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# Outdoor Recreation Net Benefits of Rail-Trails

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Net economic values were estimated with the individual travel cost method for user samples from three rail-trails in geographically diverse regions of the U.S. Estimates of rail-trail demands were derived from count data and continuous data models. Model specifications included travel costs, activity variables, and other user group characteristics. In general, recreation users valued rail-trails located in rural areas more highly than in suburban areas. Consumer surplus trip values were relatively stable across recreation demand models.

KEYWORDS: *Recreation modeling, trails, recreation demand, recreation benefits*

A relatively new type of recreation site is the recycling of an abandoned railroad bed into a rail-trail, which is able to accommodate recreation activities and transportation purposes. As of mid-1991, there were approximately 415 rail-trails in the United States and many more in either the planning or construction phases (Moore, Graefe, Gitelson, & Porter, 1992). The Rails-to-Trails Conservancy reported that in 1988 rail-trails were used 27 million times for recreational purposes (Moore, Graefe, Gitelson, & Porter, 1992). Annual use in 1988 varied from 1,800 user-days for a 7.5 mile trail in Illinois to a high to 1 million user-days on the 44.5 mile Washington and Old Dominion Trail in Northern Virginia. Regnier (1989) found corresponding increases in the miles of rail-trails, from 70 to 156, and visits, 81,000 to 217,000, between 1980 and 1988 in Minnesota. A 1978 study of the Lafayette/Moraga Trail in California estimated annual use at 116,000 visits.

Lawton (1986), investigating the annual economic impact of the 23.5 mile Sugar River Trail (bicycle trail) near New Glarus, Wisconsin, found that trail users spent nearly $430,000 in 1985 or $9.04 per person. Users of the Elroy-Sparta Trail in Wisconsin during 1988 spent on the average $14.88 per day and the annual economic impact was estimated to be $1,257,000 (Schwecke, Sprehn, & Hamilton, 1989). A 1989 study by the U. S. Forest Service of 19 Illinois bicycle trails, some of which were rail-trails, found that on average users spent $2.89 per person/trip. Similarly, Minnesota reported the average amounts rail-trail users expected to spend on the day they were interviewed varied from $1.90 to $8.38.

In the determination of visitor spending for rail-trails and estimates of economic impacts, no measures of the user benefits were derived for rail-

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trails. Other than the Mendelsohn and Roberts (1983) hedonic study of the demand for forest attributes by hikers in the Olympic National Park, we can find no other published valuation studies of trails. This study is intended to expand the recreation economics literature on trails by estimating the net benefits realized by representative individuals from a sample of geographically diverse rail-trail settings in the U.S.

The term net benefit in recreation economics expresses a gain (consumer surplus) in annual income or well being and is interpreted as user willingness-to-pay, over and above the actual travel expenditures, for access to a particular site. In light of the projected growth in day trips for hiking (91.2 million in 1987 to 293 million by 2040) and cycling (114.6 million in 1987 to 222 million by 2040), estimates of the economic benefits of rail-trail sites should be useful to land managers and recreation trail planners (Cordell, Bergstrom, Hartmann, & English, 1989). Federal agencies (e.g., U.S. Forest Service) estimate the values of different types of recreational trips as part of their outdoor recreation planning processes. Study results could be used to evaluate the aggregate benefits from introducing new rail-trails or changes in the types of activities supported at existing trails as the product of the benefit per trip times the typical number of trips taken annually per user by the number of recreationists. A requisite step in the estimation of user benefits is to statistically model user demand for trips to rail-trails.

## Study Sites and Research Method

Study data were obtained from three separate surveys of rail-trail participants in different states during 1991 (Moore, Graefe, Gitelson, & Porter, 1992). Rail-trails represented the diversity of the overall population in the United States with the following criteria used in selecting trails: region of country, surrounding population, density of population, physical setting, land ownership pattern, trail length, and type of managing authority. The rail-trails included the Heritage Trail in Dubuque County, in eastern Iowa, the Tallahassee to St. Marks Historic Railroad Trail in northern Florida, and the Lafayette/Moraga Trail near Oakland, California. The Heritage Trail (26 miles) is a crushed limestone trail that winds through rural countryside, consisting of open farmland to a wooded river valley, the St. Marks Trail (16 miles) is a paved asphalt trail that runs adjacent to small towns and undeveloped forest land, and the Lafayette/Moraga Trail (7.6 miles) is paved asphalt and passes through dense urban and suburban areas.

In selecting the sample of trail users, researchers used a two-part strategy in which trail users were first given a short on-site interview and, then, sent a detailed mail questionnaire. The on-site surveys were conducted using a stratified sampling method to assure coverage by time of day, day of week, season of year, and section of trail. The combined response rate for the mail questionnaires was 79.3%, with 1,705 of the 2,151 questionnaires being returned.

Questionnaire items of interest to this study sought information from participants about their rail-trail use patterns. We restricted site samples to single-day trips from an affirmative responses to the questionnaire items, "Was the rail-trail the primary reason for visit?" and a negative response to the question, "On an overnight trip?" The resulting sample sizes were 307, 522, and 717 respondents for the Heritage, St. Marks, and Lafayette/Moraga, respectively. Rail-trail and user characteristics are summarized in Table 1.

Dummy variables (0,1) representing walking and bicycling were included in the analysis. The remaining activities like horseback riding, jogging, etc. accounted for less than 8% of trail use, and were excluded to avoid the dummy variable trap that makes the regression models inestimable (Greene, 1990). Group composition was operationally defined by the age

*TABLE 1*
*Sample Rail-Trails and User Characteristics*

| | Rail-trails | | |
|---|---|---|---|
| Characteristics | Heritage (*n* = *307*) | St. Marks (*n* = *522*) | Lafayette/ Moraga (*n* = *717*) |
| Trail setting | Rural | Mixed (Rural small towns) | Suburban |
| Surface | Compacted limestone | Asphalt paved | Asphalt paved |
| Most popular activity | Bicycling | Bicycling | Walking |
| Length of trails | 26 miles | 16 miles | 7.6 miles |
| Mean trips | 37 (± 70) | 43 (± 75) | 137 (± 110) |
| Median trips | 10 | 12 | 120 |
| Mean age | 45.7 | 38.3 | 50.2 |
| Mean one-way miles | 34.2 | 30.8 | 5.2 |
| Car transport | 88% | 84% | 56% |
| Mean on-trail hrs. | 2.5 | 2.3 | 1.1 |
| Annual visits | 134,986 | 171,774 | 408,950 |
| *Rank-order of perceived trail benefits* | | | |
| Health & fitness | 1 | 1 | 1 |
| Preserving open space | 3 | 2 | 2 |
| Aesthetic beauty | 2 | 2 | 3 |
| Community pride | 4 | 3 | 4 |
| Recreation opportunities | 5 | 2 | 5 |

*Notes.* The three trails selected include the Heritage Trail in eastern IA, the St. Marks Trail in northern FL, and the Lafayette/Moraga Trail near Oakland, CA. Table data were taken from *The Impacts of Rail-Trails* (Moore, Graefe, Gitelson, and Porter, 1992). Mean trip values in parentheses are the standard errors.

distributions and the number of individuals. Definitions of variables and descriptive summary statistics are displayed in Table 2.

*TABLE 2*
*Summary Descriptive Statistics of Sampled Rail-Trails*

| Variables[a] | Means | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|
| | | Heritage Trail ($n$ = *307*) | | |
| r | 37.37 | 70.56 | 1 | 365 |
| $TC_r$ | 20.94 | 33.08 | .10 | 188.40 |
| B | .65 | .48 | 0 | 1 |
| W | .33 | .47 | 0 | 1 |
| GS | 1.79 | 1.20 | 1 | 9 |
| A1 | .79 | 1.32 | 0 | 7 |
| A2 | 1.24 | .97 | 0 | 8 |
| I | 50,000.54 | 21,709.97 | 20,000 | 99,999 |
| | | St. Marks Trail ($n$ = *522*) | | |
| r | 43.30 | 75.59 | 1 | 365 |
| $TC_r$ | 16.11 | 12.47 | .09 | 289.37 |
| B | .81 | .39 | 0 | 1 |
| W | .12 | .33 | 0 | 1 |
| GS | 1.61 | 1.04 | 1 | 8 |
| A1 | 1.03 | 1.55 | 0 | 21 |
| A2 | .82 | .96 | 0 | 7 |
| I | 51.876.58 | 24,406.74 | 20,000 | 99,999 |
| | | Lafayette/Moraga Trail ($n$ = *717*) | | |
| r | 136.58 | 110.06 | 1 | 365 |
| $TC_r$ | 2.26 | 3.36 | .06 | 42.64 |
| B | .21 | .41 | 0 | 1 |
| W | .75 | .43 | 0 | 1 |
| G | 1.38 | .68 | 1 | 9 |
| A1 | .40 | .81 | 0 | 7 |
| A2 | 1.16 | .78 | 0 | 9 |
| I | 74,078.77 | 25,335.86 | 20,000 | 99,999 |

[a]r Annual visits to sample rail-trail sites.
$TC_r$ Combined out-of-pocket and opportunity costs, based on hourly wage rates, for travel to and from a rail-trail. Mileage, travel time, and occupations, which were used in the calculation of $TC_r$, were obtained from respondents.
I Annual household income, measured from responses to an income scale with $20,000 categorical increments.
B 1 if primary activity was bicycling, 0 otherwise.
W 1 if primary activity was walking, 0 otherwise.
GS Number of individuals in a group.
A1 Number of individuals in group age 26 years or less.
A2 Number of individuals in group older than 26.

*Specification of a Rail-Trail Model*

Within applied recreation economics, the focus has been on trips to the recreation sites that enter the household production process much like any other consumable goods (Mendelsohn & Brown, 1983). The public sector typically supplies access to users for rail-trail trips, and the household produces trips with inputs of such durable purchases as a car, clothing, and recreational equipment coupled with a demand to visit a rail-trail. We make the assumption that an individual is maximizing satisfaction when choosing a specific rail-trail over other trails. Using the individual travel cost method (ITCM) from revealed preference theory, we combine the decision regarding the selection of a particular rail-trail and how much to use that trail (Wilman, 1984). Individuals do not buy trips to a rail-trail unless they find it worth the price, as measured by their travel costs to that trail. A property of the ITCM is that the expenditure behaviors of participants exhibit an inverse relationship between trip travel costs and the number of annual trips taken to a designated rail-trail. Consequently, participants are willing to buy more trips at lower prices than at higher prices, assuming that their incomes, preferences, etc., do not change.

The ITCM involves vehicle-related costs spent traveling to and from rail-trails and the opportunity cost of travel time at some fixed portion of an hourly wage rate per trip. Travel costs are the necessary input into the production of a trail experience since the cost of travel does not contribute positively to a trail user's satisfaction from on-site time (Smith, 1989). It is assumed therefore that on-trail time is not part of the computation of user benefits (Fletcher, Adamowicz, & Tomasi, 1990).

Using compact notation, a specification of the ordinary demand function $h(\cdot)$ for a user of a rail-trail is $r_i = h_i(TC_r, I, S, GS, TA)$, where $r$ is the annual quantity of trips demanded by user $i$, $TC_r$ is the travel cost to include the opportunity cost of travel time per trip, $I$ is the annual income earned from work and fixed income, and $S$ is the prices to users of substitute rail-trails. Studies of outdoor recreation behavior suggest that the interrelationships between people, place, and activity are the essential factors in recreation decisions (Clark & Downing, 1984). In specifying the rail-trail demand function, we include two independent variables from recreation engagement theory—compositions of the user groups ($GS$) and respondents' participation in trail activities ($TA$)—to account for the different demanders of rail-trails (Williams, 1984). The quality characteristics of sample rail-trails are omitted in the separate site demand functions because they are invariant across users who visit each trail.

Travel costs (TC) were measured from the direct costs of transportation at $.19 per mile multiplied by the round-trip number of miles driven. The figure of $.19 per mile was arrived at by subtracting the depreciation cost of approximately $.09 per mile (Department of Transportation, North Carolina) from the federal rate of $.28 per mile. The out-of-pocket cost of travel with bicycles and walking to rail-trails was zero. The opportunity cost of time was assumed to be income foregone, and was empirically measured from the hourly wage rates associated with respondents' occupations (taken from the categories proposed by Smith in 1983 and corrected for 1992). By taking an estimate of the fraction of income foregone while travelling to and from the rail-trail site, the opportunity cost of time spent traveling, or best alternative uses of that time, were valued at 58% for Heritage, 52% St. Marks, and 34% Moraga/Lafayette. Mean travel costs were $20.94 at Heritage, $16.11 St. Marks, and $2.26 Lafayette/Moraga (McConnell & Strand, 1981).[1]

We acknowledge the importance of substitute prices or quality measures of other rail-trails in the specifications of the demand functions (Rosenthal, 1987; Kling, 1989). However, the availability of substitute trails differed among the three rail-trails in our sample. There were no other rail-trails close enough to two trails to be considered substitutes by day-trip users. The nearest rail-trail to Heritage was 170 miles away and to St. Marks 350 miles. The issue of substitutes for our sample of rail-trails was somewhat more complex than the lack of other rail-trails might imply, however. There were other settings in which trail activities could occur, but these trails would not be considered substitutes for rail-trails by most respondents. Also, we were valuing rail-trail sites, not trail activities, and rail-trails have very distinct characteristics. They generally extend long distances, have very low grades, hard surfaces, straight alignments, and do not allow motorized vehicles. Only multi-purpose greenway trails might share similar characteristics and could be considered substitutes. Such sites did not exist in the vicinity of these two study rail-trails. The most similar setting near the Heritage was a flood wall along the Mississippi River, which was suitable for bicycling, walking, and running, but was less than a mile long and did not offer the natural surroundings afforded by the Heritage. The levies in the St. Marks National Wildlife Refuge, near the southern terminus of that trail, offered an excellent setting for mountain bikes, but not for walking and touring bikes. The only alternative sites for these cyclists were county highways.

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[1]McConnell and Strand (1981) specify price in their model as the argument in the right-hand side of the equation, $r=f[c+(\alpha)(1-t)g'(w)]$ where r is trips per year, c is out-of-pocket costs per trip, α is travel time to the rail trail per trip from respondents, and $(1-t)g'(w)$ is the after tax marginal income foregone per unit time. Hourly wage rates were associated with respondents' occupations from the hedonic wage rates for occupation categories from Smith (1983) and corrected for 1992. Using the marginal wage rates, $g'(w)$, for the occupational categories of survey respondents, $r = B_0 - B_1 c - B_2 y$ where the opportunity cost per unit of time is $y = (\alpha ga)(g'(w))$ and $B$ are the coefficients. The ratios of coefficients $B_2/B_1$ from the equations below were used to estimate the fraction of income foregone while travelling to and from the rail-trail site. Alternative models for valuing time in ITCM are discussed by McKean, Johnson, and Walsh (1995). The resulting models including the gross estimates of income $I$:

| | | | | | |
|---|---|---|---|---|---|
| Heritage | $r =$ | $49.981$ | $- .414c$ | $- .238y$ | $- .0001I$ |
| | | $(5.411)$ | $(-.994)$ | $(-.923)$ | $(-.692)$ |
| St. Marks | $r =$ | $54.079$ | $- .275c$ | $- .143y$ | $- .0001I$ |
| | | $(7.197)$ | $(-1.045)$ | $(-.807)$ | $(-.951)$ |
| Lafayette/Moraga | $r =$ | $171.960$ | $- 9.140c$ | $- 3.092y$ | $- .0002I$ |
| | | $(13.25)$ | $(4.13)$ | $(-3.978)$ | $(-1.249)$ |

There were two alternative trails approximately six miles from the Lafayette/Moraga that might be considered substitutes by many users. One trail traveled through developed surroundings and the second followed a water district canal and was less scenic than the Lafayette/Moraga. Survey researchers did not directly obtain data from respondents regarding substitute trails. Indirect methods were inadequate for estimating distances and travel times from zip code addresses since we would be second-guessing respondents about their choices of trail access from a variable number of points along the substitute greenway or canal walkways.

*Estimation*

Without knowledge of the "true" benefits from rail-trails to users, it is customary to display results from alternative demand models for each rail-trail separately and compare the models. Our specification of trail behavior with the assumption that we can observe interior solutions to the constrained utility maximization process underlying a trail demand function follows current estimation methods for *on-site* data (Smith, 1988). Given the decision by an individual to use a rail-trail, we combine into one decision whether to participate and to select a rail-trail. Consequently, the only relevant alternatives for analyzing on-site data are the continuous models—ordinary least squares (OLS) or OLS with the logarithmic transformation of dependent variable—and maximum likelihood (ML) estimators (Smith, 1989).

An issue that can arise when ITCM is applied to data from on-site surveys is sample selection bias (Smith, 1988). Our three samples of individuals visited rail-trails at least once, and no information was available on individuals who chose not to visit the rail-trails. In addition, truncation bias can arise due to the logarithmic transformation of one trip, which is zero. In this case, we are questioning whether an explicit recognition of the truncated error is important in the estimation of parameters. In effect, were first trip users over-represented in the data, and do they create marked effects on our characterizations of other rail-trail users? The Tobit regression takes account of selection bias at low levels of rail-trail trips, and uses the available data to estimate demand function parameters (Greene, 1990; Smith, 1988).[2]

The Poisson regression meets the necessary statistical assumptions to estimate recreation demand functions (Creel & Loomis, 1990; Hellerstein, 1992). Poisson estimates the number of occurrences (counts) of an event in nonnegative integer quantities—the number of annual trips to a rail-trail. Count data models have been shown to be robust to such potential sampling issues as censoring and endogenous stratification, which are related to the

[2]The underlying regression is $r = \beta x + \varepsilon$, which includes an error term ($\varepsilon \sim N[0,\sigma 2]$), and $r$ is the annual trips (Greene, 1990). Sigma ($\sigma^2$) is an ancillary parameter and is the standard error of the regression, which is comparable to the estimated mean square error that is normally reported in regression. Regression estimates were obtained using the censoring regression routine in LIMDEP (Greene, 1990).

ITCM and use of on-site surveys (Shaw, 1988). Endogenous stratification occurs when the frequent users of a recreation site are more likely to be sampled, than individuals who visit a site infrequently. The implicit assumption that the variance equaled the conditional mean in the Poisson regression is too strong a restriction for recreation data, and hence fails to account for the *over-dispersion* in the data where the conditional variance exceeds the conditional mean. Cameron and Trivedi (1986) relaxed this restriction to account for over-dispersion and recommended a compound Poisson model with a negative binomial distribution.[3]

From a more practical recreation modeling standpoint, we include robust regression results since we are dealing with recreation data and non-normal disturbances (error) in a multiple variable framework. Robust regression refers to a general class of statistical procedures designed to reduce the sensitivity of annual trip estimates to failures in the assumptions of the parametric model. In brief, robust regression is characterized as a form of weighted regression because the downweighting of residuals for influential outliers (high number of trips at larger travel costs per trip) occurs during the iterative estimation and re-estimation of regression parameters by the computer. Advantages of robust regression include less sample-to-sample variation and more accurate confidence intervals (Hamilton, 1992).[4]

## Results

A variety of alternative regression models were considered for the independent variables assumed to affect individual demand functions for rail-trails. In our demand specification, the independent variables were selected for alternative models at the different rail-trail locations because they reflect those determinants expected to influence trail demand under a travel cost and recreational engagement framework (Table 3).

The travel cost parameters of the three separate samples of respondents indicated broad consistency in the parameter sign of the effects of travel costs per trip ($TC_r$) across all the alternative models by trail locations. The

[3]The negative binomial, $ln\lambda_i = \beta x_i + \varepsilon$, includes a vector of the determinants of demand and error term, and $\lambda_i$ is the natural logarithm of the trip counts. The negative binomial model is one extension of Poisson regression that allows the variance to differ from the conditional mean. Log-likelihood functions are maximized using the algorithm Newton's method with the econometric software, LIMDEP (Greene, 1990). The variance is $Var(exp(\beta x)) = exp(\beta x)\,(1 + \alpha\, exp(\beta x))$ (Greene, 1990). The computer program sets the nuisance parameter or alpha ($\alpha$) in the measurement of variance equal to an arbitrary constant since the maximum likelihood (ML) estimator assumes that only the mean can be specified correctly. See Cameron and Trivedi (1986) for an extended discussion of these issues and Poisson regression models.

[4]Hamilton (1992) provides a comprehensive discussion on a robust regression method. Robust regression reduces the impact of gross outliers in the data because the solution minimizes the squared deviations. Robust regression initially screen data points based on Cook's D (distance) $>$ 1 to eliminate gross outliers prior to calculating starting values and then performs Huber iterations followed by biweight function iterations (Hamilton, 1992). This minimizes the sum of absolute residuals, rather than the sum of squared residuals.

## TABLE 3

*Continuous, Censored, and Count Data Regressions of the Trip Demands for Sampled Rail-Trails*

| Independent[a] variables | Continuous regression models: Linear | Semi-log | Robust[b] | Double-log | Censored: Tobit[b] | Count data: Negative binomial |
|---|---|---|---|---|---|---|
| | | | Heritage Trail ($n$ = *307*) | | | |
| $TC_r$ | −.3925 | −.0252 | −.0234 | −.7017 | −.0458 | −.0330 |
| W | 36.40 | | | | | .70 |
| A1 | | −.28 | −.30 | −.33 | −.30 | −.16 |
| Constant | 34.08 | 3.41 | 3.41 | 4.49 | 3.21 | 3.62 |
| Alpha ($\alpha$) | | | | | | *1.511* |
| Sigma ($\sigma$) | | | | | *1.67* | |
| $R^2$ | *.12* | *.32* | | *.38* | | |
| MSE | *66.137* | *1.439* | | *1.495* | | |
| $\mathcal{L}$ | | | | | | *−1272.01* |
| Pseudo $R^2$ | | | | | *.13* | *.06* |
| | | | St. Marks Trail ($n$ = *522*) | | | |
| $TC_r$ | −.2737 | −.0155 | −.0151 | −.4706 | −.0295 | −.01221 |
| B | −36.49 | −.55 | −.46 | | −.61 | −.76 |
| W | 33.48 | .80 | .88 | | .79 | |
| GS | −7.61 | −.32 | −.35 | −.31 | −.39 | −.17 |
| Constant | 89.40 | 3.33 | 3.36 | 4.10 | 3.41 | 4.56 |
| Alpha ($\alpha$) | | | | | | *1.658* |
| Sigma ($\sigma$) | | | | | *1.73* | |
| $R^2$ | *.14* | *.23* | | *.25* | | |
| MSE | *70.006* | *1.517* | | *1.497* | | |
| $\mathcal{L}$ | | | | | *−935.14* | *−2305.53* |
| Pseudo $R^2$ | | | | | *.08* | *.03* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Lafayette/Moraga Trail ($n$ = 717) | | | | |
| $TC_r$ | −6.968 | −.1485 | −.2078 | −.4528 | −.1616 | −.1025 |
| B | | −.76 | −.69 | −.87 | −.79 | −.53 |
| GS | −16.60 | −.30 | −.26 | −.33 | −.29 | −.32 |
| A1 | −19.21 | −.31 | −.30 | −.30 | −.34 | −.18 |
| Constant | 186.71 | 5.08 | 5.35 | 4.75 | 5.01 | 5.68 |
| Alpha (α) | | | | | | *.933* |
| Sigma (σ) | | | | | *1.370* | |
| $R^2$ | *.20* | *.32* | | *.34* | | |
| MSE | *98.315* | *1.323* | | *1.310* | | |
| ℒ | | | | | *−231.47* | *−4143.66* |
| Pseudo $R^2$ | | | | | *.11* | *.02* |

[a]Variables are travel cost (TC), bicycling (B), walking (W), group size (GS), number in group ages ≤26 (A1), and ages >26 (A2).
[b]Based on a semi-log specifications of the demand functions.
*Notes.* All coefficients are significant at the .05 level. MSE is the mean square error. ℒ is the log likelihood ratio values, which serves the same purpose as the F test serves for least squares. Sigma (σ) is an ancillary parameter and is the standard error of the truncated regression, which is comparable to the estimated MSE reported in linear regression. Variable coefficients are in the natural logarithmic values for all models, except for the linear regression results. The pseudo $R^2$ is an informal goodness-of-fit index that measures the fraction of an initial log likelihood value explained by the model. Although not reported in the table results, annual income, activity, and group variables were retained in all models to avoid specification error. Also, likelihood-log tests were performed for the alpha values in the negative binomial models. The large $\chi^2$ values asserted that the rail-trail data being conditional on the Poisson was virtually zero.

higher elasticities of demand for annual trips with respect to travel costs were at Lafayette/Moraga than at St. Marks or Heritage. The demand equations exhibited no significant annual income effects, which was not unexpected, in that the amount of available discretionary time for a day's outing and travel, incorporated into travel cost as an opportunity cost, was more of a factor in rail-trail decisions than their annual incomes (Bockstael, McConnell, Strand, 1991).

The remaining significant parameters in the alternative models and rail-trail locations included group size (*GS*), which had inverse relationships to the annual quantities of rail-trail trips to St. Marks and Lafayette/Moraga. Groups comprised of more participants under 26 years (*A1*) demanded significantly fewer trips at the Heritage and Lafayette/Moraga locations, across all models. This finding confirmed survey observations and modeling expectations that the more frequent participants used rail-trails in group sizes of one or two, and were older than 26 years.

The trail activity parameters were mixed in sign and significance across alternative models and trail locations. The bicycling (*B*) parameter for the paved asphalt, Lafayette/Moraga had a negative sign with cyclists demanding significantly fewer trips. Users who were likely to walk (*W*) the St. Marks, also an asphalt paved rail-trail, demanded significantly more annual trips; while cyclists on the St. Marks demanded significantly fewer trips even though bicycling was the more popular activity. We must emphasize that the lack of statistical significance in the cases of the activity parameters was not indicative of the popularity of these activities, rather our findings related specifically to the modeling of individuals' demands for annual rail-trail trips.

Since recreation economic theory does not offer guidance as to the appropriate statistical estimator, we used "work in progress" techniques like the Box-Cox transformations toward normality and Davidson and Mackinnon tests for linearity versus log-linearity, both of which asserted the travel cost semi-log models to provide the better fit of the continuous data (Greene, 1990). Within rail-trail locations, quantitative differences in estimated parameters and judgements regarding their significance between alternative models were equally important in selecting the appropriate models and the computed net benefits. However, the differences in the size and importance of estimated parameters across alternative models must be interpreted cautiously because they were not directly comparable (Greene, 1990). For example, the higher levels of statistical significance of the OLS semi-log model than the Tobit (semi-log specifications) and the negative binomial can be misleading. The pseudo $R^2$, which is from the maximum likelihood estimate of trips demanded by individuals and displayed in Table 2, is an informal goodness-of-fit index that measures the fraction of the initial log-likelihood value that is explained by the demand model (Greene, 1990). Negative binomial results, instead of the Poisson, were reported because the alpha's ($\alpha$) were significant, and we rejected the Poisson assumptions ($\alpha$*'s* = *0*) (Cameron & Trivedi, 1986).[5] Overall, the significance of the same variables across alternative models were consistent; even though, there were differences in the magnitudes of parameters. Inspections of the resulting graphic displays of the curves from the non-linear models were convex to the origins, which is customary to the demand curves that are generated from ITCM's.

## Discussion

An important use of ITCM is the estimation of recreation benefits of recreation sites to individuals. Consumer surplus (CS) is a measure of the net recreation benefits to individuals among the different rail-trails and in evaluating the accuracy of benefit estimators. It expresses a not observable utility in terms of observable dollars, and is interpreted as an individual's willingness-to-pay over and above the mean trip travel costs for a rail-trail trip.[6]

The three samples of rail-trail users were similar in their responses as to the perceived benefits to their health and fitness from trail activities, aesthetic beauty (quality of place), and from knowing that the existence of rail-trails work to preserve open spaces for recreational opportunities and community pride. The economic values of these perceived benefits to users were embedded within the recreation site selection decision in the ITCM.

To simplify comparisons, Table 4 reports CS and the estimators used in net benefit computations. CS per trip ranged from $21.83 to $81.99 at Heritage, $33.89 to $112.31 at St. Marks, and $4.81 to $19.48 at Lafayette/Moraga. CS were larger for the Heritage and St. Marks than for the Lafayette/Moraga, suggesting that rail-trail users in rural Iowa and Florida valued trails more highly than did the suburban Lafayette/Moraga area residents who found this trail more readily accessible and took larger volumes of trips.

However, comparisons within the separate rail-trail samples indicated a diversity in CS among the demand estimators, even when we held the assumptions used in constructing travel costs and other key variables constant. With the exception of the Lafayette/Moraga, which had the fewest first-trip

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[5]Likelihood-ratios to test $\alpha = 0$ (equivalent to $ln\alpha = -\infty$) or the process being Poisson were significant. The $\chi^2(1)$ were 15,653 (Heritage), 30,648 (St. Marks), and 48,612 (Moraga); all of which were significant at the *.000* level.

[6]An individual's CS is derived by the integral in (1) that gives the change in the area to the left of the trail demand curve for an individual's ($i$) willingness-to-pay over and above the mean trip travel cost ($p$) for a rail-trail trip ($v$):

$$CS = \int_{p}^{p^{-}} v_i \, dp_i \quad (1)$$

We simplify the notation in (1) by suppressing constant terms and the other determinants of demand that would appear normally in the demand functions. Since the trip travel cost cannot be observed at zero trips, the upper trip travel cost is truncated at the choke or highest trip price ($p^{-}$) that any one trail user is willing to pay (Smith, 1989). A trail user chooses the number of rail-trail trips by maximizing (1), where the marginal utility of additional trips is zero.

*TABLE 4*
*Comparisons of Net Benefits per Trip*

| Demand functions | | Consumers Surplus (CS) per Trip: Heritage | St. Marks | Lafayette/ Moraga |
|---|---|---|---|---|
| Linear | CS | $46.74 | $ 78.60 | $ 9.77 |
| | Trips | 38 | 43 | 136 |
| Semi-logarithmic | CS | 39.37 | 65.54 | 6.70 |
| | Trips | 9 | 11 | 67 |
| Robust | CS | 41.86 | 65.13 | 4.81 |
| | Trips | 9 | 11 | 84 |
| Double-logarithmic | CS | 65.83 | 112.31 | 16.70 |
| | Trips | 5 | 7 | 50 |
| Tobit | CS | 21.82 | 33.89 | 6.16 |
| | Trips | 7 | 9 | 65 |
| Negative binomial | CS | 30.18 | 49.78 | 9.56 |
| | Trips | 22 | 32 | 122 |

*Notes.* Choke prices (the highest travel costs) for Heritage, St. Marks, and Lafayette/Morage were $188, $289, and $43, respectively. CS is the consumer surplus per rail-trail trip, and the integrals of the functions were calculated using Simpson's rule for approximating integrals. An alternative method for semi-logarithmic results is the approximation $-(1/\beta)$, where $\beta$ is the coefficient on travel cost. Constant terms were not corrected for logarithmic bias. This bias does not alter consumer surplus estimates per trip, only the mean sample estimates of rail-trail trips.

users, Tobit CS values were comparatively lower than those from alternative demand models since the Tobit estimators were sensitive to on-site sample selection effects. In computing the Tobit CS values, we assumed that the probability of visiting a rail-trail was held constant (Smith, 1988).

CS from robust regression estimators were more conservative than the semi-log OLS models. By testing whether the semi-log travel cost parameters were more than one (robust) standard errors from the corresponding robust regression parameters, we roughly assessed the influence of outlier observations upon the semi-log models. Travel cost parameters in Table 2 were similar for the Heritage and St. Marks sites, but we were encouraged to lean toward the consumer surplus from robust regression estimators for the Lafayette/Moraga. Taking the difference between the robust travel cost parameter and the semi-log and, then, dividing by the robust standard error *[(−.2077636) − (−.148516) / .0123168]*, resulted in a value of *−4.81* which was clearly more than one (robust) standard error for the corresponding robust travel cost parameter (Hamilton, 1992).

Count data estimators are designed to mitigate many of the problems associated with continuous data models. The CS values from the Tobit and count data models were in the range expected for the Heritage and St. Marks Trails. Both were in rural settings with one-way travel means of over 30 miles and 2 hour average stays. CS of $4.81 per trip from the robust regression for the Lafayette/Moraga Trail appeared to more closely reflect the expected welfare value of a suburban trail, given the ease of accessibility.

Bergstrom and Cordell (1991) estimated community demands for outdoor recreation trips to state and federal sites for outdoor activities and the net benefits per trip with the zonal TCM and the 1989 Public Area Recreation Visitors Survey (PARVS). However, net benefits from zonal and individual TCM involve different underlying assumptions (McConnell & Bockstael, 1984). The 1989 CS estimates for activities that might occur on rail-trails were $26.10 for day hiking, $7.37 for jogging, $31.92 for biking, and $36.95 for walking. If we assume that the rural locations of the Heritage and St. Marks Trails were similar to the state recreation sites in the PARVS, the CS rail-trail estimates of $30.18 to $49.78 were within the range of the 1989 CS estimates for day hiking, biking, and walking.

## Conclusion

Rail-trail demand models were estimated for three rail-trails using the individual travel cost method. Important determinants of demand for rail-trails were travel cost, recreation activities, and the sizes and age groupings of trail parties. An important use of ITCM is the estimation of recreation benefits from rail-trails for use by planners in studying the welfare benefit of existing or potential rail-trail conversions. Using the values of $30.18 for Heritage, $49.78 for St. Marks, and $4.81 per trip for Lafayette/Moraga and multiplying these values by the total annual trips to the appropriate rail-trail (see Table 1), annual rail-trail benefits were $4,073,877 for Heritage, $8,550,909 for St. Marks, and $1,967,049 for Lafayette/Moraga. The annual benefits per mile of rail-trail were $156,687 (Heritage), $534,432 (St. Marks), and $258,822 (Lafayette/Moraga).

As a final note, the sensitivity of net benefits suffered from two sources of error—omitted variable and the likelihood of recall errors from asking respondents the number of trips to trail sites in the past 12 months (Smith, 1990; Bockstael & Strand, 1987). In hindsight, recall errors could have been reduced if the data had contained information from non-trail users where we could have directly incorporated the selection effects of non-users into our modeling efforts. In brief, this would involve a 2-step estimator where we first model an individual's decision to visit a trail and, if significant, then estimate in the quantity of trips to that trail. Next, our omission of substitute trail prices at the Lafayette/Moraga Trail, in particular, may have resulted in an overstatement of consumer surplus for users participating in less skilled activities at rail-trails. Overall, the variability in consumer surplus can be attributed to needed research that can better measure the decision variables that describe the household's demand for trails and greenways.

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