)**	**(4)**	**(5)**	**(5)**	**(6)**	**(6)**
Swimming	0.406*	1.500*	0.020	1.020	0.468*	1.597*
	(0.236)	(0.354)	(0.230)	(0.235)	(0.258)	(0.412)
Boating	0.570**	1.768**	−0.437*	0.646*	−0.061	0.941
	(0.240)	(0.424)	(0.240)	(0.155)	(0.261)	(0.245)
Fishing	−1.446***	0.236***	−0.400*	0.670*	0.254	1.289
	(0.232)	(0.055)	(0.242)	(0.162)	(0.277)	(0.357)
Viewing	−1.157***	0.314***	−0.629**	0.533***	0.097	1.102
	(0.220)	(0.069)	(0.224)	(0.120)	(0.254)	(0.280)
Picnicking	0.070	1.072	0.205	1.228	0.452*	1.571*
	(0.233)	(0.250)	(0.241)	(0.296)	(0.269)	(0.422)
Age	0.009	1.009	−0.022**	0.978***	0.009	1.009
	(0.008)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
Female	0.179	1.196	0.389*	1.475*	−0.327	0.721
	(0.212)	(0.253)	(0.216)	(0.318)	(0.232)	(0.168)
Income $\geq$ 50,000	0.010	1.010	0.475**	1.608*	0.445*	1.560*
	(0.251)	(0.253)	(0.236)	(0.380)	(0.248)	(0.387)
College degree	0.098	1.103	0.245	1.278	−0.482**	0.618**
	(0.220)	(0.243)	(0.219)	(0.279)	(0.229)	0.141)
White	0.550	1.734	1.001**	2.720**	0.059	1.060
	(0.467)	(0.809)	(0.464)	(1.262)	(0.417)	(0.442)
No. of trips	−0.036***	0.964***	−0.017**	0.984**	−0.015**	0.985**
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)	(0.006)
Members under 16	0.479***	1.614***	0.029	1.030	0.002	1.002
	(0.098)	(0.159)	(0.107)	(0.110)	(0.125)	(0.126)
Urban	−0.071	0.931	0.254*	1.289*	0.314**	1.369**
	(0.118)	(0.110)	(0.130)	(0.167)	(0.135)	(0.185)
South	0.953***	2.594***	0.870***	2.387***	−0.007	0.993
	(0.240)	(0.623)	(0.259)	(0.619)	(0.286)	(0.284)
Pacific	0.331	1.392	0.724**	2.063***	0.411	1.509
	(0.293)	(0.408)	(0.286)	(0.589)	(0.284)	(0.428)
Rocky Mountain	−0.238	0.788	1.088***	2.968***	−0.155	0.856
	(0.367)	(0.290)	(0.316)	(0.938)	(0.360)	(0.308)
Constant	−0.572	0.565	−0.839	0.432	−2.305**	0.100**
	(0.781)	(0.441)	(0.794)	(0.343)	(0.827)	(0.082)
N	63		62		45	

Notes: Multinominal logit estimates (log likelihood = $-5,142.42$, LR chi^2 = 827.17, and prob. > chi^2 = 0.00). Dependent variable is the probability of observing a particular ranking patterns, as indicated by column headings (1 – closeness, 2 – water quality, 3 – wildlife, 4 – size). Standard errors are in parentheses. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level. Coeff. and RR stand for multinomial logit regressions coefficients and relative risk ratio, respectively.

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Table 7 (continued). Freshwater Amenity Characteristics, Freshwater-Based Recreation Activities, and Socioeconomic/Demographic Characteristics (Multinomial Logit Estimates) (Base Category: 3 > 1 > 2 > 4)

	2 > 1 > 4 > 3		1 > 3 > 4 > 2		1 > 4 > 2 > 3		Other Categories	
	Coeff.	RR	Coeff.	RR	Coeff.	RR	Coeff.	RR
Variables	(7)	(7)	(8)	(8)	(9)	(9)	(10)	(10)
Swimming	0.257	1.294	0.047	1.048	−0.311	0.732	0.239	1.270
	(0.258)	(0.334)	(0.274)	(0.287)	(0.266)	(0.194)	(0.189)	(0.239)
Boating	0.976***	2.653***	−0.057	0.945	−0.145	0.865	0.308	1.360
	(0.277)	(0.736)	(0.284)	(0.268)	(0.276)	(0.238)	(0.197)	(0.267)
Fishing	−1.751***	0.174***	−0.045	0.956	−2.141***	0.117***	−1.100***	0.332***
	(0.258)	(0.045)	(0.295)	(0.282)	(0.283)	(0.033)	(0.196)	(0.065)
Viewing	−1.061***	0.346***	−1.150***	0.317***	−1.458***	0.232***	−0.695***	0.499***
	(0.241)	(0.083)	(0.260)	(0.082)	(0.262)	(0.060)	(0.182)	(0.090)
Picnicking	−0.408*	0.665*	−0.398	0.672	−0.463*	0.629*	0.044	1.045
	(0.233)	(0.168)	(0.265)	(0.178)	(0.266)	(0.167)	(0.189)	(0.197)
Age	−0.013	0.987	−0.004	0.996	0.007	1.001	−0.021***	0.979***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.007)	(0.006)
Female	0.652***	1.920***	−0.397	0.672	0.006	1.001	−0.135	0.873
	(0.238)	(0.457)	(0.270)	(0.182)	(0.256)	(0.257)	(0.173)	(0.150)
Income $\geq$ 50,000	−0.016	0.984	0.563**	1.755**	−2.465***	0.085***	−0.216	0.805
	(0.279)	(0.275)	(0.281)	(0.494)	(0.552)	(0.046)	(0.199)	(0.160)
College degree	0.586**	1.797**	0.915***	2.496***	−0.097	0.907	−0.265	0.767
	(0.255)	(0.457)	(0.279)	(0.696)	(0.261)	(0.237)	(0.173)	(0.132)
White	−1.155***	0.315***	0.893	2.442	−0.322	0.724	−0.459	0.631
	(0.381)	(0.120)	(0.593)	(1.447)	(0.490)	(0.355)	(0.309)	(0.195)
No. of trips	0.002	1.002	−0.057***	0.945***	0.005	1.001	−0.014***	0.986***
	(0.005)	(0.005)	(0.017)	(0.016)	(0.005)	(0.005)	(0.004)	(0.004)
Members under 16	0.078	1.081	−0.026	0.974	0.485***	1.624***	0.152*	1.164*
	(0.117)	(0.127)	(0.128)	(0.125)	(0.114)	(0.184)	(0.088)	(0.101)
Urban	0.224	1.252	0.301*	1.351*	0.152	1.163	0.453***	1.570***
	(0.148)	(0.185)	(0.160)	(0.216)	(0.152)	(0.176)	(0.103)	(0.162)
South	0.545*	1.724*	−0.288	0.750	0.275	1.316	0.425**	1.520**
	(0.287)	(0.495)	(0.316)	(0.237)	(0.284)	(0.373)	(0.203)	(0.311)
Pacific	0.523*	1.688*	−0.185	0.831	−0.715*	0.489*	−0.071	0.931
	(0.314)	(0.530)	(0.349)	(0.290)	(0.394)	(0.192)	(0.232)	(0.215)
Rocky Mountain	1.337***	3.807***	−0.375	0.688	−0.645	0.524	0.314	1.368
	(0.338)	(1.286)	(0.399)	(0.274)	(0.455)	(0.238)	(0.263)	(0.360)
Constant	0.521	1.683	−1.236	0.291	1.416	4.121	2.054***	7.802***
	(0.795)	(1.338)	(0.976)	(0.284)	(0.867)	(3.572)	(0.589)	(4.595)
N	35		25		24		92	

Notes: Multinominal logit estimates (log likelihood = $-5,142.42$, LR chi^2 = 827.17, and prob. > chi^2 = 0.00). Dependent variable is the probability of observing a particular ranking patterns, as indicated by column headings (1 – closeness, 2 – water quality, 3 – wildlife, 4 – size). Standard errors are in parentheses. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level. Coeff. and RR stand for multinomial logit regressions coefficients and relative risk ratio, respectively.

Those who participate in wildlife or nature viewing are less likely by a factor of between 0.2 and 0.5 to choose categories 1 > 2 > 3 > 4, 2 > 3 > 1 > 4, 1 > 2 > 4 > 3, 1 > 3 > 2 > 4, 2 > 1 > 4 > 3, 1> 3 > 4 > 2, 1 > 4 > 2 > 3, and Other Categories relative to the base category. Those who participate in viewing are less likely to choose {closeness, water quality}, {water quality, wildlife}, and {closeness, size}.

Finally, visitors who participate in picnicking are more likely by a factor of between 1.4 and 1.5 to choose categories 1 > 2 > 3 > 4 and 3 > 2 > 1 > 4 but less likely by a factor of 0.6 to choose categories 2 > 1 > 4 > 3 and 1 > 4 > 2 > 3 compared to the base category. Hence, visitors who participate in picniking are, in general, more likely to choose {closeness, water quality} and {wildlife, water quality}, but they are less likley to choose {water quality, closeness} and {closeness, size}.

Controls have different signs based on the ranking pattern equations. *Age* is negatively significant to explain categories 2 > 3 > 1 > 4, 1 > 3 > 2 > 4 (closeness, wildlife} and {water quality, wildlife}), and Other Categories. *Female* is positively significant to explain categories 1 > 3 > 2 > 4 and 2 > 1 > 4 > 3 (closeness, wildlife} and {water quality, closeness}). Individuals with *Income* $\geq$ *50,000* are more likely to choose categories 2 > 1 > 3 > 4, 2 > 3 > 1 > 4, 1> 3 > 2 > 4, and 3 > 2 > 1 > 4 (water quality, closeness}, {water quality, wildlife}, and {closeness, wildlife}). Individuals with a college degree are less likely to choose the category 3 > 2 > 1 > 4 (wildlife, water quality}) but more likely to choose categories 2 > 1 > 4 > 3 and 1 > 3 > 4 > 2 (water quality, closeness} and {closeness, wildlife}).

Whites are more likely to choose categories 1 > 2 > 3 > 4 and 1 > 3 > 2 > 4 (closeness, water quality} and {closeness, wildlife}) but less likely to choose the category 2 > 1 > 4 > 3 (water quality, closeness}). *No. of Trips* is negatively significant to explain categories 1> 2 > 3 > 4, 2 > 3 > 1 > 4, 1 > 2 > 4 > 3, 1 > 3 > 2 > 4, 3 > 2 > 1 > 4, 1 > 3 > 4 > 2 (closeness, water quality}, {water quality, wildlife}, {closeness, wildlife}, and {wildlife, water quality}), and Other Categories. *Members under 16* is significant to explain categories 1 > 2 > 3 > 4, 2 > 1 > 3 > 4, 1 > 2 > 4 > 3, 1 > 4 > 2 > 3 (closeness, water quality} and {closeness, size}), and Other Categories.

Urban is negatively significant to explain categories 1 > 2 > 3 > 4, 1 > 3 > 2 > 4, 3 > 2 > 1 > 4, 1 > 3 > 4 > 2 (closeness, water quality}, {closeness, wildlife}, and {wildlife, water quality}), and Other Categories. People in the *Southern* region are more likely to choose categories 1 > 2 > 3 > 4, 2 > 1 > 3 > 4, 1 > 2 > 4 > 3, 1 > 3 > 2 > 4, 2 > 1 > 4 > 3 (water quality, wildlife}, {water quality, closeness}, and {closeness, wildlife}), and Other Categories; people in the *Pacific* region are more likely to choose categories 2 > 3 > 1 > 4, 1 > 3 > 2 > 4, and 2 > 1 > 4 > 3 (water quality, wildlife}, {closeness, wildlife}, and {water quality, closeness}) but less likely to choose the category 1 > 4 > 2 > 3 (combination {closeness, size}); and people in the *Rocky Mountain* region are more likely to choose categories 2 > 3 > 1 > 4, 1 > 3 > 2 > 4, and 2 > 1 > 4 > 3 (water quality, wildlife}, {closeness, wildlife}, and {water quality, closeness}) compared to people in the *Northern* region.

Discussions

Visitors place importance on amenity characteristics based on their activity choices and socioeconoic and demographic characteristics. Recreation activities such as swimming or boating (e.g., kayaking, sailing, etc.) need direct contact with water, unlike other activities such as viewing or picnicking. Our findings support the hypothesis that swimmers or boaters are more likely to place importance on water quality, an observation consistent with previous findings that water quality is an important factor in beach selection (Dvarskas, 2007; Hanley, Bell, and Alvarez-Farizo, 2003; Murray, Sohngen, and Pendleton, 2001). In contrast, we find that boaters are less likely to place importance on wildlife compared to other attributes such as size or water quality. Size probably matters more to boaters because bigger water bodies offer more surface area and easier navigation. Although the NSRE did not specify the types of boating activities (e.g., motor boating, kayaking, or sailing), it is reasonable to assume that kayakers and sailors probably are more sensitive to the percieved risk of and danger from wildlife attacks (e.g., alligators). A recent study of public attitudes toward alligators also found that perceptions of risk and nuisance are related to negative attitudes toward alligators (Hayman et al., 2014).

Our findings also indicate that fishers and nature viewers are more likely to place importance on wildlife compared to other attributes such as size or water quality. This corroborates the findings of Duffus and Dearden (1990) that the number of fish, bird, and other wild animals are important for fishers and nature viewers. In contrast, we find that nature viewers are less likely to place importance on closeness. This is not surprising considering the fact that nature viewers might be interested in recreating on remote, natural landscapes that are often at considerable distance from their usual residence in town and cities. In our sample, more than 77% of respondent were from urban areas where public open space is relatively scarce and viewing opportunities are generally not available within walking distance. Our results also indicate that urban residents are less likely to place importance on closeness but more likely to place importance on size. Hence, the urban origin of respondents may partly explain the preferences of nature viewers on amenity characteristics.

Our findings indicate that older people and people with children are more likely to place importance on closeness, probably because of the travel cost involved and budget constraints of bigger households (Ghimire et al., 2014a; Gross, Gross, and Seidman, 1978; Rapoport, Rapoport, and Strelitz, 1975; Torkildsen, 1992). Physical distance of travel could become a limiting factor among the elderly. We also find that college graduates place importance on closeness, which might be attributable to the opportunity cost of time. The literature also suggests there are significant differences in recreation preferences or participation by culture/ethnicity (Floyd, 1998). For instance, compared to whites, blacks are significantly less likely to participate in most forms of non-consumptive activities such as camping. Compared to whites, blacks and other ethnic minorities tend to spend less on outdoor recreation (Zheng and Zhang, 2013). We also find that whites are more likely to place importance on closeness but less likely to place importance on size compared to non-whites. Differences in recreation preferences or participation may partially explain the differences in preferences for amenity characteristics by ethnicity.

Females and older people are less likely to place importance on wildlife than their respective counterparts. Although the NSRE did not specify the term wildlife, it presumably includes both large game mammals and very small invertebrates and likely includes fish and insects. Previous studies have shown that age and gender exert a prominent influence on the formation of attitudes toward wildlife (Bowman et al., 2004; Morzillo et al., 2007). Older people and females are, in general, more likely to express negative attitudes toward wildlife (Bjerke, Reitan, and Kellert, 1998; Dougherty, Fulton, and Anderson, 2003; Kellert, 1985; Kellert and Berry, 1987). In an empirical study, Hayman et al. (2014) found negative attitudes of older people toward alligators in Florida. Likewise, Agee (2008) found negative attitudes toward bears and bear restoration by females and elderly people in Georgia. Hence, the attitudes of females and elderly people toward wildlife may partly explain their preferences on the wildlife amenity in outdoor recreation. An informational campaign or persuasive communication targeted to women and elderly people may help improve their attitudes toward wildlife.

Experiencing wildlife-related adventure is often costly. Certain activities require participants to pay access fees on recreation lands in addition to the license fees required for some outdoor recreation activities such as hunting and fishing (Poudyal et al., 2012a). We can therefore expect that higher income, in general, enables people to pay for wildlife-related expenses (e.g., buying permits or lease rights from landowners). Per expectations, our findings also indicate that people with higher incomes are more likely to place importance on wildlife than they do on size of the bodies of water. Considering the fact that children are more vulnerable than adults to wild animal attacks, we may expect that people with children, in general, do not tend to place importance on wildlife in their amenity characteristic choices (Linnell et al., 2002). Our findings also indicate that individuals with family members under sixteen are less likely to place importance on wildlife compared to closeness or size.

Size of the body of water is more important for boating compared to other activities such as swimming, fishing, viewing, or picnicking. Our findings also indicate that boaters are more likely to place importance on size, but fishers, viewers, or picnickers are less likely to place importance on size. As expected, we find that people with children are more likely to place importance on size.

Conclusions and Implications

Using a novel application of spectral analysis, this study shows how freshwater recreationists trade off among amenity characteristics of recreation sites. Findings from this study have several implications in planning and management of freshwater and other outdoor recreation resources. First, results from the spectral analyses indicate that closeness is the most preferred amenity characteristic and the combination {closeness, size} is most preferred among recreationists. Hence, recreational planners interested in finding new freshwater site for recreational use could target combining closeness (to population centers) and size (of water body) whenever possible. In other words, bigger water bodies located closer to population centers would be preferable to smaller water bodies located farther away.

Second, visitors' rankings of freshwater amenity characteristics are related to their recreation pursuits and socioeconomic and demographic characteristics. These findings could offer meaningful guidance in site selection of new areas to develop water-based recreation. For example, acquisition or development plans to establish recreation areas with public swimming access should consider water quality, but size is an additional criterion to be considered if boating access is to be provided.

Recreation preferences and demand for types of outdoor recreation are becoming increasingly heterogeneous following structural changes in the U.S. population (Poudyal et al., 2012b). Linking demographic trends with amenity preferences as revealed in these findings can help managers design creative entrepreneurship and adopt effective zoning for recreation areas. For example, recreation conflicts among different types of users could be avoided by zoning bodies of water for different users (i.e., designating bigger lakes for boating or investing limited dollars to keep smaller bodies of water cleaner for swimmers).

Third, recreation planners in the private and public sectors alike also benefit from the findings regarding demographic differences on amenity ranking (e.g., size and closeness are more important than wildlife to households with children, closeness is not as important as size to urban dwellers, etc.) in understanding the amenities desired by their market constituents. Our findings may also provide guidance to managers for prioritizing maintenance of their resources. Managers of public recreation agencies usually operate under tight budgets, and knowing what is most important to their user groups could help them allocate limited resources to enhance the most desirable amenity characteristics. For instance, in a lake that is popular for swimming, managers may want to prioritize improving water quality over enhancing wildlife habitat.

Fourth, as certain recreationists have higher preferences for certain attributes, they may also be willing to pay a premium to use sites with desired characteristics (Poudyal et al., 2012a), which could provide an opportunity for resource managers to collect additional revenue in user fees. As the litearure in economic valuation of water-based ecosystem services continues to emerge, new studies based upon our findings could help identify the willingness to pay of various user segments for recreating on sites with desirable characteristics. Agencies can then develop appropriate market protocals (e.g., specific use fee, donation, etc.) and facilitate payment for these amenity services.

Finally, this paper is the first to identify ranked choices in freshwater amenity characteristics and the factors affecting these choices. Although some of the findings appear to be confirmatory rather than completely new, the model presented here could be extended to understanding recreationists' trade off of site attributes in other activities. For example, spectral analysis and a rank-ordered model could be combined to analyze hunters' survey data to explore how hunters rank the importance of game abundance, site accessibility, harvest restrictions, etc., to examine hunters' preferences for site amenity characteristics and the determinants of their ranking choices.

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Appendix A: Spectral Analysis

First-Order Analysis

The space U_0 is the set of constant function that is the average frequency of the data, suggesting that it has one dimension. The space U_1 is the space of first-order function evaluated using Mallows's approach. Therefore, consider a function,

$$\pi \to \delta_{i\pi(j)} \begin{cases} 1 & \text{if } \pi(j) = 1 \\ 0 & \text{otherwise} \end{cases},$$

where i is site amenity characteristics and j is the rank given to the amenity characteristics (Diaconis, 1988, 1989; Paudel, Pandit, and Dunn, 2013).

The first-order function becomes $\sum_{i,j} a_{ij}\delta_{i\pi(j)}$. For direct sum decomposition, the coefficients should satisfy the following condition:

$$\sum_{i,j} a_{ij} = 0.$$

Second-Order Analysis

The second-order analysis consists of ranking a pair of amenity characteristics to a pair of ranks. The rank can come in ordered or unordered mode. For instance, a visitor can rank the first and second amenity characteristics either {first and second} or {second and first} unordered second order. Following Mallows's approach, let

$$\pi \to \delta_{\{i,i'\}\{\pi(j)\pi(j')\}} \begin{cases} 1 & \text{if } \{\pi(j)\pi(j')\} = \{i,i'\} \\ 0 & \text{otherwise} \end{cases}.$$

Then, the unordered second-order function will be of the following form:

$$\sum_{i,i',j,j'} a_{i,i',j,j'}\delta_{\{i,i'\}\{\pi(j)\pi(j')\}},$$

where $\alpha_{i,i',j,j'}$ are chosen so that U_2 is orthogonal to $U_0 \oplus U_1$ (Diaconis, 1988, 1989; Paudel, Pandit, and Dunn, 2013).

Appendix B: Computation of First-Order Analysis

The first-order space decomposed in two invariant subspaces for each preference. For instance, the first-order, first preference space $U^{(3,1)}(= U_1)$ with its data vector $f^{(3,1)}$ consists of two invariant subspaces: $U^{(3,1)}$, mean effect, with data vector $f^{(3,1)}$ and $V_1^{(3,1)}$, the first-order pure effects, with data vector $f_1^{(3,1)}$ The function $f_0^{(3,1)}$ is found by projecting $f^{(3,1)}$ onto $U_0^{(3,1)}$, and $f_1^{(3,1)}$ is found by projecting $f^{(3,1)}$ onto$U_1^{(3,1)}$. Finally, we get the following decomposition:

$$f^{(3,1)} = \begin{pmatrix} 324 \\ 250 \\ 188 \\ 41 \end{pmatrix}, f_0^{(3,1)} = \begin{pmatrix} \frac{803}{4} \\ \frac{803}{4} \\ \frac{803}{4} \\ \frac{803}{4} \end{pmatrix}, f_1^{(3,1)} = \begin{pmatrix} \frac{493}{4} \\ \frac{197}{4} \\ \frac{-51}{4} \\ \frac{-639}{4} \end{pmatrix}.$$

$$f^{(3,1)} = f_0^{(3,1)} + f_1^{(3,1)}$$

Appendix C: Computation of Second-Order Analysis

The second-order unordered effect space $U^{(2,2)}(=U_2)$ with data vector $f^{(2,2)}$ decomposes into three invariant subspaces: $U_0^{(2,2)}$, mean effect, with data vector $f_0^{(2,2)}$, $U_1^{(2,2)}$, first-order effect, with data vector $f_1^{(2,2)}$, and $U_2^{(2,2)}$, two-dimensional second-order unordered pure effect. Finally, this gives the following decomposition:

$$\begin{pmatrix} 292 \\ 185 \\ 65 \\ 183 \\ 52 \\ 26 \end{pmatrix} = \begin{pmatrix} 133.84 \\ 133.84 \\ 133.84 \\ 133.84 \\ 133.84 \\ 133.84 \end{pmatrix} + \begin{pmatrix} 167.99 \\ 25.99 \\ -53.51 \\ 64.49 \\ -107.01 \\ -98.00 \end{pmatrix} + \begin{pmatrix} -9.83 \\ 25.17 \\ -15.33 \\ -15.33 \\ 25.17 \\ -9.82 \end{pmatrix}.$$

$$f^{(2,2)} = f_0^{(2,2)} + f_1^{(2,2)} + f_2^{(2,2)}.$$

Appendix D: Freshwater Amenity Characteristics Ranking Question

Please rank the following four freshwater amenity characteristics, from the most important to the least important to you in deciding various freshwater based recreation activities (Interagency National Survey Consortium, USDA Forest Service, and Human Dimensions Research Laboratory, 2010).

- The size, depth, and overall amount of water at the site — call it *size*
- The cleanness of the water at the site — call it *cleanness*
- The amount of fish, birds, or other wildlife at the site — call it *wildlife*
- The closeness of the site to your home — call it *closeness*

Table Appendix E. Freshwater Amenity Characteristics, Freshwater-Based Recreation Activities, and Socioeconomic/Demographic Characteristics (Marginal Effects in Multinomial Logit Estimates) (Base Category: 3 > 1 > 2 > 4)

Variables	1 > 2 > 3 > 4 (1)	2 > 1 > 3 > 4 (2)	2 > 3 > 1 > 4 (3)	1 > 2 > 4 >3 (4)	1 > 3 > 2 > 4 (5)	3 > 2 > 1 > 4 (6)	2 > 1 > 4 > 3 (7)	1 > 3 > 4 > 2 (8)	1 > 4 > 2 > 3 (9)	Other Categories (10)
Swimming	0.027*	0.020*	−0.025*	0.018	0.009	−0.019*	0.011	−0.001	−0.024***	−0.008
	(0.016)	(0.014)	(0.013)	(0.014)	(0.013)	(0.011)	(0.011)	(0.010)	(0.008)	(0.019)
Boating	−0.010	−0.026**	−0.013	0.028**	0.030**	−0.043***	−0.011	0.041***	−0.014*	0.027
	(0.015)	(0.013)	(0.014)	(0.014)	(0.013)	(0.012)	(0.011)	(0.011)	(0.008)	(0.019)
Fishing	−0.022*	0.001	0.071***	0.012	−0.041***	0.031***	0.058***	−0.044***	−0.049***	−0.047***
	(0.014)	(0.012)	(0.014)	(0.013)	(0.011)	(0.011)	(0.012)	(0.010)	(0.009)	(0.017)
Viewing	−0.036***	0.055***	0.057***	−0.020*	−0.034***	0.003	0.041***	−0.019**	−0.029***	0.001
	(0.014)	(0.013)	(0.013)	(0.012)	(0.011)	(0.011)	(0.011)	(0.009)	(0.008)	(0.016)
Picnicking	0.040**	0.011	−0.008	0.002	0.000	0.009	0.021*	−0.025**	−0.021**	−0.005
	(0.016)	(0.014)	(0.013)	(0.014)	(0.013)	(0.012)	(0.012)	(0.010)	(0.008)	(0.019)
Age	0.001	0.001	0.001*	−0.001***	0.001***	−0.001**	0.001***	0.000	0.000*	−0.002***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.011	0.014	−0.005	0.006	0.008	0.023**	−0.022**	0.031***	−0.003	−0.044**
	(0.014)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.010)	(0.010)	(0.008)	(0.017)
Income $\geq$ 50,000	0.005	0.041***	−0.013	0.063***	−0.008	0.023**	0.016*	−0.006	−0.103***	−0.061***
	(0.015)	(0.013)	(0.013)	(0.013)	(0.014)	(0.011)	(0.010)	(0.011)	(0.022)	(0.020)
College degree	−0.021	0.010	−0.001	0.015	0.007	0.016	−0.028***	0.030***	−0.004	−0.059***
	(0.014)	(0.012)	(0.012)	(0.013)	(0.012)	(0.011)	(0.010)	(0.011)	(0.008)	(0.017)
White	0.085**	0.009	−0.012	0.004	0.033	0.061**	−0.005	−0.066***	−0.017	−0.122***
	(0.036)	(0.023)	(0.023)	(0.022)	(0.027)	(0.025)	(0.017)	(0.014)	(0.016)	(0.028)
No. of trips	−0.001	0.001**	0.001***	0.000	−0.002***	0.000	0.000	0.001***	0.000***	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Members under 16	0.006	0.014***	−0.014**	−0.007	0.024***	−0.010**	−0.009*	−0.005	0.012***	−0.004
	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.007)
Urban	−0.045***	−0.006	−0.014**	−0.004	−0.018***	0.007	0.009	0.003	−0.000	0.063***
	(0.007)	(0.007)	(0.006)	(0.008)	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)	(0.012)
South	0.013	−0.001	−0.034**	−0.002	0.041***	0.033**	−0.021	0.006	−0.007	0.002
	(0.015)	(0.014)	(0.014)	(0.015)	(0.012)	(0.013)	(0.012)	(0.011)	(0.008)	(0.019)
Pacific	−0.039	0.001	−0.012	0.044**	0.017	0.041***	0.016	0.021*	−0.033*	−0.042*
	(0.021)	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)	(0.012)	(0.013)	(0.013)	(0.024)
Rocky Mountain	−0.057	0.013	−0.019	0.033*	−0.036*	0.061***	−0.020	0.058***	−0.035*	0.021
	(0.024)	(0.018)	(0.018)	(0.018)	(0.021)	(0.016)	(0.015)	(0.013)	(0.015)	(0.026)
N	103	69	65	63	62	45	35	25	24	92

Notes: Marginal effects in multinomial logit estimates. Dependent variable is the probability of observing a particular ranking patterns, as indicated by column headings (1 – closeness, 2 – water quality, 3 – wildlife, and 4 – size). Standard errors are in parentheses. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.