Journal of Agricultural and Applied Economics, 38,2(August 2006):317–326

Wilderness and Primitive Area Recreation Participation and Consumption: An Examination of Demographic and Spatial Factors

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This paper explores the influence of demographic and spatial variables on individual participation and consumption of wildland area recreation. Data from the National Survey on Recreation and the Environment are combined with geographical information system–based distance measures to develop nonlinear regression models used to predict both participation and the number of days of participation in wilderness and primitive area recreation. The estimated models corroborate previous findings indicating that race (black), ethnicity (Hispanic), immigrant status, age, and urban dwelling are negatively correlated with wildland visitation, while income, gender (male), and education positively affect wildland recreation participation and use. The presence of a distance or proximity factor mitigates some of the influence of race and ethnicity. The results of the cross-sectional models are combined with U.S. Census projections of total population, changes in population characteristics, and estimates of current National Forest Wilderness visitation estimates to give some insight into pressure that might be expected on the nation's designated wilderness during the next half century. Results generally indicate that per-capita participation and visitation rates will decline over time as society changes. Total wilderness participation and visitation will, however, increase, but at a rate less than population growth.

Key Words: logistic, negative binomial, participation, recreation, visits, wilderness

JEL Classifications: Q21, Q26, Q24

Visits to wilderness and primitive areas are increasing in the United States (Taylor). Recreational use of the original 54 Wilderness areas, as designated by the Wilderness Act of 1964, increased by 86% between 1965 and 1994 (Cole). Participation monitoring has demonstrated that Wilderness use was increasing faster than outdoor recreation use in general (Watson, Cordell, and Hartmann). Recent trends indicate that visitor use of Wilderness is still increasing and will continue to increase with additional designations (Watson and Cole). Recreation use of National Forest (NF) Wilderness grew 9.6% annually between 1965 and 1974 and by 10% annually between 1975

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and 1985. After 1985, as designation leveled off, the increase in use grew more slowly with an increase of 8.4% by 1993. The same pattern was seen in National Park Service (NPS) Wilderness use following designation (Cordell et al. 1999). Cordell and Teasley conservatively estimated 40.4 million visits to Wilderness or other primitive areas for 1995. Future estimates show increased use per acre and an increase in the number of people who want to experience the opportunities afforded by Wilderness (Cordell et al. 1999).

Alternatively, recent and continuing changes in the ethnic fabric of U.S. society raise questions about culturally induced shifts in outdoor recreation preferences and a subsequent decline in Wilderness visitation (Johnson et al. 2004; Taylor; Murdock et al.). In-depth analyses and understanding of shifting social, spatial, and economic variables, as well as impacts of growing demand for Wilderness or other primitive area recreation, are needed to inform Wilderness and other public land managers about potential user conflicts and pressures on the resource. Moreover, information about the number of future users can serve as a barometer for societal support for maintaining recreation access to the National Wilderness Preservation System (NWPS).

In this study statistical models for individual participation in and consumption of Wilderness and primitive area recreation are explored and developed. The influence of sociodemographic and spatial factors on people's decision-making process whether to participate in Wilderness recreation, and if so how often, are also tested. Lastly, estimated models are combined with census projections of expected changes in total population and population composition over the next half century and NF Wilderness visitation to forecast recreation participation and use on NF Wilderness and the NWPS overall.

Data and Methods

This study uses data from a variety of sources. Statistical models were based on data from the National Survey on Recreation and the Environment (NSRE). The NSRE is the eighth version of the U.S. National Recreation Surveys started in the 1960s. The current survey started in 2000 and continued through 2004 (Cordell, Green, and Betz). The NSRE is a random-digit-dialing telephone survey of more than 90,000 households nationally. The survey gathers information on a number of outdoor recreation and environmental topics, including outdoor recreation participation, environmental attitudes, natural resource values, attitudes toward natural resource management policies, household structure, lifestyles, and demographics. The data are weighted using post-stratification procedures to adjust for nonresponse according to age, race, gender, education, and rural/urban strata (Cordell, Green, and Betz). Data for this study were taken from the eighth of 18 versions of NSRE between March and June 2001. The total sample size was just under 5,000 observations.

In order to examine the impact of spatial factors on participation, zip codes from the U.S. zip code points (ESRI Data and Maps) were matched with respondent's zip codes to create a base location map for respondents. These points were placed at the delivery based centroid representing 5-digit zip code areas. Zip codes with few or no delivery locations were assigned a single business in the area (ESRI). The Wilderness Areas of the U.S. boundary map (U.S. Geological Service) was used to locate designated Wilderness areas in relation to respondent zip codes.

Data for participation and use forecasting were primarily obtained from U.S. Census Bureau data from 2004 and were used to determine interim projections by age, gender, race, and Hispanic origin. Woods and Poole, Inc., data were used to determine metropolitan population projections. National Visitor Use Monitoring (NVUM) survey data (U.S. Department of Agriculture, Forest Service) were used to determine the number of NF Wilderness days and NF Wilderness visitors for 2002. These base numbers were used to create an index to project future use.

Regression Models

Logistic regression was used to describe recreation participation behavior. Participation was based on the probability of a visit to a wildland area in the past year and was modeled as a function of various sociodemographic and spatial explanatory variables. The general form of the logistic equation is

(1) Probability (participate)

$$= 1/[1 + \exp(-\mathbf{X}B)],$$

where, exp represents the exponential function, **X** is a matrix of explanatory variables, and B is a vector of parameters. This type of model is commonly used in the recreation and social science research examining individual choice behavior (Bowker, Cordell, and Johnson; Johnson et al. 2004; Johnson, Bowker, and Cordell; Miller and Hay).

The binary (yes/no) dependent variable in this model was drawn from the NSRE question, "Did you visit a wilderness or other primitive, roadless area (within the last 12 months)?" Sociodemographic independent variables included in the X vector were the age of the respondent, gender, whether a person was born in the United States, education level, and household income. The relationship between ethnicity and participation was examined by using three categorical variables for Hispanic, black, and other (American Indian, Asian, Native Hawaiian). Additional variables were used to describe population density of the county of residence (metro or rural) and whether a respondent belonged to an environmental organization. This variable served as a proxy measure for environmental awareness of Wilderness and other primitive areas. All of the above variables are listed and defined in Table 1.

An important addition to the NSRE data was the inclusion of a distance or availability proxy variable. The respondent's zip code was used to calculate the distance to the nearest Wilderness area. ArcView 8.3 was used to calculate the distance from each zip code point to the nearest Wilderness area by joining zip code points with the Wilderness areas based on spatial location. This calculates the distance from each point to the nearest Wilderness area. Because the zip code points are delivery based centroids and the distance calculated falls on the nearest point of the closest Wilderness area, these distances are not meant to be exact. They do, however, provide a proxy for availability of a wildland setting. In order to calculate exact distance, more precise information on the respondent's location and the exact location of the Wilderness entrances would be needed. With this information, a network analysis could be performed using the cost-weighted direction function, which used road maps to determine the route along the least-cost path that the respondent could take to the closest Wilderness area. Other types of calculation that could be performed with more specific information include straight-line distance from the respondent's home to the nearest Wilderness entrance or the cost-weighted distance, which modifies the straight-line distance by some other factor (e.g. elevation).

Table 1. Variables Used In The Empirical Models

Independent Variables	Definitions
AGE	Age of respondent in years
SEX	Gender; 1 if male; 0 otherwise
HISPANIC	1 if Hispanic; 0 otherwise
BLK	1 if Black; 0 otherwise
OTHER	1 other; 0 if Black or White
BORNUSA	1 if born in the U.S.; 0 otherwise
EDUC	1 if BS or above; 0 otherwise
URBAN	1 if metro; 0 if rural
INCOME	1. $4,999 or less
	2. 5,000–9,999
	3. 10,000–14,999
	4. 15,000–19,999
	5. 20,000–24,999
	6. 25,000–34,999
	7. 35,000–49,999
	8. 50,000–74,999
	9. 75,000–99,999
	10. 100,000–149,999
	11. 150,000 or more
MEMBER	Member of an environmental/conservation group: 1 if member; 0 otherwise
MILES	Distance to the nearest wilderness area in miles
WILDERN	Willingness to visit wilderness or other primitive areas: 1 if interested; 0 otherwise

A negative binomial regression model was used to determine intensity of participation or the number of participation days. Negative binomial models have been used extensively in recreation visitation modeling (Betz, Bergstrom, and Bowker; Zawacki, Marsinko, and Bowker 2001). Following Yen and Adamowicz, the negative binomial probability distribution can be represented as

$$\text{(2)} \quad \text{Prob}(Y_i = y_i; y_i = 0, 1, 2, \ldots) = \frac{\Gamma(y_i + 1/\alpha)}{\Gamma(y_i + 1)\Gamma(1/\alpha)}\{(\alpha\lambda_i)^{y_i}(1 + \alpha\lambda_i)^{-[y_i+(1/\alpha)]}\},$$

where $\lambda_i = \exp(\Omega, X, u_i)$, with variables as listed for Equation 1; Ω is a parameter vector; Γ represents the gamma function; and α is the overdispersion parameter. The expected value for the number of days, $E(Y_i)$, is λ_i, and the variance, $\text{Var}(Y_i)$, is $\lambda_i(1 + \alpha\lambda_i)$. An asymptotically significant α indicates the presence of overdispersion, making the negative binomial model appropriate. When the overdispersion parameter α is zero, both $E(Y_i)$ and $\text{Var}(Y_i)$ are equal to λ_i and the Poisson model is appropriate (Yen and Adamowicz). Exp (u_i) is assumed to follow a gamma distribution with mean 1.0 and variance (Greene 2000). The dependent variable for this model, also obtained from NSRE data, was the individual's response to, "On how many days did you visit a wilderness or primitive area in the past 12 months?" Those not answering affirmatively to the participation question were assigned 0 days. The same explanatory variables that were used to describe participation probability in the logistic regression were used to estimate and project the amount of use (number of days).

Results

Table 2 contains sample means, both postsample weighted and unweighted, for data used in the analysis. These means indicate the presence of some response bias according to certain demographic variables. The postsample weighting procedure brings these variables in line with census values.

Table 2. Weighted and Unweighted Means for Explanatory Variables

Variable	Weighted	Unweighted
AGE	42.8	43.7
GENDER	0.474	0.438
BLACK	0.138	0.076
HISPANIC	0.152	0.067
OTHER	0.048	0.038
BORNUSA	0.882	0.945
MEMBER	0.229	0.259
INCOME	6.92	7.09
EDUCATION	0.208	0.320
URBAN	0.793	0.658
MILES	75.7	76.7

The logistic participation and negative binomial days regression models were estimated using LIMDEP 7.0 (Greene 1995). Results of the logistic participation regression are presented in Table 3. Quantitative interpretation of the logistic regression parameters is not transparent; hence the last column in Table 3 displays the change in probability of participation with a one-unit change in the relevant explanatory variable. For example, with other factors set to sample means, a male is 12.2% more likely than a female to have visited a wilderness or primitive area in the past year. Similarly, a black is 19% less likely than a white to have visited this type of site.

Past studies have shown that the typical outdoor recreation participant is white, male, able bodied, and well educated, with an above average income (Cordell, Bergstrom, and Bowker; Johnson et al. 2004; Cordell et al. 1999). The average age among Wilderness visitors is increasing (Watson), but for the general population the likelihood of participation in Wilderness recreation decreases with age (Johnson et al.). Also, while the proportion of female participants appears to be increasing (Watson), women are still less likely to visit a wilderness or primitive area (Johnson et al. 2004). Past studies have indicated that blacks, Latinos, and Asians are less likely to say that they have ever visited a Wilderness area and that immigrants are less likely then native born respondents to visit Wilderness (Johnson et al.). The estimated models corroborate previ-

Table 3. Logistic Regression Parameter Estimates, $n = 4400$

Variable (Weighted)	Parameter	Std. Error	Pr > ChiSq	Change in Visit Probability
Intercept	−1.99	.291	.0000	−.386
AGE	−.019	.002	.0000	−.003
GENDER	.634	.070	.0000	.122
BLACK	−.986	.122	.0000	−.19
HISPANIC	−.824	.176	.0000	−.159
OTHER	−.585	.182	.0013	−.113
BORNUSA	1.31	.211	.0000	.254
MEMBER	.768	.078	.0000	.148
INCOME	.088	.021	.0000	.017
EDUCATION	.101	.086	.2363	.019
URBAN	−.139	.085	.1039	.026
MILES	−.002	.0006	.0003	−.0004

ous findings indicating that income, gender (male), immigrant status (born in the United States), and environmental awareness are all factors positively correlated with wildland recreation participation; while race (black and other), ethnicity (Hispanic), age, and urban dwelling negatively affect wildland recreation participation and intensity. Education did not have a significant impact on the probability of participation.

Although not included in the literature cited above, another factor that is negatively correlated with wildland recreation participation is distance, with the chance of participation decreasing as distance increases. The presence of a distance or proximity factor tends to mitigate some of the influence of race and ethnicity (e.g., 5% decrease in black coefficient). Studies indicate that visitors are generally from the state the Wilderness area is located in and from the closest region in the state (Roggenbuck and Watson). Part of the negative correlation between race and visitation could be due to the geographic distribution of black populations (Johnson et al. 2004), hence the importance of including both distance and race in participation models.

Table 4. Negative Binomial Parameter Estimates, $n = 4357$

Variable	Parameter Estimate	Std. Error	*P*-Value
Intercept	.046	.280	.0939
AGE	−.009	.002	.0000
GENDER	.42	.071	.0000
BLACK	−1.39	.085	.0000
HISPANIC	−1.40	.189	.0000
OTHER	.037	.171	.8269
BORNUSA	1.72	.151	.0000
MEMBER	.751	.088	.0000
INCOME	.057	.018	.0015
EDUCATION	−.359	.100	.0003
URBAN	−.721	.079	.0000
MILES	−.003	.0004	.0000

Results of the negative binomial regression are presented in Table 4. Results indicate that the explanatory variables have similar qualitative effects on wilderness and primitive area visitation days as on the probability of participation. Unlike the logistic regression, interpretation of the parameter estimates for the negative binomial is more transparent. With expected days specified in a semilog form, parameter estimates can be interpreted as the percentage change in days per one-unit change in the explanatory variable. Hence, other factors constant, males can be expected to spend about 42% more days per year visiting Wilderness and primitive areas than females. Education still has a positive correlation with the number of days that a person visits but has a more significant impact than on participation. This indicates that the level of education a person has may not significantly impact whether on not a person visits a wilderness or primitive area, but if a person does visit, then the num-

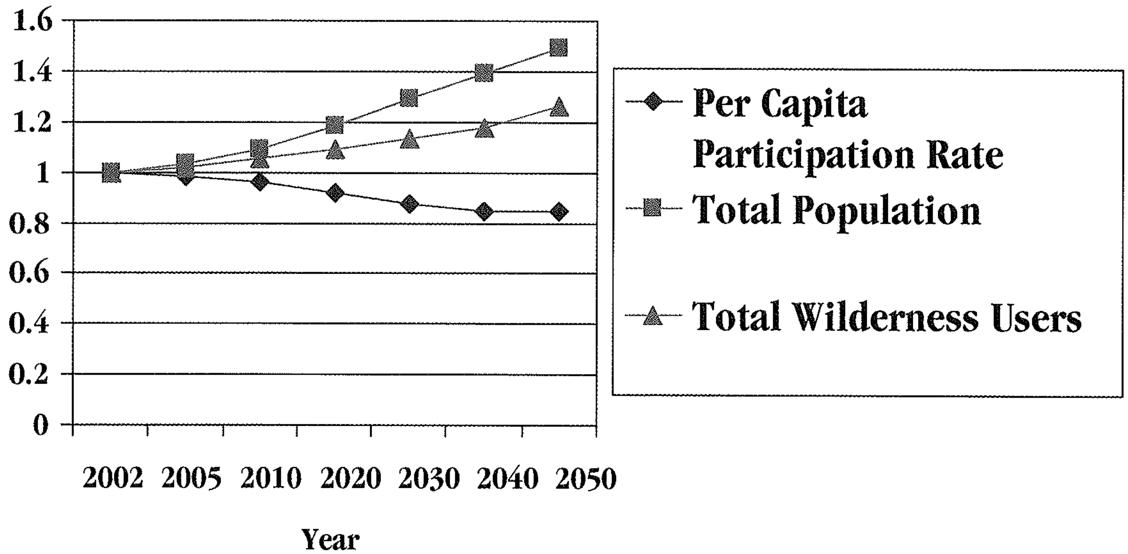

Figure 1. Participation Index 2002 to 2050

ber of days increases with amount of education. The only other ambiguity between the results for the logistic and negative binomial regressions was that the variable for other races was not significant in determining the number of days on-site. Other races are less likely to participate than whites, but more likely than blacks or Hispanics. However, days of participation for other races is not statistically discernable from whites.

Projections

In order to assess future participation and use of Wilderness, the estimated regression models are combined with projections of explanatory variables from other sources. U.S. Census projections were used to estimate total population and means for age, gender, race (black), ethnicity (Hispanic), other race, native born, and urban dwelling. Projected means for these variables at 10-year intervals are combined with the parameter estimates for the respective participation and days models to develop an index of per-capita rates through 2050. These per-capita indices are combined with projected population growth to yield indices for total participation and total days on-site for the same time periods. It should be noted that the regression models and consequent indices are based on NSRE responses to "wilderness and other primitive areas," not just designated Wilderness. Nevertheless, given the potential for substitution across such areas in filling recreation preferences, this is arguably a good first approximation for future participants and users of Wilderness.

The participation index is reported in Figure 1. The estimated logistic model combined with projected changes in the composition of the U.S. population indicates that potential Wilderness participation per capita will decrease by 15% nationwide in the next half century. This result is primarily driven by increases in population proportions for categories that are currently negatively correlated with participation in wilderness and primitive area recreation. Over the same time period, the general population is expected to increase by 49%. The growth of the population will accordingly dominate the decrease in participation per capita, leading to an overall increase in potential Wilderness recreation participants by 26%.

Wilderness day indices are reported in Figure 2. Here the pattern is similar to the predicted trend in participation. For example, the potential annual per-capita days spent in Wilderness will decline by 19% out to the year 2050. However, the 49% increase in population growth during the same time will offset

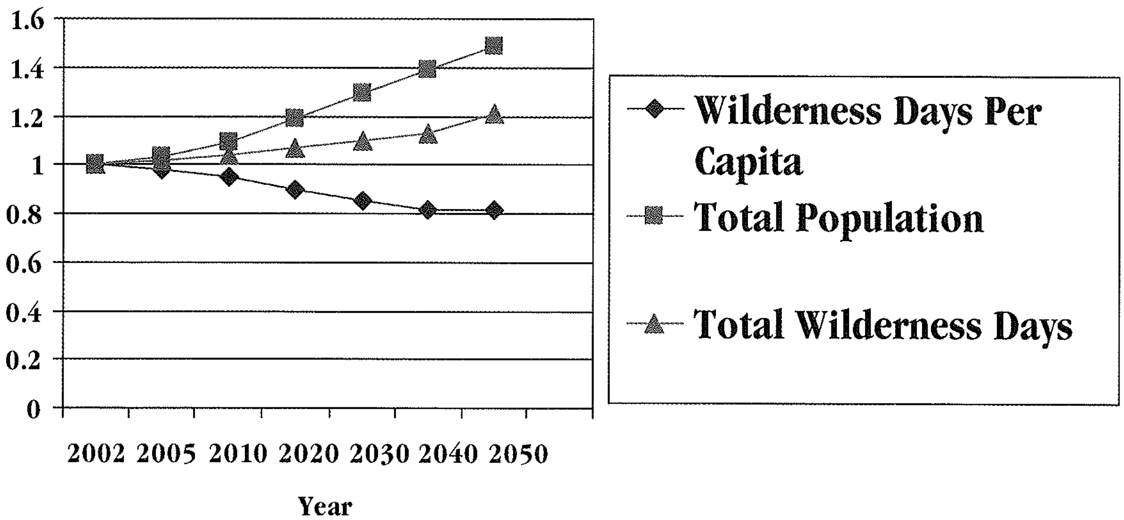

Figure 2. Wilderness Visitor Days Index 2002 to 2050

the per-capita decline resulting in a net increase in potential Wilderness visitor site-days of about 21%.

The projection indices can be combined with estimates of annual participants and days to describe the potential magnitude of future Wilderness use. In spite of the difficulties associated with counting Wilderness users, a number of estimates exist for visitor days to the NWPS and various components thereof. For example, Cole estimated nearly 17 million visitor days of use throughout the NWPS for 1994. Loomis, using Cole's data, subsequently estimated 12 million visitor days for NF wilderness and 14 million visitor days for NF and NPS wilderness combined. Cordell and Teasley, using household data for the same time, estimated between 15.7 and 34.7 million trips to the NWPS annually. Finally, using a different approach, Loomis and Richardson estimated 26.7 million visits annually to the NWPS. These estimates present a range of annual use somewhere between about 14 million and 35 million days per year, while providing no estimate of the number of unique participants.

Alternatively, preliminary estimates of NF Wilderness site-visits from the NVUM project indicated about 10.5 million site-visits to NF Wilderness in 2001 (English et al.). This estimate has been subsequently revised to 8.8 million site-visits and 12.4 million site-days, annually, based on the complete 4-year cycle of NVUM data collection (USDA Forest Service). Using estimated visitor shares among the 4 federal agencies managing the NWPS as reported in Bowker et al. (2005a), we estimate annual recreation use for the NWPS at 10.7 million visits per year. With a multiday average trip length computed from NVUM Wilderness visitors (2.52), this translates to approximately 16.3 million on-site days system wide. This is considerably lower than the 26.6 million days reported in Bowker et al. (2005a). However, their estimate is based on the preliminary NVUM visit estimate and an average trip length derived from previously published site-level Wilderness studies of over 4 days per visit.

Table 5 presents estimates of current NF and NWPS Wilderness days for 2002 and 2050 based on the day index in Figure 2. For additional perspective, an estimate of potential days at all wild and primitive areas nationally is presented. The latter is based on estimated mean visitation from the negative binomial model, current population, and the days index. The 21% increase in Wilderness use predicted by the negative binomial simulations translates to 15 million and 19.7 million site-days, respectively, on NF Wilderness and the NWPS by 2050. This amounts to annual increases of

Table 5. Number of Wilderness Days (millions)

	2002	2010	2020	2030	2040	2050
NF wilderness	12.40	12.88	13.21	13.63	14.05	15.00
All NWPS	16.28	16.91	17.34	17.89	18.43	19.69
All wild and primitive areas	741	770	790	814	840	897

2.6 and 3.4 million days, respectively, on the 35 million acres of NF Wilderness and 106 million acres for the NWPS, over half of which is in Alaska.

An estimate of the number of unique individuals annually visiting the NF Wilderness (2.27 million) and the NWPS (2.77 million) is reported in Table 6. The estimates for 2002 are derived using the NVUM estimate for Wilderness site-days (USDA Forest Service), day-use and relative agency share estimates from Bowker et al. (2005a), and an NVUM-based weighted estimate (3.88) of individual NF wilderness visits per year (Bowker et al. 2005b). Also reported are projections through 2050 based on simulations of the logistic participation models and census projections. By the middle of this century, it is estimated that NF Wilderness will be used by 2.9 million unique visitors, while the NWPS will see about 3.5 million unique visitors annually. As in Table 5, we also report the number of unique individuals visiting wild and primitive places in general to lend perspective.

Discussion

Essential Wilderness attributes include relative naturalness, lack of development, and low visitor density (Freimund and Cole). With an increase in total U.S. population of almost 50% by the year 2050, the amount of pressure on Wilderness is expected to increase, threatening these Wilderness attributes. Past experience shows that with an increase in population growth there will be an increase in total recreation use, including the density of recreation use in most Wilderness areas (Freimund and Cole). The issue of use levels in wild lands is not a new concern. In fact, as early as the 1930s there was concern expressed over this matter (Freimund and Cole). Since that time there have been major developments in monitoring and managing for use levels.

Our models, combined with census projections for population growth and expected structural changes in the U.S. population, suggest that Wilderness use and Wilderness users will increase at less than half the rate of the general population increase. Nevertheless, the amount of pressure on these wildland resources is still increasing. Moreover, as more wildlands and rural areas are developed the remaining lands will come under increasing pressure. Between 1982 and 1997, 3% of natural range was converted to agricultural or developed uses and 11.7 million acres of natural forest cover was converted to developed uses (Cordell and Overdevest). In this study it was determined that distance to a Wilderness area was an important factor in determining the probability of participation and amount of participation. Populations surrounding areas with abundant natural scenery and opportunities for outdoor recreation are increasing. This is especially true for Wilderness areas proximal to rapidly growing cities in the West and Southwest.

Another factor potentially increasing Wilderness use at a rate faster than we predict is

Table 6. Number of Wilderness Participants (millions)

	2002	2010	2020	2030	2040	2050
NF wilderness	2.27	2.39	2.47	2.57	2.68	2.87
All NWPS	2.77	2.91	3.01	3.14	3.27	3.50
All wild and primitive areas	56.6	59.5	61.6	64.1	66.8	71.5

the possibility of Hispanic and Asian-American acculturation resulting in stronger preferences for Wilderness on the part of these groups in the future (Johnson et al. 2004). For the general population, greater mobility and growing interest in health and physical activity and the environment, as well as new technological developments in outdoor recreation equipment (Hendee, Stankey, and Lucas), are all factors contributing to increased use.

In order to effectively manage Wilderness over the long term, an orderly planning process is needed to develop strategies necessary to meet specific management objectives (Hendee, Stankey, and Lucas). Studies like this one can help with developing goals, objectives, and plans to help deal with increased pressures that wilderness and primitive areas will be subjected to in the future. Hendee, Stankey, and Lucas outline a framework for Wilderness management planning that can be flexible and adapted to individual Wilderness areas and needs. This framework can be used to develop goals and objectives and to assess current conditions and make assumptions about future trends, pressures, and problems related to each objective (Hendee, Stankey, and Lucas). Results from this study can be used to help make assumptions about future trends and pressures on wild and primitive areas based on projected population and sociodemographic changes. With projected increases in visitation pressure, managers may have to limit use levels to provide "outstanding opportunities for solitude" as legislated by The Wilderness Act (Freimund and Cole) and to protect the naturalness of the land.

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