Outdoor Recreation Participation in the United States–Projections to 2060

A Technical Document Supporting the Forest Service 2010 RPA Assessment

J.M. Bowker, Ashley E. Askew, H. Ken Cordell, Carter J. Betz, Stanley J. Zarnoch, and Lynne Seymour

The Authors:

J.M. Bowker, Research Social Scientist, U.S. Department of Agriculture, Forest Service, Forest Sciences Laboratory, Athens, GA 30602; **Ashley E. Askew**, Doctoral Candidate, University of Georgia, Department of Statistics, Athens, GA 30602; **H. Ken Cordell**, Pioneering Research Scientist, and **Carter J. Betz**, Outdoor Recreation Planner, U.S. Department of Agriculture, Forest Service, Forest Sciences Laboratory, Athens, GA 30602; **Stanley J. Zarnoch**, Mathematical Statistician, U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC 28804; and **Lynne Seymour**, Associate Professor and Graduate Coordinator, University of Georgia, Department of Statistics, Athens, GA 30602.

This national assessment report is one of several reports by the Forest Service, U.S. Department of Agriculture, completed for the 2010 Renewable Resources Planning Act Assessment. The objective of this report is to evaluate how changes in population, demographics, economic conditions, land use, and climate likely will affect participants and days of participation nationally for 17 natural resource-based recreation activities. The report offers projections to 2060 that explicitly incorporate possible changes in population, demographics, economic conditions, land use, and climate.

July 2012

Southern Research Station
200 W. T. Weaver Blvd.
Asheville, NC 28804

www.srs.fs.usda.gov

Outdoor Recreation Participation in the United States—Projections to 2060: A Technical Document Supporting the Forest Service 2010 RPA Assessment

J.M. Bowker, Ashley E. Askew, H. Ken Cordell, Carter J. Betz,
Stanley J. Zarnoch, and Lynne Seymour

July 2013

This on-line publication contains links to the following spreadsheets referenced within GTR-SRS-160, Outdoor recreation participation in the United States—projections to 2060: a technical document supporting the Forest Service 2010 RPA Assessment:

Web Appendix A

Web Appendix B

Web Appendix C

Web Appendix D

Contents

Introduction 1

Methods and Data 7

Results 10

Key Findings 25

Conclusions 31

Acknowledgments 32

Literature Cited 33

List of Figures

Figure 1—U.S. population growth through 2060 by RPA scenario. 5

Figure 2—Historic and projected U.S. Gross Domestic Product (GDP) through 2060 by RPA scenario. 5

Figure 3—National non-Federal land use change by major categories, RPA A1B scenario 2010–60 (thousand acres). 6

Figure 4—RPA regions and sub-regions. 6

Figure 5—U.S. temperature and precipitation changes from the reference period (1961–90) to the decade surrounding the year 2060 (2055–64).. 8

Outdoor Recreation Participation in the United States—Projections to 2060: A Technical Document Supporting the Forest Service 2010 RPA Assessment

J.M. Bowker, Ashley E. Askew, H. Ken Cordell, Carter J. Betz, Stanley J. Zarnoch, and Lynne Seymour

Abstract

We developed national projections through 2060 of participation for 17 outdoor recreation activities. The projections were made under futures that vary by population growth, socioeconomic conditions, land use changes, and climate. We used a two-step approach to project the number of participants and the days of participation. The estimation step yielded national-level statistical models of adult participation rate and days of participation by activity. The simulation step combined the models with external projections of explanatory variables at 10-year intervals to 2060. Per capita estimates for participation and days were then combined with population projections to derive estimates of participants and days of participation by activity. Results were derived across three 2010 Resources Planning Act Assessment scenarios that each feature three associated climate futures. Findings indicated that outdoor recreation will remain a key part of the social and economic fabric of the United States. In the absence of climate change, the number of participants in the 17 recreation activities is projected to increase over the next 5 decades. In some cases, the participation rate will decline, but population growth will ensure that the number of participants increases. Some climate futures led to projected declines in participants, e.g., snowmobiling and undeveloped skiing showed declines in participant numbers up to 25 percent, despite population growth. Climate was also shown to have disparate effects on projections of annual days of participation, particularly for snowmobiling, undeveloped skiing, and hunting.

Keywords: Climate change, double-hurdle model, outdoor recreation, participation rate, recreation demand, recreation projections

INTRODUCTION

The 2010 Resources Planning Act (RPA) Assessment is the fifth assessment prepared under mandate of the1974 Forest and Rangeland Renewable Resources Planning Act (RPA) (P.L. 93-378, 88 Stat 475, as amended). The RPA Assessment provides reliable information, every 10 years, on the status, trends, and projected future of the Nation's renewable resources.

The Forest Service, U.S. Department of Agriculture, has conducted natural resource analyses for more than a century. The 1974 RPA legislation established a periodic reporting requirement and broadened coverage of the Forest Service analyses to include all renewable resources on forests and rangelands of the United States. The RPA Assessment uses a 50-year projection period in its analyses of forests, rangelands, wildlife and fish, biodiversity, water, outdoor recreation, wilderness, and urban forests, as well as the effects of climate change on these resources. In this assessment report, we present national projections, through 2060, of outdoor recreation participation and use for 17 natural resource-based recreation activities or activity composites. In contrast to previous RPA assessments, this report develops recreation projections, for alternative futures, that allow variation in population growth, socioeconomic conditions, land use changes, and climate.

Participation and Use

For this report, a participant in an outdoor recreation activity is an adult resident of the United States who has reported engaging in that activity at least once in the past 12 months. Participation is a general indicator of the size of a given recreation market, and it also can be a gauge of public interest. Land managers and legislators can benefit from knowing how many people participate in a given recreation activity and how this measure could change over time and affect both public support and potential ecological and social carrying capacities (Dale and Weaver 1974, Manning 1997). For example, if more than 80 percent of the population hikes but 4 percent of the population goes snowmobiling, public resource management agencies and private land managers may see a greater need for hiking trails than for snowmobiling trails. Measures of participation, either per capita (participation rates) or in absolute numbers of participants, provide the broadest measure of a recreation market.

A second measure of recreation use is consumption or participation intensity. Consumption can be measured in number of times, days, visits, or trips within a time span, e.g., in a given year. The Forest Service has used such consumption measures as recreation visitor days and national forest visits. Consumption measures of participation (knowing how often and for how long people engage in an activity) provide an important additional dimension for resource managers who need to know how best to allocate resources, such as campsites, and plan new ones.

Participation and consumption at the national level provide the broadest measures of an outdoor recreation market. The consumption measure used in this study is the number of days in the previous year that an adult resident of the United States reported engaging in a specific activity. A day, in this case, follows the National Survey on Recreation and the Environment (NSRE) definition of an activity day, i.e., any amount of time spent on an activity on a given day, whether or not that activity was the primary reason for recreating outdoors. A person may engage in more than one activity per day, and, thus, a person's activity day total per year may not exceed 365 for any specific activity but it may when all activities are combined (Cordell 2012).

The above-named two metrics—participation and consumption—are origin based, i.e., they result from household-level surveying. There is no additional information on where the respondent engaged in the participation for any activity, although research shows that the vast majority of outdoor recreation takes place within a few hours' drive of home (Hall and Page 1999). Table 1 shows participation rates and participant numbers for 2008, along with total days spent participating and average days per participant, for the 17 outdoor recreation activities examined in this study.

Past and recent outdoor recreation trends are important indicators of what may happen with outdoor recreation in the near future (Cordell 2012, Hall and others 2009). However, simple descriptive statistics or trends do not formally address underlying factors and associations that may be driving these trends. Thus, a trend may be of limited value as an indicator if the time horizon is long or if the trend's driving factors are expected to deviate substantially from historic levels. Trend analysis, therefore, can be supplemented with projection models that relate recreation participation directly to factors known to influence participation behavior. The projection models then can be used in conjunction with external projections of relevant factors, including population growth, to simulate future recreation participation and consumption. Such modeling allows changes in recreation participation and consumption behavior to be assessed in light of previously unseen changes in factors driving this behavior, e.g., large changes in demographic, economic, land use, and climate factors.

Previous research has established that race, ethnicity, gender, age, income, and supply, and proximity to settings affect the rate of outdoor recreation participation as well as the participation intensity or consumption (Bowker and others 1999, Bowker and others 2006, Cicchetti 1973, Hof and Kaiser 1983a, Leeworthy and others 2005). Similarly, these factors, along with others, including distance and quality descriptors, have been used to explain visits to specific sites (Bowker and others 2007, Bowker and others 2010, Englin and Shonkwiler 1995, Ovaskainen and others 2001). Reliable information about these factors is often available from external sources, e.g., U.S. Census data or parallel research efforts aimed at modeling and simulating influential variables into the future. Such information thus can be available long before recreation survey results are obtained.

A two-step approach was used to project participation and consumption of 17 traditional outdoor recreation activities (table 1). The first step, or model estimation step, focused on developing national-level statistical models of adult per capita participation and days of participation (conditional on being a participant) for each of the activities. The participation model describes the probability of an individual participating in a specified activity. Then, for those activities in which an individual participated, the consumption model describes the number of days of participation. This information allows a better understanding of what influences individual recreation choices or behavior, and supports an examination of how changes in individual recreation choices or behavior might correspond to changes in underlying factors such as demographics, resource availability, and climate.

The second step, or simulation step, combines the estimated models with external projections of relevant explanatory variables to generate estimated per capita participation probabilities and conditional expected days of participation for each activity at 10-year intervals to 2060. Per capita estimates for participation and days are, in turn, combined with population projections to derive national estimates of participants and days of participation for each activity. These estimates then are used to create indices by which 2008 baseline estimates of participants and days of participation for the various activities (table 1) can be scaled. Indices of estimated adult participants for each of the 17 activities and days of annual participation are presented across the three 2010 RPA Assessment scenarios and associated climate futures described below.

RPA Future Scenarios

Overall, the various RPA Assessment analyses address a wide range of economic and ecological phenomena. Individually, the economic, social, and biological systems are quite complex. Integrating effects across these systems adds additional complexity. The 2010 Assessment uses a set of future scenarios that influence the resource projections, allowing examination of a range of possible futures for the renewable natural resources of the United States. Scenarios are used to explore alternative futures and provide a framework for evaluating a plausible range of future resource outcomes. A set of comprehensive global scenarios from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment (TAR) and Fourth Assessment (AR4) were selected to provide global context and quantitative linkages between National and global trends. The range of scenarios considered in the IPCC Assessments provided a broad spectrum of potential futures from which a subset relevant to evaluating potential future resource conditions in the United States and trends were selected (USDA Forest Service 2012).

Table 1—Outdoor recreation activities for 2008 by participants, participation rate, days, and days per participant

Activity[a]	Participants (millions)[b]	Percent participating	Days (millions)[b]	Days per participant
Visiting developed sites				
Developed site use–family gatherings, picnicking, developed camping	194	82	2,246	11.7
Visiting interpretive sites–nature centers, zoos, historic sites, prehistoric sites	158	67	1,249	7.8
Viewing and photographing nature				
Birding–viewing and photographing birds	82	35	8,255	97.7
Viewing–viewing, photography, study, or nature gathering related to fauna, flora, or natural settings	190	81	32,461	169.6
Backcountry activities				
Challenge activities–caving, mountain biking, mountain climbing, rock climbing	25	11	121	4.8
Equestrian	17	7	263	16.3
Hiking–day hiking	79	33	1,835	22.9
Visiting primitive areas–backpacking, primitive camping, wilderness	91	38	1,239	13.2
Motorized activities				
Motorized off-road use	48	20	1,053	21.6
Motorized snow use	10	4	69	7.3
Motorized water use	62	26	958	15.3
Hunting and fishing				
Hunting—small game, big game, migratory bird, other	28	12	538	19.1
Fishing—anadromous, cold-water, saltwater, warm water	73	31	1,369	18.5
Non-motorized winter activities				
Downhill skiing—downhill skiing, snowboarding	24	11	178	7.2
Undeveloped skiing—cross-country skiing, snowshoeing	8	3	52	6.6
Non-motorized water activities				
Swimming—swimming, snorkeling, surfing, diving, visiting beaches, or watersides	144	61	3,476	24.0
Floating—canoeing, kayaking, rafting	40	17	262	6.5

Source: National Survey on Recreation and the Environment (NSRE) 2005–09, Versions 1 to 4 (January 2005 to April 2009), n=24,073 (USDA Forest Service 2009).
[a]Activities are individual or activity composites derived from the NSRE. Participants are determined by the product of the average weighted frequency of participation by activity for NSRE data from 2005–09 and the adult (>16) population in the United States during 2008 (235.4 million).
[b]Because of small population and income differences, initial participant and days values for 2008 differ across Resources Planning Act scenarios, thus an average is used for a starting value.

Three RPA scenarios were developed that describe alternative national and county-level futures linked to IPCC assumptions and projections of global population growth, economic growth, bioenergy use, and climate (Alcamo and others 2003, IPCC 2007, Nakićenović and others 2000). For continuity, we retained the scenario designations used in the IPCC third and fourth assessments along with the designation RPA to remind readers that these scenarios are tied to IPCC assumptions but that some adjustments were made. The RPA scenarios are, therefore, designated as RPA A1B, RPA A2, and RPA B2. Table 2 summarizes the global and national characteristics of these scenarios, and shows that the national population growth rate is similar to global population growth rates while real GDP growth is considerably lower for the United States (and other developed countries) than the global growth rate. Detailed information about the selection of scenarios and climate projections can be found in USDA Forest Service (2012).

Population projections were developed for each RPA scenario. Projections for the IPCC A1B scenario were based on the 1990 Census. IPCC A1B population projections were updated to align with the 2004 Census population series for 2000–50 (U.S. Census Bureau 2004), with an extrapolation to 2060. The population projections for IPCC A2 and B2 were updated to begin at the same starting point, in year 2000, and to then follow a projection path that maintained the same proportional relationship to A1B as in the original IPCC projections. Figure 1 illustrates the population projections for the three RPA scenarios relative to historic population trends in the United States. County level population projections were developed for the three RPA scenarios (Zarnoch and others 2010).

Macroeconomic trends, e.g., Gross Domestic Product (GDP), disposable personal income, and labor productivity, critically influence the supply and demand of renewable resources, and thus also recreation demand. Original IPCC data were based on economic data from the early 1990s. GDP projections were updated to start with the official U.S. GDP value for 2006 for all three scenarios (U.S. Department of Commerce 2008a). GDP growth rates, provided by a commissioned report, were applied to develop an adjusted projection of GDP for the A1B scenario. Revised A2 and B2 GDP projections maintained the same proportional relationship between the three scenarios as defined by the original IPCC GDP projections. Figure 2 shows the differences among the three RPA scenario projections for updated GDP in comparison to historic U.S. GDP.

Projections of personal income (PI) and disposable personal income (DPI) also were developed. The U.S. Government's 2006 PI and DPI data were used to start the updated projection for the RPA A1B scenario (U.S. Department of Commerce 2008b). RPA A2 and B2 projections for PI and DPI maintained the same proportional relationship across scenarios that were used to calculate the trajectories for GDP. The national DPI and PI projections were disaggregated to the county level (USDA Forest Service 2012).

The RPA scenarios were completed before the global economic downturn from 2008 to 2012. The year 2006 was chosen as the base year for economic variables because data from 2006 were the most recent data available when the scenarios were constructed. The projection trend line from 2006 to 2010 does not account for the downturn in GDP and other economic variables through 2010, creating a discontinuity in the early years of the projection period. Long-term projections are not intended to predict economic ups and downs, meaning that periodic economic recessions would not be part of projected 50-year trend. While the recent global recession was severe, the range of scenarios included in this Assessment have varying rates of economic growth, both

Table 2—Key characteristics of the Resources Planning Act (RPA) scenarios

Characteristic	Scenario RPA A1B	Scenario RPA A2	Scenario RPA B2
IPCC[a] general global description	Globalization, economic convergence	Regionalism, less trade	Slow change, localized solutions
IPCC global real GDP[b] growth (2010–60)	High (6.2X)[c]	Low (3.2X)	Medium (3.5X)
IPCC global population growth (2010–60)	Medium (1.3X)	High (1.7X)	Medium (1.4X)
IPCC global expansion of primary biomass energy production	High	Medium	Medium
U.S. GDP growth (2006–60)[d]	High (3.3X)	Medium (2.6X)	Low (2.2X)
U.S. population growth (2006–60)[d]	Medium(1.5X)	High (1.7X)	Low (1.3X)

[a] IPCC = Intergovernmental Panel on Climate Change
[b] U.S. Gross Domestic Product
[c] Numbers in parentheses are the factors of change in the projection period. For example, world GDP increases by a factor of 6.2 times between 2010 and 2060 for scenario RPA A1B.
[d] Not based on IPPC assumptions.

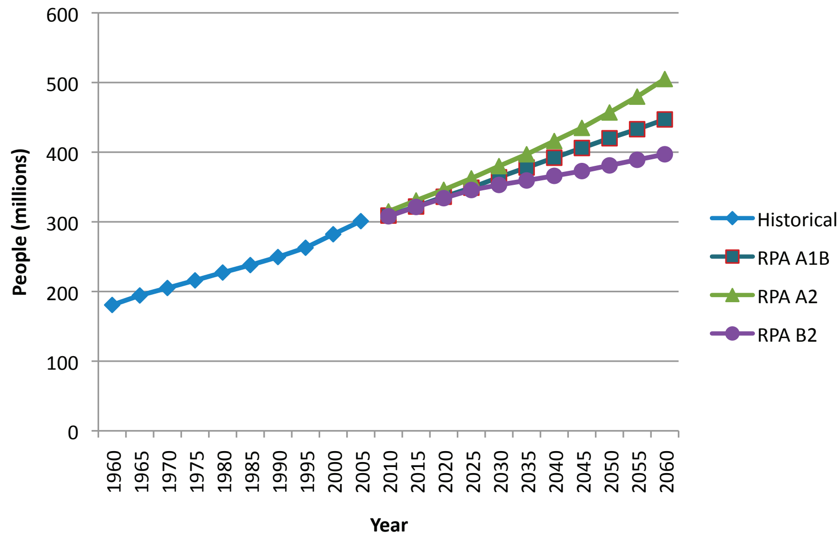

Figure 1—U.S. population growth through 2060 by RPA scenario.

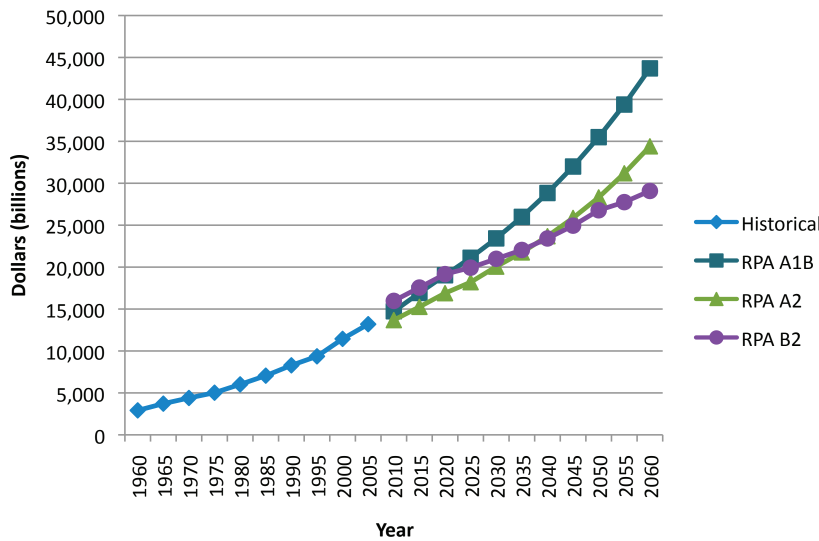

Figure 2—Historic and projected U.S. Gross Domestic Product (GDP) through 2060 by RPA scenario.

for the United States and globally, that provide a robust set of projections across the range of potential futures.

Land use change is a key factor in outdoor recreation participation and demand. Land use change was projected for all counties in the contiguous United States in five major land use classes: pasture, cropland, forest, range, and urban and developed uses (Wear 2011). All land use change was assumed to occur on non-Federal land within these categories; all other uses are held constant over the projection period, including Federal land, water area, enrolled Conservation Reserve Program lands, and utility corridors for fuels, water, and electricity.

The changes in major land uses over the projection period for scenario A1B are summarized in figure 3. The pattern of change is similar for the other scenarios, but the change in acres is smaller in both A2 and B2 (USDA Forest Service 2012). In all scenarios, increases in urban and developed uses are the dominant force in land use change, while all other land uses are projected to lose area accordingly. The highest rate of urbanization occurs in scenario RPA A1B, indicating that the strong growth in personal income combined with moderate population growth creates more development pressure than population growth alone. Scenario RPA B2 has the lowest rate of urbanization. Urban and developed area increases by 69 million acres between 2010 and 2060 for RPA A1B, almost doubling the amount of urban area over the projection period (Wear 2011).

Forest land declines by almost 31 million acres over the projection period in scenario RPA A1B, while B2 projects a loss of 16 million acres (Wear 2011). The South (fig. 4) is projected to experience the largest decline in forest area by 2060, losing about 17 million acres in scenario A1B. The large losses in the South reflect both an abundant forest resource and the region with the highest projected population growth and urbanization. The North has the second largest loss of

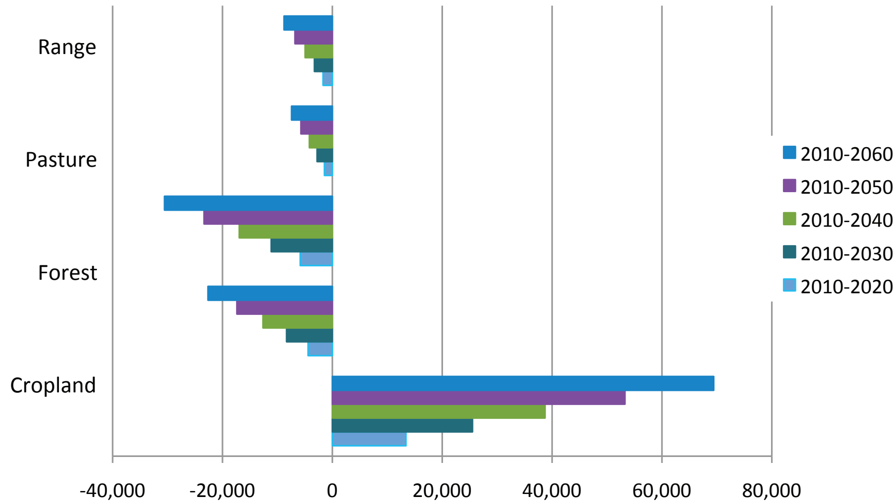

Figure 3—National non-Federal land use change by major categories, RPA A1B scenario 2010–60 (thousand acres).

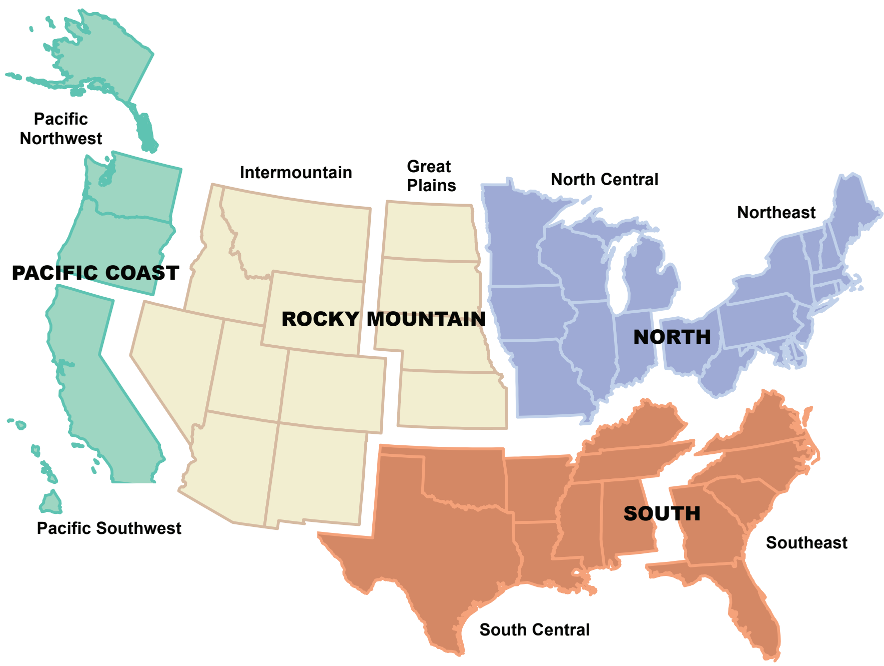

Figure 4—RPA regions and sub-regions.

forest land in A1B (almost 10 million acres), followed by smaller losses in the Rocky Mountains and Pacific Coast regions. While losses of forest land are smaller in scenarios RPA A2 and B2, the pattern of forest land loss across scenarios is similar regionally, with the exception of the Pacific Coast region. In the Pacific Coast region, the RPA A2 scenario has higher forest loss than RPA A1B, but the difference is quite small. Moreover, under each of the RPA scenarios, public forest and rangeland is expected to remain relatively static over the projection period.

After private forest land, cropland has the next greatest loss of acres, most of them in the Eastern United States, where most cropland is found. Cropland losses are nearly equally split between the North and South regions. Rangeland losses are concentrated in the Rocky Mountain region, which has about half the total rangeland losses. The remainder of rangeland losses is split between the South (primarily in Texas) and Pacific Coast (mostly southern California) regions.

Little work on a large scale related climate to outdoor recreation, but an assumption of this study was that long-term climate changes could affect recreation demand. Each IPCC scenario had multiple associated climate projections. The climate projections vary across scenarios in response to the associated levels of greenhouse gas emissions, but they also vary within a scenario because the general circulation models (GCM) differ in their approaches to modeling climate dynamics. Therefore, to capture a range of future climate conditions, three GCMs were selected for each of the three

RPA scenarios (Joyce and others, in press). Table 3 lists the IPCC scenarios and associated GCMs that were used to develop climate projections for the three RPA scenarios.

The IPCC climate projections first were downscaled to the approximately 10-km scale and then aggregated to the county scale. For detailed documentation of the development of the RPA climate scenario-based projections and downscaling process, see Joyce and others (in press). At the scale of the contiguous United States, the A1B scenario mean annual temperature and total annual precipitation show the greatest warming and the driest climate of all scenarios at 2060 (fig. 5). The A2 scenario becomes the wettest, although the precipitation changes at the scale of the United States are small to 2060. The B2 scenario projects the least warming of these three scenarios. The individual RPA scenario-climate model combinations highlight the variation within each scenario of the individual climate model projections. For example, within the A2 scenario, the CSIRO-Mk3.5 model projects the least warming and the MIROC3.2 model projects the greatest warming. While all areas of the United States show increases in temperature, the rate of change varies. Regional differences in precipitation projections vary greatly (Joyce and others, in press).

Summary

The objective of this assessment report is to evaluate how changes in population, demographics, economic conditions, land use, and climate likely will affect participants and days of participation nationally for 17 natural resource-based recreation activities. The demographic, climate, and land use projections described above were used to develop projections of future resource uses and conditions. Not all of the projected variables are used in all models, but all of the projection models used some subset of these variables. As a result, the scenarios and their underlying assumptions provide a common framework for comparing results across RPA resource analyses.

This assessment report proceeds in three main parts. First, we present the statistical methods and previous research upon which per capita participation and consumption models are based. Next, we describe the data used in the estimation step, including projections of the various income and population growth factors and relevant assumptions—and we present estimation and simulation steps for national participation and days projections by activity and RPA scenario to 2060. Finally, we discuss some of the key findings within and across categories as well as with respect to factors driving change over the projection period.

METHODS AND DATA

Models used to assess recreation demand decisions can be grouped into three basic categories: (1) site-specific user models, (2) site-specific aggregate models, and (3) population-level models (Cicchetti 1973). Cicchetti (1973) pioneered cross-sectional population-level models with the household-based 1965 National Survey of Recreation to estimate annual participation and use nationally for many outdoor recreation activities. Cicchetti (1973) then used estimated models and Census Bureau projections of socio-demographic variables and population to forecast participation and use to 2000. Researchers have used the cross-sectional population-level approach to estimate and project participation and use for recreation activities at national and regional levels (Bowker 2001, Hof and Kaiser 1983b, Leeworthy and others 2005, Walsh and others 1992) and for previous RPA Assessments (Bowker and others 1999, Hof and Kaiser 1983a). Researchers also have used alternative approaches—wherein population data were combined with individual site-level data or county-level data to project participation or consumption—to project national or regional recreation demand (Bowker and others 2006, Cordell and Bergstrom 1991, Cordell and others 1990, Englin and Shonkwiler 1995, English and others 1993, Poudyal and others 2008).

A major drawback of cross-sectional models, imposed by the nature of the data, is that the structure of the estimated models remains constant over the forecast period. For example, the factors that influence participation or use are assumed to have the same effects throughout the projection period. Hence, with model parameters constant in time, and barring major shifts

Table 3—List of General Circulation Models (GCM) used in the Resources Planning Act (RPA) scenario-climate combinations in the recreation participation models

RPA scenario	Climate 1[a]	Climate 2[a]	Climate 3[b]
	General Circulation Model		
A1B	CGCM3.1	CSIRO-Mk3.5	MIROC3.2
A2	CGCM3.1	CSIRO-Mk3.5	MIROC3.2
B2	CGCM2	CSIRO-Mk2	HadCM3

[a] AR4 GCMs were downloaded from the World Climate Research Program Climate Model Intercomparison Project 3 website.
[b] TAR 47 GCMs were downloaded from the Intergovernmental Panel on Climate Change Data Distribution Centre. See Joyce and others (in press) for additional details.

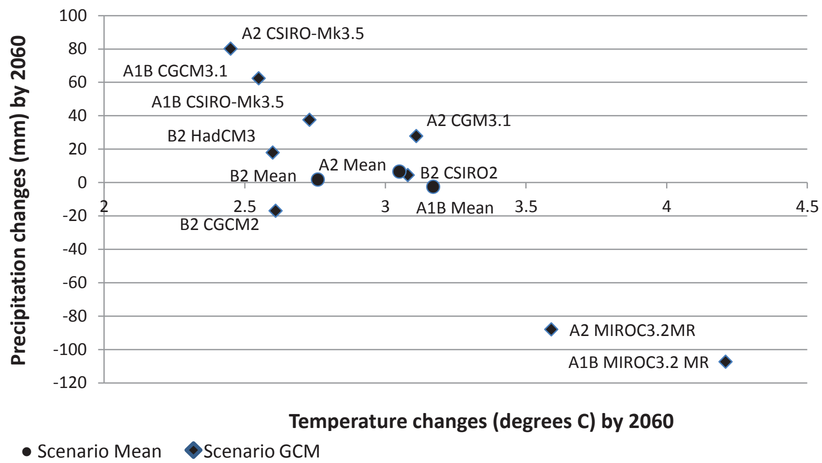

Figure 5—U.S. temperature and precipitation changes from the reference period (1961–90) to the decade surrounding the year 2060 (2055–64).

in demographics, the results often are driven by population growth. This assumption can be tenuous. For example, new sports brought about by technological changes or shifts in tastes and preferences, such as mountain biking, jet skiing, snowboarding, flat-water kayaking, and orienteering, are unlikely to be correctly represented in the models. Moreover, if data are collected while activities are in a new or rapid growth phase, recent trends can be misleading, e.g., Cordell (2012) reports a recent increase in kayaking participation of 154 percent in less than a decade, although sustaining such a rate of growth for 50 years is unlikely. Nevertheless, without appropriate time-series data, researchers are left with the inherent limitations of cross-sectional models, as a second-best alternative to estimate and forecast participation and use. A further drawback of these models is the difficulty of accounting for the dampening effects of future congestion, supply limitations, and relative price changes on growth in participation and use.

National cross-sectional population-level logistic models are used to describe the probability of adult participation in each of the 17 activities as:

$$P_i = \frac{1}{1 + \exp(-X_i B_i)} \qquad (1)$$

where

P_i = the probability that an individual participated in recreation activity i in the preceding year

The vector X_i contains socio-demographic characteristics unique to activity i across individuals, relevant supply variables for activity i across individual locations (table 4), and at least one climate variable related to conditions at or near the individual's residence

B_i represents a vector of parameters associated with activity i. The models were estimated using SAS (2004).

Logistic models for each activity, based on NSRE data from 1999–2008 (USDA Forest Service 2009), were combined with 2008 baseline population-weighted sample means for the explanatory variables to create an initial predicted per capita participation rate for each activity. The per capita participation rates were recalculated at 10-year intervals using projected changes in the explanatory variables. Indices then were created for the participation rates by which the NSRE 2005–09 average population-weighted participation frequencies (baselines) were scaled, leading to indexed per capita participation rates for each of the 17 activities. Indexing the 2005–09 averages by changes in model-predicted rates was judged to be superior in terms of mitigating potential nonlinearity biases associated with complete reliance on logistic predicted values (Souter and Bowker 1996). The indexed participation rate estimates then were combined with projected changes in population, according to each of the three 2010 RPA Assessment scenarios, to yield indexed values for total adult participants across the 17 activities.

Participation intensity or consumption models are similar to the participation models listed above except that an integer metric represents use, i.e., the number of times, days, visits, trips, or events is modeled rather than the binary (yes/no) decision to participate. The general specification for the population-level consumption model is:

$$Y_i = f(X_i, Q_i) + u_i \qquad (2)$$

where

Y_i represents the annual number of different days during which an individual participates in activity i

X_i = a vector of individual socio-demographic characteristics

Q_i = a vector of supply relevant variables for activity i

u_i = a random disturbance term specific to activity i.

Table 4—Socioeconomic and supply variables for modeling and forecasting outdoor recreation participation and days-of-participation by adult U.S. residents

Variable	Description
Gender	1=male
American Indian	1=American Indian, non-Hispanic, 0=otherwise
Asian/Pacific Islander	1=Asian/Pacific Islander, 0=otherwise
Hispanic	1=Hispanic, 0=otherwise
African-American	1=African-American, non-Hispanic, 0=otherwise
Bachelors	1=Bachelor degree, 0=otherwise
Below High School	1=less than high school, 0=otherwise
Postgraduate	1=postgraduate degree, 0=otherwise
Some College	1=some college or technical school, 0=otherwise
Age	Respondent age in years
Age Squared	Respondent age squared
Income	Respondent household income [US$(2007)]
Population Density	County area divided by population (base 1997)
Coastal	1=county on coast, 0=otherwise
For_ran_pcap	Sum of forest land acres and rangeland acres divided by population at county level and at 50-, 100-, and 200-mile radii (base 1997)
Water_pcap	Water acres divided by population at county level and at 50-, 100-, and 200-mile radii. (base 1997)
Mtns_pcap	Mountainous acres divided by population (base 1997)
Pct_mtns_pcap	Percentage of county acres in mountains divided by population multiplied by 100,000 (base 1997)
Natpark_pcap	Number of nature parks and similar institutions divided by population multiplied by 100,000 (base 1997)
Fed_land_pcap	Sum USDA Forest Service, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, USBR, Tennessee Valley Authority, and USACE acreage divided by population (base 1997)
Avg_elev	Average elevation in meters at county level and 50-, 100-, and 200-mile radii (base 1997)

These integer or count data models are often estimated using negative binomial specifications with a link function of semi-logarithmic form (Bowker 2001, Bowker and others 1999, Zawacki and others 2000).

Variations of these consumption or demand models have been developed for onsite applications, where all observed visits are recorded as positive integers (Bowker and Leeworthy 1998). Such zero-truncated models have been applied extensively in onsite recreation demand estimation and valuation research (Ovaskainen and others 2001). In some cases the estimated models have been extrapolated to general populations, assuming that visitors and non-visitors come from the same general population of users (Englin and Shonkwiler 1995). This approach, wherein population data were combined with individual site-level data, was suggested by Cordell and Bergstrom (1991) and used in a previous RPA Assessment by Cordell and others (1990) with linear models to estimate outdoor recreation trips nationally for 31 activities and to project the number of trips by activity from 1989 to 2040. English and others (1993) extended the models and projections by Cordell and others (1990) to the regional level by combining parameter estimates from national models with regional explanatory variable values. Others have questioned the efficacy of extrapolating parameter estimates from the onsite demand models to the population at large (Hagerty and Moeltner 2005).

Household data, such as from the NSRE, may report zero visits, and, therefore, problems related to onsite samples and extrapolating onsite models to general populations are not issues. In a previous RPA Assessment analysis, Bowker and others (1999) used data from the 1994–95 NSRE, the U.S. Census, and the 1997 National Outdoor Recreation Supply Information System (NORSIS) database of the Forest Service in projections from 2000 to 2050 of participation and consumption (annual days and trips) for more than 20 natural resource-based outdoor activities, nationally, and in four geographical regions of the United States. That analysis moved beyond participation modeling to include negative binomial count models to estimate consumption (days and trips annually) and project these measures over the same time period. Bowker (2001) followed the same approach, using NSRE and State-level data in projections from 2000 to 2020 of participation and consumption in outdoor recreation activities in Alaska. Leeworthy and others (2005) used NSRE 2000 data in projections from 2000 through 2010 of participation and consumption of marine-related outdoor recreation. Bowker and others (2006) applied similar methods with 2000 NSRE and National Visitor Use Monitoring data (English and others 2002, USDA Forest Service 2010) in projections from 2002 through 2050 of Wilderness and primitive area recreation participation and consumption.

Alternatively, if one thinks that observed zeros for the dependent variable (days of participation) are excessive or not entirely caused by the same data generating process as the positive values, a hurdle model structure or a zero-inflated count procedure is recommended (Cameron and Trivedi 1998). The hurdle model, employed in this analysis, combines the probability of participation (threshold) with the estimated number of days for those participating, i.e.,

$$E[Y|X] = Pr[Y > 0|X1] * E[Y|Y > 0, X2] \qquad (3)$$

The hurdle model allows different vectors of explanatory variables (X1 and X2) for the respective products of the expectation in equation 3, i.e., the probability and conditional-days portions of the model. Here, the former is estimated as a logistic (equation 1) and the latter estimated as a truncated negative binomial, thus leading to two unique sets of estimated parameters. Each of the 17 national outdoor recreation activity day hurdle models were estimated with NLOGIT 4.0 (Greene 2009), using 1999–2008 NSRE data for American households (USDA Forest Service 2009), county level climate data (Joyce and others, in press), county land use data (Wear 2011), and recreation supply data (Cordell and others, in press). While we did not formally test the hurdle model against the simpler un-truncated negative binomial model (Bowker and others 1999) for each activity, we note that, in virtually all cases, the parameter estimates and the significant variables for the logistic portion differed from the conditional days portion, thus validating the choice of the hurdle model.

As in the procedure for the participation models and indices, hurdle model parameter estimates are combined with 2008 NSRE baseline participation and days estimates, projected explanatory variables, and projected population changes under each of the RPA scenarios to provide indices of projected growth of annual days of participation for the activities listed in table 1. Three climate alternatives (table 3) are used for each of the RPA scenarios in addition to a “no climate change” alternative.

Table 4 lists socioeconomic and supply variables for the various models and projections. The preponderance of these variables was included in the NSRE database (USDA Forest Service 2009). Additional variables related to supply were obtained from Cordell and others (in press). Projections of land use change variables were obtained from Wear (2011).

Historical as well as projected climate data were obtained from Joyce and others (in press). As there was little or no literature available linking climate to household participation and consumption of recreation activities, an ad hoc approach was followed during the model estimation stage, wherein climate variables were created based on 6-year moving averages and arbitrary distances from county centroids. Table 5 lists the climate variables. Each estimated model was limited to one climate variable, and selection occurred on an ad hoc basis, primarily based on model fit.

RESULTS

As discussed in the Methods and Data section, results were estimated for 17 logistic outdoor recreation participation models (equation 1), first without climate variables and then with climate variables (Web appendices A and B, respectively, to this report). Reported results for the logistic participation models include parameter estimates for each activity, values for explanatory variables by scenario and year, odds ratios which indicate the odds of participation occurring in one group to the odds of it occurring in another group, fit statistics, and graphics of total participant growth by activity and RPA scenario. Table 6 lists climate variables used in the participation models.

Logistic parameter estimates then were combined with available projections of explanatory variables to create indexed per capita participation estimates at 10-year intervals through 2060. These indexes were, in turn, combined with population projections for each RPA scenario (A1B, A2, and B2) to develop estimated participant indexes. The participant indexes then were applied to a beginning baseline estimate of participants for each activity, based on weighted national averages calculated from 2005 to 2009 NSRE data, to yield projected adult participants. The 4-year average around 2008 was chosen to avoid any abnormality associated with a single year.

The hurdle model combines the probability of participation in an activity with the expected value of days participating, given one actually participated (equation 3). The estimated logistic models (Web appendices A and B to this report) are thus combined with conditional participation days models to complete the hurdle model. Given that only those who participated are included in the conditional days portion of the model, and thus there are no zero observations for days, a truncated negative binomial model was employed for estimation. As with the logistic participation models above, days models were estimated for each of the 17 outdoor recreation activities, first without climate variables and then with climate variables (Web appendices C and D,

Table 5—Climate variables used for estimating and forecasting outdoor recreation participation and days-of-participation by adult U.S. residents

Variable	Description
Ppt_monthly_mean100[a]	Daily mean of precipitation for all months for resident county and counties within 100 miles of resident county centroid
Ppt_monthly_mean200	Daily mean of precipitation for all months for resident county and counties within 200 miles of resident county centroid
Spring_PET_d200	Spring average daily potential evapotranspiration for resident county and counties within 200 miles of resident county centroid
Tmax_fall50	Mean monthly maximum fall temperature for resident county and counties within 50 miles of resident county centroid
Tmax_geq_25_d200	Percentage of month where mean monthly maximum temperature exceeded 25 °C for resident county and counties within 200 miles of resident county centroid
Tmax_geq_35	Percentage of months where mean monthly maximum temperature exceeded 35 °C in the resident county
Tmax_geq35_d100	Percentage of month where mean monthly maximum temperature exceeded 35 °C for resident county and counties within 100 miles of resident county centroid
Tmax_geq35_d200	Percentage of month where mean monthly maximum temperature exceeded 35 °C for resident county and counties within 200 miles of resident county centroid
Tmax_spring	Mean of the mean monthly maximum temperature in spring in the resident county
Tmax_spring100	Mean of the mean monthly maximum temperature in spring for the resident county and counties within 100 miles of resident county centroid
Tmax_summer	Mean of the mean monthly maximum temperature in summer in the resident county
Tmax_summer50	Mean of the mean monthly maximum temperature in summer for the resident county and counties within 50 miles of resident county centroid
Tmax_summer100	Mean of the mean monthly maximum temperature in summer for the resident county and counties within 100 miles of resident county centroid
Tmax_summer200	Mean of the mean monthly maximum temperature in summer for the resident county and counties within 200 miles of resident county centroid
Tmax_winter	Mean of the mean monthly maximum temperature in winter in the resident county
Tmax_winter100	Mean of the mean monthly maximum temperature in winter for the resident county and counties within 100 miles of resident county centroid
Tmin_leq_0	Percent of month where mean monthly minimum temperature was below 0 °C in the resident county
Tmin_leq_neg10	Percent of month where mean monthly minimum temperature was below -10 °C in the resident county
Total_ppt100	Monthly mean of total monthly precipitation in resident county and counties within 100 miles of resident county centroid
Total_ppt200	Monthly mean of total monthly precipitation in resident county and counties within 200 miles of resident county centroid
Winter_PET_d50	Mean of average daily potential evapotranspiration in winter for resident county and counties within 50 miles of resident county centroid
Winter_PET_d200	Mean of average daily potential evapotranspiration in winter for resident county and counties within 200 miles of resident county centroid
Yearly_PET_d200	Mean of average daily potential evapotranspiration for resident county and counties within 200 miles of resident county centroid.

[a] All variable means are calculated over 6-year periods, e.g., historic data are based on 2001–06 data, 2060 projections are based on means from 2055–60. Seasons were divided into 3-month periods based on the following categories: winter (December, January, and February), spring (March, April, and May), summer (June, July, and August), and fall (September, October, and November).

Table 6—Climate variables for each activity participation and days-of-participation model

Recreation activity	Model	Climate variable
Developed site use	Participation	tmax_summer100
	Days	tmax_spring
Interpretive site use	Participation	tmax_geq35_d100
	Days	tmax_geq_35_d200
Birding	Participation	tmax_geq35_d100
	Days	tmax_spring100
Nature viewing	Participation	tmax_geq_35
	Days	spring_PET_d200
Challenge	Participation	total_ppt100
	Days	winter_PET_d50
Equestrian	Participation	tmax_geq35_d200
	Days	tmax_geq_35
Day hiking	Participation	tmax_summer
	Days	tmin_leq_neg10
Primitive area use	Participation	tmax_geq35_d100
	Days	tmax_summer50
Off-road driving	Participation	total_ppt200
	Days	tmax_geq_25_d200
Motorized water	Participation	tmax_geq35_d200
	Days	tmax_geq_35
Motorized snow	Participation	tmax_geq35_d200
	Days	yearly_PET_d200
Hunting	Participation	tmax_fall50
	Days	ppt_monthly_mean200
Fishing	Participation	tmax_geq35_d100
	Days	total_ppt200
Developed skiing	Participation	tmax_winter
	Days	tmax_winter100
Undeveloped skiing	Participation	tmax_geq_35
	Days	winter_PET_d200
Swimming	Participation	tmin_leq_0
	Days	tmax_summer200
Floating	Participation	tmax_geq35_d200
	Days	ppt_monthly_mean100

respectively, to this report). Table 6 lists climate variables used in the days models.

Total days for each activity were estimated following a procedure similar to that for estimating participants. First, days of participation per participant were regressed on relevant explanatory variables without climate variables (Web appendix C) and with climate variables (Web appendix D). Parameter estimates from the respective negative binomial models then were combined with projected explanatory variables at 10-year intervals to create indexed per capita days of participation for each activity. These indexes, in turn, were combined with population projections for each of the RPA scenarios (A1B, A2, and B2) to develop estimated per participant days indexes. The participant days indexes then were applied to a beginning baseline estimate of participation days for each activity, based on weighted national averages calculated from 2005 to 2009 NSRE data, to yield projections of total adult activity days. As with the participant estimates, a 4-year average around 2008 was chosen to avoid any aberration associated with a single year. The results of participation models are shown in a series of tables (tables 7–23) that describe the results with no climate change, i.e., historical climate trends are assumed to continue, for each of the three RPA scenarios and also with results for the nine RPA scenario-climate combinations. Table 3 lists the GCMs used for the tables that follow in the Results section (under the headings of Climate 1, Climate 2, and Climate 3).

Visiting Developed Sites

Activities associated with visiting developed sites include family gathering, picnicking, and developed camping. Per capita participation in visiting developed sites is currently high and projected to remain relatively constant across all the RPA scenarios (table 7). Scenario RPA A1B showed the greatest change in participation rate from 2008, with a 3-percent increase. However, given the long time horizon, the differences among the scenarios, with and without climate variables, are relatively minor. More noticeable is that, when coupled with population growth, the number of potential developed site users increases from a little more than 190 million in 2008 to between 272 and 346 million by 2060, a change of between 40 and 77 percent.

Average annual days per developed site use participant are projected to decline slightly, from 11.67 to around 11.5 days. Incorporating climate resulted in consistently lower results, but the effect was quite small across all RPA scenarios. Given the small changes in average days of developed site use per participant across the RPA scenario and climate alternatives, the key driver in the increase in total days for this activity was population growth. RPA A2, with the highest population growth among the alternatives, led to increases in total days from 67 to 74 percent, depending on the associated climate forecast. Scenario RPA B2, with the least population growth, showed a 36 to 40 percent increase in developed site use days across climate futures. Across all scenarios, the expected increase in annual days of developed site use averaged more than 1,200 million days nationally.

Visiting interpretive sites includes visits to nature centers, zoos, historic areas, and prehistoric areas. More than 157 million adults, or about 67 percent of all those over the age of 16, participated in at least one activity in this outdoor recreation category annually from 2005 to 2009.
The projections indicate participation rates could increase from between 4 and 9 percent, and total participants by more than 70 percent, by 2060 across the RPA scenarios and associated climate alternatives (table 8). For this activity

Table 7—Projected developed site visit participation and use (family gathering, picnicking, developed camping) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC[a]**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.819	0.840	3	2	1	1
A2	0.819	0.829	1	0	0	(1)[e]
B2	0.819	0.830	1	0	0	0
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	192.7	310.9	61	60	58	58
A2	196.1	346.4	77	74	75	74
B2	192.2	272.7	42	40	40	40
	Days per participant		Percent increase (decrease) from 2008			
A1B	11.67	11.49	(2)	(3)	(4)	(4)
A2	11.67	11.48	(2)	(3)	(3)	(4)
B2	11.67	11.52	(1)	(3)	(3)	(2)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	2,235	3,549	59	56	53	52
A2	2,274	3,949	74	68	69	67
B2	2,229	3,121	40	36	36	38

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 8—Projected interpretive site visit participation and use (nature centers, prehistoric sites, historic sites, other) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.669	0.728	9	9	8	7
A2	0.669	0.705	5	4	5	4
B2	0.669	0.706	6	5	5	5
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	157.4	268.5	71	70	69	68
A2	160.1	293.6	84	82	83	81
B2	157.0	231.1	48	46	47	46
	Days per participant		Percent increase (decrease) from 2008			
A1B	7.81	8.40	8	9	10	13
A2	7.81	8.12	4	6	5	8
B2	7.81	8.11	4	6	6	6
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	1,243	2,286	84	86	88	91
A2	1,264	2,417	91	94	92	95
B2	1,239	1,899	53	55	55	56

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.

composite, climate effects resulted in little difference in participation rates but consistently projected higher numbers of days per participant (up to half a day per year on average). As per capita participation is expected to rise between 4 and 9 percent, the number of participants will exceed the rate of population growth, with A2 showing 84 percent growth to at least 294 million participants by 2060. RPA B2, having the lowest projected population growth, still showed an increase in visiting interpretive sites to more than 230 million participants per year over the next 50 years. The greater participation rate growth in this activity group compared to developed site use has several possible causes: developed site use is negatively correlated with age, which is expected to rise by 2060, and positively correlated with available Federal land per capita. Those variables are less important in interpretive site participation. Total annual days of interpretive site visitation is projected to increase by nearly double for scenarios RPA A1B and A2, while growing by more than 50 percent for the lower population growth scenario RPA B2.

Viewing and Photographing Nature

The category of viewing and photographing nature includes birding, which includes viewing and photographing birds, and a more general activity aggregate called viewing. The latter consists of activities including anything that involves viewing, photography, or study of natural settings; or gathering of outdoor fauna and flora. From 2005 to 2009, an average of 35 percent of all adults, or 82 million people, participated annually in birding. In the more broadly defined viewing aggregate, which would include birding, nearly 81 percent of the adult population, or about 190 million people, participated annually during the same period.

Participation in birding is expected to increase between 4 and 8 percent over the next 50 years to more than 36 percent of adults, or 117 to 150 million people (table 9). Scenario RPA A1B indicated the greatest per capita participation rate growth, most likely due to income, a positive influence on birding, increasing more, relative to the other scenarios. Across the three RPA scenarios, the inclusion of a climate variable (annual days with maximum temperature exceeding 35 °C within a 100-mile radius) resulted in slightly lower projected participation rates for 2060. Combining the participation growth rates with expected population changes led to an 81 percent increase in birders under the higher population growth scenario, RPA A2, to nearly 150 million birding participants by 2060. The RPA B2 and A1B scenarios resulted in participant increases of 40 to 46 percent and 53 to 69 percent, respectively, over the next 5 decades.

Days per participant in birding decline uniformly across all RPA scenarios, regardless of climate variables. The decline ranges from 1 to 7 percent, or about 4 days per participant, annually (table 9). Given that adult birders averaged nearly 98 days of participation per year from 2005 to 2009, an annual decline of 4 days does not have much of an effect on the annual total days of birding, which should increase between 37 and 71 percent by 2060, with the largest increase, 5,965 million days per year, occurring under scenario RPA A2.

The adult participation rate in the broader viewing category will remain essentially unchanged over the next 50 years. Participation rate increases across all RPA scenarios will be from 0 to 3 percent. Scenarios RPA A2 and B2 will lead to around 1-percent increases, while RPA A1B will effect an increase of 3 percent in the adult participation rate by 2060, when climate change is considered (table 10). Scenario RPA A1B yielded the highest participation rate growth, primarily due to higher incomes which correlate positively with the viewing activities. Despite the larger participation rate increase with RPA A1B, viewing participants will increase the most under the RPA A2 scenario because of the larger increase in population growth. By 2060, between 267 and 338 million adults will participate in at least one form of nature viewing, an increase of 41 to 76 percent from the 190 million adult nature viewers of 2008.

Annual average nature viewing days per participant declined across all scenarios by between 8 and 14 percent, or 16 days, per year, resulting in one of the largest relative declines in days per participant across all activities (table 10). Adding climate variables to the model had little effect on the results. The decline in viewing days per participant appears to be driven by a number of factors, among them, projected increases in population density and minority populations, and projected decreases in both forest and rangeland and national park acres per capita. Unlike participation, the biggest decline in annual participant viewing days was associated with scenario RPA A1B, likely attributable to the negative correlation of participant days with household income, combined with the income growth being greatest under A1B.

Backcountry Activities

The backcountry activities category encompasses activities most often pursued in undeveloped but accessible lands, including the four activities, or composites, studied for this report: (1) challenge activities, (2) equestrian activities, (3) hiking, and (4) visiting primitive areas.

Challenge activities, often associated with young and affluent adults, include caving, mountain climbing, and rock climbing. Nearly 11 percent of adults currently engage in challenge activities, a rate expected to increase under all of the RPA scenarios by at least 4 percent over the next 50 years, with the biggest participation rate increases, between 15 and 20 percent, depending on the climate projections, coming under scenario RPA A1B (table 11). The higher rate of participation for challenge activities under A1B is mainly due to the higher projected income growth relative to RPA A2 and B2, given the positive association of income with participation. Challenge

Table 9—Projected birding participation and use (viewing or photographing) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.346	0.371	8	5	3	(3)[e]
A2	0.346	0.359	4	(2)	1	(4)
B2	0.346	0.360	4	1	1	0
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	81.4	136.8	69	65	61	53
A2	82.9	149.4	81	71	76	67
B2	81.2	117.9	46	40	41	40
	Days per participant		Percent increase (decrease) from 2008			
A1B	97.7	93.9	(4)	(4)	(5)	(6)
A2	97.7	92.3	(6)	(6)	(6)	(7)
B2	97.7	95.4	(2)	(3)	(3)	(1)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	8,215	13,341	62	59	54	45
A2	8,357	14,322	71	61	66	57
B2	8,194	11,680	43	37	38	39

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 10—Projected nature viewing participation and use (viewing or photographing birds, other wildlife, natural scenery, gathering, other) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.805	0.810	1	3	3	2
A2	0.805	0.810	1	0	1	0
B2	0.805	0.815	1	1	1	1
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	189.4	307.0	63	62	61	60
A2	192.7	338.1	76	74	75	74
B2	188.9	266.7	42	41	41	41
	Days per participant		Percent increase (decrease) from 2008			
A1B	169.6	150.5	(11)[e]	(12)	(13)	(14)
A2	169.6	154.8	(9)	(10)	(10)	(10)
B2	169.6	155.3	(8)	(10)	(10)	(9)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	32,303	46,648	44	42	41	39
A2	32,860	52,835	61	57	58	56
B2	32,219	41,805	30	28	28	28

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 11—Projected challenge activity participation and use (mountain climbing, rock climbing, caving) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.107	0.126	18	15	20	20
A2	0.107	0.114	7	5	4	9
B2	0.107	0.115	7	8	7	6
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	25.1	46.4	85	81	87	88
A2	25.6	47.5	86	82	81	90
B2	25.1	37.6	50	51	49	47
	Days per participant		Percent increase (decrease) from 2008			
A1B	4.77	4.71	(1)[e]	0	1	1
A2	4.77	4.69	(2)	0	0	1
B2	4.77	4.73	(1)	1	0	1
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	120	219	82	81	89	90
A2	122	224	83	83	81	92
B2	120	178	49	52	49	48

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.

activity participation is projected to grow from slightly more than 25 million people currently to about 47 million under both RPA A1B and A2, while reaching nearly 38 million annual adult participants by 2060 under RPA B2, where lower population growth accounts for the difference.

Days per participant for challenge activities are almost unchanged across scenarios and climate alternatives, remaining at less than 5 days per year among participants, totaling about 120 million in 2008. Coupled with population growth rates, scenarios RPA A1B and A2 are projected to lead to annual challenge activity days totaling between 219 and 224 million days by 2060, or a potential increase of 99 to 113 million days above current use. The lower population growth associated with RPA B2 would result in an increase of about 60 million challenge activity days by 2060.

Equestrian activities, limited in this study to horseback riding on trails, claimed 7 percent of the American adult population annually as participants in 2008—a percentage expected to increase to nearly 19 percent by 2060 under scenario RPA A1B, while increasing 4 percent or less for scenarios RPA A2 and B2 (table 12). The difference can be attributed mostly to the higher income over the next 50 years associated with RPA A1B, despite that scenario RPA B2 is less susceptible to forest and rangeland loss per capita over the same time period. Incorporating climate change into the models consistently increased participation rates compared to the models with no climate change, showing considerably larger differences than for most activity groups. When population growth is included to derive the number of annual participants, RPA A1B leads to an increase of nearly 87 percent (no climate change) and 110 percent (Climate 3), or from over 16 million in 2008 to between 30 and 35 million adults annually in 2060. The high population growth under scenario RPA A2 leads to at least 77 percent more equestrian activity participants in 2060 than in 2008, while the lower economic and population growth of scenario RPA B2 yields a potential increase in participant numbers of 7 to 11 million adults by 2060, depending on climactic conditions.

While climate had a positive effect on participation rates, it had a negative effect on days in the field per participant, which is opposite of the trend projected without climate effects. The effect of climate varies, but it is consistently negative across the nine outcomes. Some of the effects are large compared to the simulations without climate. For example, the projections from the Climate 3 (MIROC3.2) simulations led to between 15 and 20 percent fewer equestrian days annually per participant than the projected 16.8 percent from the no-climate alternative. Averaged across all RPA scenarios and associated climate simulations, the decrease in the number of equestrian days per participant annually is about 9 percent, or 1.5 days per year (table 12). Factoring population growth

Table 12—Projected equestrian activity participation and use (riding horseback on trails) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.07	0.083	19	22	26	34
A2	0.07	0.071	2	10	5	12
B2	0.07	0.072	4	9	8	9
	Adult participants (thousands)		Percent increase (decrease) from 2008			
A1B	16,393	30,570	87	92	98	110
A2	16,676	29,531	77	90	83	96
B2	16,350	23,602	44	51	50	52
	Days per participant		Percent increase (decrease) from 2008			
A1B	16.3	16.8	3	(4)[e]	(9)	(20)
A2	16.3	16.8	3	(10)	(4)	(15)
B2	16.3	16.8	3	(6)	(6)	(8)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	262	503	92	83	80	69
A2	267	486	82	70	76	65
B2	261	388	49	42	42	40

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

to 2060 leads to increases in the total days of equestrian activity of 40 to 92 percent, depending on the RPA scenario and climate combination. By 2060, if climate is incorporated, the absolute increase in equestrian days averages 166 million days, and, without climate change, the average increase across RPA scenarios is 196 million days. Thus, it appears that the increased number of days per year over 35 °C dampens participant days in the field by about 15 percent.

Hiking is the most popular single backcountry activity, with, about a third of American adults, or about 79 million people, hiking in 2008. Among the three RPA scenarios, hiking participation per capita is expected to increase by 3 to 10 percent by 2060, increasing the most under RPA A1B in lieu of climate change (table 13). Hiking is the only activity in which Hispanics demonstrated a higher participation rate than Whites (Web appendix A). As the participation rates are similar across scenarios, RPA A2's higher population growth led to the greatest increase in hiking participants over the time span, nearly 88 percent, resulting in about 150 million hikers by 2060. Scenarios RPA B2 and A1B led to hiking participant increases from 2008 of about 45 and 72 percent, respectively, depending on the climate change alternative.

Annual days of hiking per participant are virtually identical across all RPA scenarios, increasing about 6 percent, or about 1.5 days per year by 2060 (table 13). Thus, total annual days of hiking will mirror, or slightly exceed, population growth across all the scenarios and climate alternatives, nearly doubling by 2060 under scenario RPA A2 to 3,682 million days. Increases in total annual hiking days under scenarios RPA A1B and B2 are projected to range from 54 to 82 percent.

The final backcountry activity, an aggregate called visiting primitive areas, consists of such activities as backpacking, primitive camping, and visiting a wilderness, both designated and undesignated. This composite accounted for 90 million participants in 2008, or about 38 percent of all adults. Annual per capita participation in this category is expected to decline by up to 9 percent over the next 50 years across various simulation scenarios, amounting to an average of a nearly 2-percentage point drop in per capita participation. Increased population density, declining wilderness acres per capita, and declining forest and rangeland per capita appear to be factors influencing the participation rate decline (Web appendix A). However, overall participation is expected to increase between 31 and 65 percent across scenarios by 2060, because population growth offsets the decline in participation rates.

Average annual days spent by participants visiting primitive areas is projected to decline between 1 and 5 percent across all RPA scenarios (table 14), dropping, on average, by about half a day by 2060 under various climate change alternatives. Hence, total annual days of primitive area visitation will

Table 13—Projected day hiking participation and use by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

RPA scenario	Year					
	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.333	0.365	10	8	5	4
A2	0.333	0.360	8	4	5	3
B2	0.333	0.357	7	5	5	4
	Adult participants (thousands)		Percent increase (decrease) from 2008			
A1B	78.3	134.4	72	69	64	63
A2	79.6	149.8	88	80	82	80
B2	78.1	116.7	50	46	46	45
	Days per participant		Percent increase (decrease) from 2008			
A1B	22.9	24.2	6	7	6	6
A2	22.9	24.2	6	6	6	6
B2	22.9	24.3	6	7	6	6
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	1,826	3,330	82	81	75	74
A2	1,857	3,682	98	90	93	90
B2	1,821	2,901	59	57	56	54

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.

Table 14—Projected primitive area visitation and use (visiting wilderness, primitive camping, backpacking) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

RPA scenario	Year					
	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.383	0.381	1	(1)[e]	(2)	(5)
A2	0.383	0.363	(5)	(8)	(6)	(9)
B2	0.383	0.365	(5)	(6)	(6)	(6)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	90.2	141.0	56	54	53	49
A2	91.7	151.6	65	60	53	59
B2	89.9	120.0	34	31	31	31
	Days per participant		Percent increase (decrease) from 2008			
A1B	13.2	13.1	(1)	(3)	(5)	(5)
A2	13.2	13.0	(1)	(5)	(4)	(5)
B2	13.2	13.1	(1)	(3)	(3)	(4)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	1,233	1,909	55	50	45	41
A2	1,255	2,046	63	53	57	51
B2	1,230	1,630	33	27	27	26

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

increase between 26 and 63 percent, or slightly less than the population growth assumed for each alternative. By 2060, RPA A2, with the largest projected population growth, could see an increase as large as 800 million days of primitive area visitation, while RPA B2 could yield an increase of about 400 million days.

Motorized Activities

Three categories of motorized activities were considered: (1) off-road driving, (2) motorized water use, and (3) motorized snow use. Participation in off-road driving averaged about 20 percent of the adult U.S. population, or about 48 million adults annually between 2005 and 2009 (table 15). Future participation rates in off-road driving are expected to decline under two of three RPA scenarios, RPA A2 (16 to 18 percent) and RPA B2 (7 to 8 percent), while the percent of adult participants under RPA A1B will be about the same in 2060 as today. The relatively larger decline in participation rate under RPA A2 can be attributed to smaller income growth than under RPA A1B and a larger decline in Federal and private forest and rangeland than under either RPA B2 or A1B (Web appendix A). Despite the static or declining rate of growth in per capita participation, the number of participants in off-road driving will increase between 28 and 58 percent under the assessment scenarios to somewhere between 62 and 75 million people, because the rate of population growth will outstrip any decline in per capita participation through 2060. Alternative climate futures do not appear to have an appreciable effect on participation percentages or actual numbers.

Annual days per off-road driving participant are projected to decline by 3 to 7 percent, or about 1.4 participant days, annually by 2060 (table 15). The decline, consistent across the RPA scenarios, is invariant to climate alternatives. The declines in participation rate and average annual days per participant imply that, under all scenarios, the total number of days of off-road driving will increase by less than the respective population growth rates. Nevertheless, RPA A1B yields a potential increase of about 500 million days of off-roading per year by 2060, while RPA B2 implies an increase of a little more than 200 million days.

Motorized water use includes participation in motor boating, waterskiing, and using personal watercraft. This combination of related activities has the highest per capita participation rate among motorized outdoor activities at 26 percent, about 62 million adult participants (table 16). Under scenario RPA A1B, per capita participation is expected to grow between 5 and 15 percent over the next 5 decades to as much as 30 percent of all adults. Under scenarios RPA A2 and B2, the participation rate most likely will decline. Income growth under RPA A1B is the biggest factor affecting this difference. The projection models with climate variables consistently projected smaller increases and larger declines than the models with no climate, particularly Climate 3. Overall, the number of adult participants in motorized water activities will increase faster than the population under scenario RPA A1B, to between 102 and 112 million in 2060, depending on the climate alternative. With per capita participation constant or declining under both RPA B2 and A2, the number of motorized water activity participants generally trails population growth, yielding 74 and 107 million adult participants in 2060, respectively.

Motorized water use participant days totaled between 951 and 970 million days in 2008, or a little more than 15 days annually per participant (table 16). Scenario RPA A1B led to an increase in days per participant, while RPA A2 and B2 showed declines of 2 to 9 percent. Again, income growth under RPA A1B accounts for most of the difference. Thus, under RPA A1B, the annual motorized water use days will increase faster than the population growth, between 65 and 90 percent, depending on the climate alternative. Under RPA B2 and A2, total days will increase slower than the population, between 30 and 60 percent, depending on climate projections. In all cases, incorporating climate (table 6) into the models caused a smaller increase or larger decrease in days per participant and therefore total days.

Motorized snow use (snowmobiling) is a geographically limited activity undertaken by 4 percent of the adult population, or 9 to10 million people in 2008. Per capita participation in snowmobiling is expected to decline between 13 and 72 percent under all assessment and climate scenarios (table 17). The climate effects, based on the variable Tmax_geq35_d200 (table 5), are more variable within scenario RPA A1B than within RPA A2 or B2. Given the relatively low current participation rate, a 13 percent decline translates to half a percentage point, while a 72 percent decline suggests a reduction of almost 3 percentage points. Across all RPA scenarios, the largest decrease in the participation rate is associated with Climate 3, which uses climate data from the MIROC3.2 model for scenarios RPA A1B and A2, and the HADCM3 model for RPA B2. Population growth outstrips the decline in participation rates for the no-climate scenarios, yielding 2060 total participation ranging from more than 10 million in B2 to about 13 million adults annually in scenarios A1B and A2. However, incorporating climate projections into the forecasts leads to net decreases in the number of participants in seven of nine climate change cases (table 17). For the two climate change cases showing net participant increases, the increases were negligible over the 50-year projection period.

Similar to changes in participation rates, average annual days per participant declined across all scenario-climate combinations. Decreases were small (2 to 4 percent) for simulations with no-climate change variables, while somewhat larger for the projections with climate change, 9 to 24 percent, or from less than a day to 1.75 days per year (table 17). Ultimately combining projections of participant numbers and days per participant, the no-climate change alternative yielded increases in total snowmobiling days, by 2060, of 8 and 33 percent, or 5 and 23 million days, respectively for RPA B2

Table 15—Projected motorized off-road participation and use (off-road driving) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.204	0.203	0	(1)[e]	1	1
A2	0.204	0.169	(18)	(18)	(18)	(16)
B2	0.204	0.189	(8)	(7)	(7)	(8)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	47.9	75.0	56	55	57	58
A2	48.8	70.2	44	42	42	45
B2	47.8	61.7	29	29	29	28
	Days per participant		Percent increase (decrease) from 2008			
A1B	21.6	20.2	(6)	(6)	(3)	(3)
A2	21.6	20.2	(7)	(5)	(4)	(4)
B2	21.6	20.3	(6)	(5)	(5)	(5)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	1,048	1,532	46	46	53	53
A2	1,066	1,433	34	36	36	39
B2	1,045	1,264	21	23	22	21

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 16—Projected motorized water activity participation and use (motor boating, waterskiing, personal watercraft use) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.263	0.304	15	14	11	5
A2	0.263	0.257	(2)[e]	(7)	(4)	(10)
B2	0.263	0.265	1	(3)	(2)	(3)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	62.0	112.2	81	78	74	65
A2	63.0	107.2	70	61	66	57
B2	61.8	86.9	41	36	36	35
	Days per participant		Percent increase (decrease) from 2008			
A1B	15.3	16.0	4	3	2	0
A2	15.3	14.3	(6)	(8)	(7)	(9)
B2	15.3	14.9	(2)	(4)	(4)	(4)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	953	1,806	90	84	78	65
A2	970	1,551	60	48	55	43
B2	951	1,304	37	31	31	30

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 17—Projected motorized snow activity participation and use (snowmobiling) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.04	0.035	(13)[e]	(32)	(49)	(72)
A2	0.04	0.031	(23)	(60)	(43)	(69)
B2	0.04	0.032	(21)	(49)	(46)	(51)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	9.44	12.99	37	6	(20)	(56)
A2	9.60	12.94	35	(31)	1	(46)
B2	9.42	10.39	10	(29)	(25)	(32)
	Days per participant		Percent increase (decrease) from 2008			
A1B	7.25	7.04	(3)	(10)	(24)	(24)
A2	7.25	6.95	(4)	(9)	(18)	(22)
B2	7.25	7.12	(2)	(13)	(14)	(13)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	68.4	91.0	33	(6)	(40)	(67)
A2	69.6	89.8	29	(44)	(17)	(58)
B2	68.3	73.8	8	(38)	(36)	(41)

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

and A1B. However, including climate led to a net decline in total snowmobiling days of between 6 and 67 percent across the scenarios, or about 4 to 46 million days.

Consumptive Activities

The traditional consumptive wildlife pursuits of hunting and fishing remain popular outdoor activities, with about 28 million and 73 million annual adult participants, respectively, in 2008. However, on a per capita basis, these pursuits have shown some decline from past decades (Cordell 2012). Hunting is the legal pursuit of big game, small game, or migratory birds (as identified by an NSRE hunting screener question). The annual adult hunting participation rate, nearly 12 percent in 2008, is projected to decline between 22 and 31 percent across RPA scenarios by 2060 (table 18), with climate change making the decline even slightly larger, at 24 to 35 percent. Scenario RPA A2 showed the biggest decrease, which led to an annual participation rate of about 8 percent. Factors which appear to drive the drop in hunting participation are increased education levels, increased population density, diminishing availability of private and public land, and increased minority populations (Web appendix A). The population growth associated with RPA A2 exaggerates the decline in available hunting land per capita, thus leading to the larger participation rate drop among hunters. The decline in the rate of annual participation in hunting is offset by population growth to the extent that the number of hunters should increase between 5 and 23 percent across all the RPA assessment scenarios, or by about 1.4 to 6.4 million adults, over the next 50 years.

Across all RPA scenarios, average annual days in the field by hunters is projected to decline between 12 and 14 percent or a little more than 2 days per person per year (table 18). Climate appears to have little or no effect on the average annual days hunters spend in the field. Total annual adult hunting days, estimated at about 540 million in 2008, is expected to remain roughly the same through 2060, at between an 8 percent increase and an 8 percent decrease, depending on the RPA scenario and associated climate change alternative. Scenario RPA B2, with the lower population growth, is likely to yield slight declines in total hunting days, regardless of the associated climate alternative.

Fishing participation includes warm- and cold-water fishing, saltwater fishing, and anadromous fishing. Like hunting, the adult participation rate for fishing is expected to drop over the next 5 decades. Currently, 31 percent of adults claim to fish, but this rate is expected to decline by 3 to 17 percent by 2060 (table 19). On average, the inclusion of climate change alternatives across the RPA scenarios leads to about a 3 percentage point decline in the participation rate

Table 18—Projected hunting participation and use (all legal hunting) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.119	0.093	(22)[e]	(24)	(25)	(28)
A2	0.119	0.082	(31)	(34)	(33)	(35)
B2	0.119	0.092	(23)	(25)	(25)	(24)
	Adult participants (million)		Percent increase (decrease) from 2008			
A1B	27.9	34.2	23	21	18	13
A2	28.4	34.1	20	15	16	14
B2	27.8	29.9	8	5	5	6
	Days per participant		Percent increase (decrease) from 2008			
A1B	19.1	16.8	(12)	(12)	(14)	(14)
A2	19.1	16.8	(12)	(12)	(12)	(14)
B2	19.1	16.8	(12)	(13)	(12)	(12)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	535	576	8	7	2	(3)
A2	544	574	6	2	3	(2)
B2	534	506	(5)	(8)	(8)	(7)

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 19—Projected fishing participation and use (warm water, cold-water, saltwater, anadromous) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.309	0.300	(3)[e]	(6)	(8)	(6)
A2	0.309	0.277	(10)	(17)	(13)	(8)
B2	0.309	0.282	(9)	(13)	(12)	(8)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	72.7	110.6	53	48	44	54
A2	74.0	115.3	56	45	51	58
B2	72.5	92.3	28	22	22	29
	Days per participant		Percent increase (decrease) from 2008			
A1B	18.5	17.5	(5)	(5)	(6)	(7)
A2	18.5	17.2	(7)	(6)	(6)	(8)
B2	18.5	17.7	(4)	(4)	(4)	(3)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	1,363	1,965	44	41	35	25
A2	1,386	2,020	46	36	43	30
B2	1,359	1,665	23	17	17	17

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

(7 versus 10 percent). Also like hunting, population growth for each scenario is enough to effect increases in adult fishing participants from a low of 22 percent under RPA B2, Climate 1 and Climate 2, to 58 percent, or potentially 119 million participants under RPA A2, Climate 3.

Fishing days per participant are forecast to decline between 3 and 8 percent by 2060, or about a day less in the field annually per angler (table 19). Overall, annual fishing days will increase across all RPA scenarios, but at a rate somewhat lower than population growth. Under RPA B2, fishing days per year are projected to increase by 17 to 23 percent per year, while under both A1B and A2, the growth rate will roughly double that of RPA B2. Across all RPA scenarios and climate alternatives, the projected increase in fishing days per year likely will exceed 200 million, ranging from 1,584 to 2,020 million total angler days per year.

Non-Motorized Winter Activities

Non-motorized winter activities include developed skiing (downhill skiing and snowboarding) and undeveloped skiing (cross-country skiing and snowshoeing). Developed skiing claimed an adult participation rate of 10 percent, about 24 million participants, annually from 2005 through 2009. Under constant climactic conditions, the participation rate for developed skiing is expected to increase by 11 to 13 percent under assessment scenarios RPA A2 and B2, and by 45 percent under scenario RPA A1B (table 20). As with other income-dependent activities, the higher growth in household income associated with scenario RPA A1B, relative to RPA A2 and B2, appears to be driving the difference in developed skiing participation rates (Web appendix A). The increases in participation rates for all scenarios, combined with the respective population growth rates, suggest that developed skiing participation will grow as much as any activity reported in this report, or more. For example, under scenarios RPA B2 and A2, the total number of adult participants is expected to increase from 24 million in 2008 to between 37 and 47 million by 2060. A bigger increase, 127 percent, from nearly 24 million to about 54 million skiers, is projected for developed skiing participants under scenario RPA A1B. Unlike snowmobiling, there is little difference between the no-climate alternative and the various climate simulations across all RPA scenarios.

Days of developed skiing per participant are expected to increase by 9 to10 percent for scenario RPA A1B, while remaining effectively constant for RPA A2 and B2 (table 20). Overall, however, increases in the participation rate, annual days per participant, and population will lead to large increases in developed skiing across all RPA scenarios and associated climate change alternatives. The high income growth consistent with RPA A1B led to increases in the number of developed skiing days of by 142 to 150 percent, or about 250 million days, across the climate alternatives. Scenarios RPA A2 and B2 resulted in skiing day increases of between 50 and 97 percent, depending on climate alternative.

Undeveloped skiing often is pursued locally and does not require extensive recreation-site facilities. A little more than 3 percent of the adult population, 7 to 8 million people, engaged in undeveloped skiing in 2008. With the exception of scenario RPA A1B with no climate change effects, participation rates for undeveloped skiing are projected to decline from 6 to 63 percent by 2060 (table 21). Climate change effects markedly accelerated the decline in participation rates for undeveloped skiing across all RPA scenarios, especially under Climate 3 (MIROC3.2 for scenarios RPA A1B and A2; HADCM3 for scenario RPA B2). Participant numbers for undeveloped skiing increase between 32 and 67 percent under the no-climate alternative to nearly 13 million adults under scenario A1B. However, despite population growth in the RPA alternatives, seven of nine climate change alternatives showed decreases in the number of undeveloped skiing participants by 2060, with the largest decreases, 30 and 42 percent fewer participants, coming from RPA A2 and A1B, respectively, under the Climate 3 (MIROC3.2) simulations.

Days per adult participant for undeveloped skiing are projected to remain relatively constant, at a little less than 7 days per year, regardless of RPA scenario-climate combination (table 21). Total days of undeveloped skiing, in the absence of climate change, increase at about the population growth rate, from more than 51million to between 69 and 87 million days annually by 2060. Introducing climate into the models yielded considerably different results for undeveloped skiing days, ranging from a 25 percent increase to a 45 percent decrease, with both the increase and the decrease coming under scenario RPA A1B.

Non-Motorized Water Activities

Non-motorized water activities consist of swimming and floating. Swimming includes various kinds of outdoor swimming, including such related activities as snorkeling, surfing, diving, and visiting beaches or watersides. Swimming is the fourth most popular outdoor activity, with a 61 percent adult participation rate and more than 142 million participants annually (table 22). RPA A1B had nearly double the participation rate increase of both RPA A2 and B2. Given population growth and lack of climate effects, participant numbers increased uniformly across RPA alternatives at a little more than the respective population growth rates. RPA A2, with the highest population growth, results in an increase in participants of 85 percent or about 123 million adults by 2060, whereas RPA B2 yields a 47 percent increase, or about 67 million more participants after 5 decades. Climate variables had almost no effect on participation projections.

Table 20—Projected developed skiing participation and use (downhill skiing, snowboarding) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.101	0.147	45	44	43	43
A2	0.101	0.114	11	11	9	4
B2	0.101	0.115	13	8	17	14
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	23.7	54.2	127	126	123	124
A2	24.1	47.2	95	92	89	81
B2	23.7	37.7	58	50	63	60
	Days per participant		Percent increase (decrease) from 2008			
A1B	7.19	7.90	10	9	9	9
A2	7.19	7.26	1	0	0	(1)[e]
B2	7.19	7.31	2	0	2	1
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	171	437	150	146	142	143
A2	174	341	97	92	88	79
B2	170	274	61	50	64	61

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 21—Projected undeveloped skiing participation and use (cross-country skiing, snowshoeing) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	**2008**	**2060 No CC**	**2060 No CC[a]**	**2060 Climate 1[b]**	**2060 Climate 2[c]**	**2060 Climate 3[d]**
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.033	0.035	6	(18)[e]	(36)	(63)
A2	0.033	0.029	(8)	(50)	(30)	(60)
B2	0.033	0.030	(6)	(35)	(34)	(38)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	7.78	12.94	67	28	0	(42)
A2	7.91	12.71	61	(13)	21	(30)
B2	7.76	10.20	32	(9)	(7)	(14)
	Days per participant		Percent increase (decrease) from 2008			
A1B	6.58	6.72	2	(3)	(6)	(5)
A2	6.58	6.69	2	(4)	(4)	(7)
B2	6.58	6.74	3	(4)	0	(2)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	51.2	87.0	70	25	(5)	(45)
A2	52.1	85.2	64	(16)	16	(35)
B2	51.1	68.8	35	(13)	(7)	(15)

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Table 22—Projected swimming participation and use (screener for various swimming activities) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.609	0.676	11	11	11	11
A2	0.609	0.645	6	6	6	6
B2	0.609	0.642	5	6	5	5
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	143.2	249.1	74	74	74	74
A2	145.7	268.4	85	84	84	85
B2	142.8	209.8	47	47	47	47
	Days per participant		Percent increase (decrease) from 2008			
A1B	24.0	25.1	5	3	1	1
A2	24.0	23.7	(1)[e]	(4)	(3)	(4)
B2	24.0	23.8	(1)	(3)	(3)	(3)
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	3,459	6,299	82	80	76	76
A2	3,519	6,429	83	78	79	78
B2	3,450	5,037	46	43	43	42

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

Days per participant are projected to increase slightly under RPA A1B but decline slightly under both RPA A2 and B2. Climate had a small negative effect on days per participant, slightly retarding growth under RPA A1B, but leading to marginal decreases under RPA A2 and B2. Nevertheless, because of the high societal participation rate and the high number of days of annual engagement, swimming-related activities will increase between 42 and 83 percent, or by 1,587 to 2,910 million days per year by 2060.

The adult participation rate for floating—including canoeing, kayaking, tubing, and rafting on either flat or whitewater—averaged about 17 percent, or about 40 million participants, annually between 2005 to 2009. Across the RPA scenarios, in the absence of climate change, the participation rate is expected to increase slightly for RPA A1B to more than 17 percent annually by 2060 (table 23). Under each of the lower-income scenarios, RPA A2 and B2, the rate of participation for adults is expected to drop by between 7 and 11 percent over the next 5 decades, with the rate falling to a little below 15 percent under scenario RPA A2. Including climate change alternatives, the participation rate is projected to range from a 3 percent increase to a 27 percent decline. Under RPA A1B, with these changes in participation rates, the number of adults annually participating in floating activities is projected to increase between 26 and 62 percent, but under scenarios RPA A2 and B2, the participation rate will increase 18 to 56 percent, growing slightly less than their respective population growth rates. By 2060, the number of adults annually participating in floating activities should be 47 to 65 million, an increase of 7 to 25 million more adults than the current number.

Annual floating days per participant are projected to remain constant at 6 to 7 days under each RPA scenario and all associated climate alternatives. Thus, total annual days of floating increases under each RPA scenario will mirror participant increases closely, from 18 to 62 percent. Under the no-climate change alternative, the average across RPA scenarios is about 128 million days per year, and somewhat less, about 83 million days per year, when climate change is considered.

KEY FINDINGS

Outdoor recreation will remain an integral part of the social and economic fabric of the United Sates. Over the next 5 decades, barring climate change, the number of participants in the 17 outdoor recreation activities, or activity aggregates, examined in this study, is projected to increase. In a number of cases, the per capita participation rate will decline, but, under

Table 23—Projected floating participation and use (canoeing, tubing, kayaking, rafting) by adult U.S. residents, 2008 to 2060, by Resources Planning Act (RPA) scenario and related climate futures

	Year					
RPA scenario	2008	2060 No CC	2060 No CC[a]	2060 Climate 1[b]	2060 Climate 2[c]	2060 Climate 3[d]
	Per capita participation		Percent increase (decrease) from 2008			
A1B	0.169	0.171	3	0	(7)[e]	(20)
A2	0.169	0.146	(11)	(23)	(15)	(27)
B2	0.169	0.155	(7)	(15)	(14)	(16)
	Adult participants (millions)		Percent increase (decrease) from 2008			
A1B	39.8	64.6	62	56	46	26
A2	40.5	63.0	56	34	47	26
B2	39.7	51.7	30	19	20	18
	Days per participant		Percent increase (decrease) from 2008			
A1B	6.50	6.50	0	0	(1)	(1)
A2	6.50	6.49	0	0	0	(1)
B2	6.50	6.51	0	0	0	0
	Total days (millions)		Percent increase (decrease) from 2008			
A1B	261	422	62	56	44	24
A2	265	411	55	34	47	25
B2	260	338	30	18	20	18

[a] Climate variable omitted from model and projection.
[b] Climate 1 uses forecast data from CGCM3.1 for scenarios A1B and A2; CGCM2 for scenario B2.
[c] Climate 2 uses forecast data from CSIRO-MK3.5 for scenarios A1B and A2; CSIRO-MK2 for scenario B2.
[d] Climate 3 uses forecast data from MIROC3.2 for scenarios A1B and A2; UKMO-HADCM3 for scenario B2.
[e] Parentheses denote a decrease.

each RPA scenario, population growth will be large enough to ensure that all activities will see growth in the number of adult participants. Climate change could lead to some deviations. For example, despite population growth, snowmobiling and undeveloped skiing could experience declines in participant numbers by up to 25 percent.

In general, participation intensity, or total days of participation will increase similarly to the number of participants. Under each of the RPA scenarios, all activities will increase in the absence of climate change. However, participation days in snowmobiling and undeveloped skiing, as well as hunting, are likely to decline, yielding fewer days of participation in 2060 than today. A more specific discussion of participant numbers, days of participation, and the factors responsible follows.

Per Capita Participation

In the next 50 years, under the three 2010 RPA Assessment scenarios and related climate alternatives, the outdoor recreation activities projected for most growth in per capita participation are developed skiing (4 to 45 percent growth), equestrian activities (2 to 34 percent growth), challenge activities (4 to 20 percent growth), swimming (5 to11 percent growth), day hiking (3 to 10 percent growth), and visiting interpretive sites (4 to 9 percent growth). Depending on the RPA Assessment scenario and climate combination, motorized boating could show a participation rate increase up to 15 percent, or a decrease up to 10 percent.

Other activities most likely will experience declines in adult participation rates, including visiting primitive areas (9 percent decline to 1 percent increase), motorized off-road activities (18 percent decline to 0 percent increase), motorized snow activities (72 to 13 percent decline), hunting (35 to 22 percent decline), fishing (17 to 3 percent decline), undeveloped skiing (63 percent decline to 6 percent increase), and floating activities (27 percent decline to 3 percent increase).

Change in participation rates for the remaining activities studied in this report will be marginal, vacillating around zero. Generally, activities with currently low per capita rates of participation, such as developed skiing, undeveloped skiing, and equestrian activities, have considerable room for growth, while activities with already high participation rates, such as developed site use, viewing, and swimming, have less room for growth.

Participant Numbers

The growth rate of participant numbers in the various activities generally follows the growth of participation rates. Slight deviations occur when a higher participation growth rate in one RPA Assessment scenario, often RPA A1B, is offset by a higher population growth in a different scenario, such as RPA A2. Across all scenarios and climate alternatives (table 24), the highest growth rates for participant numbers will be in developed skiing (50 to127 percent increase), equestrian activities (44 to110 percent increase), challenge activities (47 to 90 percent increase), day hiking (45 to 88 percent increase), and swimming (47 to 85 percent increase).

The lowest growth rates for participant numbers will occur in visiting primitive areas (31 to 65 percent increase), motorized off-road activities (28 to 58 percent increase), motorized snow activities (56 percent decline to 37 percent increase), hunting (5 to 23 percent increase), fishing (22 to 58 percent increase), and floating activities (18 to 62 percent increase). Activities with already high participation rates likely will not demonstrate large percentage increases in participant numbers. However, smaller percentage increases in already highly popular activities can mean quite large increases in the absolute number of adult participants.

While growth rates for participant numbers are important, a potentially more important measure for natural resource managers is growth in absolute numbers of participants. The activities that will show the biggest average increases from 2008 to 2060 in participants (table 24) are developed site use (112 to 116 million), nature viewing (112 to 114 million), interpretive site use (104 to 106 million), and swimming (99 million). These are currently the four most popular activities examined in this report. Activities with participant increases of at least 40 million include day hiking (50 to 55 million), birding (47 to 53 million), primitive area use (42 to 47 million), and motorized boating (35 to 40 million). Activities expected to have the smallest participant increases include hunting (4 to 5 million), snowmobiling (2.5 million decline to 3 million increase), and undeveloped skiing (1 million decline to 4 million increase).

Participant Days Per Year

As described in equation 3, average activity days per year per participant are used in conjunction with participation rate and population to determine total activity days per year. Yearly days per participant are projected to decrease for most outdoor recreation activities between 2008 and 2060. Two activities, visiting interpretive sites and day hiking, are expected to experience increases across the RPA scenarios and climate alternatives, with average annual days per participant climbing to between 8 and 9 days for visiting interpretive sites and between 24 and 25 days for day hiking. Two activity categories, challenge and floating, will maintain the same number of annual days per participant in 2060 as in 2008. All other activities will decline in days per participant per year, with the largest declines in nature viewing (11 percent decline), snowmobiling (13 percent decline), and hunting (13 percent decline). For nature viewing, with a 2008 average of 170 days per year, an 11 percent decrease by 2060 could translate into an average of 14 fewer activity days per year for nature viewers. However, for snowmobiling and hunting, where participants engage less often, the declines are less than a day and around 2 days per year, respectively. For the remaining activities, the changes, while negative, are relatively minor.

Total Activity Days Per Year

Total days are the product of population, participation rate, and days per participant. The five fastest growing outdoor activities, in total days from 2008 to 2060 (table 25), are developed skiing (50 to 150 percent increase), day hiking (54 to 98 percent increase), interpretive site use (53 to 95 percent increase), challenge activities (48 to 92 percent increase), and equestrian (40 to 92 percent increase). Alternatively, the five activities expected to grow the least are snowmobiling (67 percent decline to 33 percent increase), undeveloped skiing (45 percent decline to 70 percent increase), hunting (8 percent decline to 8 percent increase), fishing (17 to 46 percent increase) and off-road driving (21 to 53 percent increase). The wide variation from decline to increase for snowmobiling and undeveloped skiing activity days per year is associated with the Climate 3 (MIROC3.2) alternatives for A1B and A2 (fig. 5 and tables 17 and 21), which noticeably warmer and dryer than the other climate alternatives.

Higher growth rates do not necessarily imply larger absolute growth. Activities that are currently popular may have slower rates of growth in total days than less popular alternatives, yet their increase in total days may greatly exceed those for less popular activities, despite the latter's faster growth. Averaged over all RPA scenarios and climate alternatives (table 25), the five activities for which total days increase the most over the next 50 years are nature viewing (13,597 to 14,635 million days), swimming (2,298 to 2,446 million days), hiking (1,366 to 1,470 million days), developed site use (1,185 to 1,294 million days), and birding (3,764 to 4,859 million days). For the most part, these are composite activities that often can be done simultaneously, e.g., nature viewing and day hiking or developed site use and swimming.

The five activities expected to increase the least in total days, when averaged across all RPA Assessment scenarios and climate alternatives (table 25), are snowmobiling (27 million decline to 16 million increase), hunting (8 million decline to 14 million increase), undeveloped skiing (5 million decline to 29 million increase), challenge activities (86 to 89 million increase), and floating (83 to 128 million increase). These activities are space intensive and typically require investments in equipment and training. Moreover, the two winter activities typically require some level of snow cover in the local area.

Table 24—Changes in total outdoor recreation participants between 2008 and 2060 across all activities and scenarios

Activity[a]	2008 Participants[b] (millions)	2060 Participant range[c] (millions)/ [percent]	2060 Average participant change[c] (millions)	2060 Participant range[d] (millions)/ [percent]	2060 Average participant change[d] (millions)
Visiting developed sites					
Developed site use (family gathering, picnicking, developed camping)	194	273- 346 [42-77]	116	271-339 [40-75]	112
Interpretive site use (nature centers, prehistoric sites, historic sites, other)	158	231-294 [48–84]	106	231-289 [46-83]	104
Viewing and photographing nature					
Birding (viewing or photographing)	82	118-149 [46-81]	53	115-144 [40-76]	47
Nature viewing (viewing or photographing birds, other wildlife, natural scenery, gathering, other)	190	267-338 [42-76]	114	268-333 [41-75]	112
Backcountry activities					
Challenge (mountain climbing, rock climbing, caving)	25	38-48 [50-86]	19	37-48 [47-90]	18
Equestrian (horseback riding on trails)	17	24-31 [44-87]	11	25-35 [50-110]	13
Day hiking	79	117-150 [50-88]	55	114-143 [45-82]	50
Primitive area use (visiting wilderness, primitive camping, backpacking)	91	120-152 [34-65]	47	119-145 [31-60]	42
Motorized activities					
Off-road driving	48	62-75 [29-56]	21	62-76 [28-58]	21
Motorized water (motor boating, water skiing, personal watercraft use)	62	87-112 [41-81]	40	84-111 [35-78]	35
Motorized snow (snowmobiling)	10	10-13 [10-37]	3	4-10 [(56)-6]	(2.5)[e]
Consumptive					
Hunting (all types of legal hunting)	28	30-34 [8-23]	5	29-34 [5-21]	4
Fishing (warm water, cold water, saltwater, anadromous)	73	92-115 [28-56]	33	89-115 [22-58]	30
Non-motorized winter					
Developed skiing (downhill skiing, snowboarding)	24	38-54 [58-127]	23	36-54 [50-126]	21
Undeveloped skiing (cross-country skiing, snowshoeing)	8	10-13 [32-67]	4	5-10 [(42)-28]	(1)
Non-motorized water					
Swimming (screener for various swimming and related activities)	144	210-268 [47-85]	99	212-266 [47-85]	99
Floating (canoeing, kayaking, rafting)	40	52-65 [30-62]	20	47-62 [18-56]	13

Source: National Survey on Recreation and the Environment (NSRE) 2005–09, Versions 1 to 4 (January 2005 to April 2009), n=24,073 (USDA Forest Service 2009).

[a] Activities are individual or activity composites derived from the NSRE. Participants are determined by the product of the average weighted frequency of participation by activity for NSRE data from 2005–09 and the adult (>16) population in the United States during 2008 (235.4 million).

[b] Because of small population and income differences, initial values for 2008 differ across RPA scenarios, thus an average is used for a starting value.

[c] Participant range across Resources Planning Act (RPA) scenarios A1B, A2, and B2, without climate considerations.

[d] Participant range across RPA scenarios A1B, A2, and B2, each with three selected climate futures.

[e] Parentheses denote negative number.

Table 25—Changes in total outdoor recreation days between 2008 and 2060 across all activities and scenarios

Activity[a]	2008 Days[b] (millions)	2060 Days range[c] (millions)/ [percent]	2060 Average days change[c] (millions)	2060 Days range[d] (millions)/ [percent]	2060 Average days change[d] (millions)
Visiting developed sites					
Developed site use (family gathering, picnicking, developed camping)	2,246	3,121-3,949 [40-74]	1,294	3,055-3,796 [36-69]	1,185
Interpretive site use (nature centers, prehistoric sites, historic sites, other)	1,249	1,899-2,417 [53-91]	952	1,935-2,435 [55-95]	988
Viewing and photographing nature					
Birding (viewing or photographing)	8,255	11,680 -14,322 [40-74]	4,859	10,050-13,313 [36-69]	3,764
Nature viewing (viewing or photographing birds, other wildlife, natural scenery, gathering, other)	32,461	41,805-52,835 [30-61]	14,635	41,550-51,288 [28-58]	13,597
Backcountry activities					
Challenge (mountain climbing, rock climbing, caving)	121	178-219 [49-83]	86	179-232 [48-92]	89
Equestrian (horseback riding on trails)	263	388-503 [49-92]	196	369-482 [40-83]	166
Day hiking	1,835	2,901-3,682 [59-98]	1,470	2,825-3,541 [54-93]	1,366
Primitive area use (visiting wilderness, primitive camping, backpacking)	1,239	1,630 -2,046 [33-63]	622	1,562-1,946 [26-57]	519
Motorized activities					
Off-road driving	1,053	1,264-1,532 [21-46]	357	1,274-1,611 [21-53]	385
Motorized water (motor boating, water skiing, personal watercraft use)	958	1304-1806 [37-90]	596	1,245-1,763 [30-84]	495
Motorized snow (snowmobiling)	69	74-91 [8-33]	16	23-65 [(6)-(67)]	(27)[e]
Consumptive					
Hunting (all types of legal hunting)	538	506-576 [(5)-8]	14	494-575 [(8)-7]	(8)
Fishing (warm water, cold water, saltwater, anadromous)	1,369	1,665-2020 [23-46]	514	1,602-1,958 [17-41]	397
Non-motorized winter					
Developed skiing (downhill skiing, snowboarding)	178	274-437 [61-150]	179	258-422 [50-146]	165
Undeveloped skiing (cross-country skiing, snowshoeing)	52	69-87 [35-70]	29	28-64 [(45)-25]	(5)
Non-motorized water					
Swimming (screener for various swimming and related activities)	3,476	5,037-6,429 [46-83]	2,446	4,396-6,257 [42-80]	2,298
Floating (canoeing, kayaking, rafting)	262	338-422 [30-62]	128	309-409 [18-56]	83

Source: National Survey on Recreation and the Environment (NSRE) 2005–09, Versions 1 to 4 (January 2005 to April 2009), n=24,073 (USDA Forest Service 2009).

[a] Activities are individual or activity composites derived from the NSRE. Participants are determined by the product of the average weighted frequency of participation by activity for NSRE data from 2005–09 and the adult (>16) population in the United States during 2008 (235.4 million).

[b] Because of small population and income differences, initial values for 2008 differ across RPA scenarios, thus an average is used for a starting value.

[c] Participant range across Resources Planning Act (RPA) scenarios A1B, A2, and B2, without climate considerations.

[d] Participant range across RPA scenarios A1B, A2, and B2, each with three selected climate futures.

[e] Parentheses denote negative number.

RPA Assessment Scenarios

The RPA scenarios drive the activity participant projections primarily through two avenues. First, because the number of participants is a product of estimated per capita participation and population, these estimates are population driven, and, in many cases, this means that RPA A2, with the largest projected population growth, often correlates with the greatest projected increase in participant numbers. Similarly, RPA B2, with the lowest rate of population growth, generally coincides with the least growth for any given activity. However, RPA A2's population growth influences the per capita participation negatively, as most participation models had negative signs on population density, which increases with population growth. As well, supply variables, such as water area per capita and land per capita, with typically positive influences on per capita participation, decline as per capita land and water areas decline with population growth, even in the case of essentially fixed acreages like public lands. In most cases, the difference was not enough to offset population growth's influence as a product.

Another important difference emerging in the per capita participation modeling was the effect of income on such activities as developed skiing, challenge activities, equestrian activities, hunting, and motorized activities. In virtually all these cases, the income growth under scenario RPA A1B was enough to offset the difference in population growth between RPA A2 and A1B, leading to the largest participant increases for RPA A1B. This effect seemed consistent across activities that typically require more capital for effective participation.

In addition to the two avenues driving participant estimates, total days estimates include a third avenue, namely average annual days per participant. While qualitatively similar, the average days per participant were influenced somewhat less by the RPA Assessment scenarios than were the participation rates. However, when population change, participation rate, and days per participant are combined to estimate total days, the effects of the different scenarios are, in general, slightly greater than for participant numbers alone.

Climate Alternatives

Participant numbers and days of participation were projected for RPA Assessment scenarios with and without associated climate alternatives (fig. 5). Details regarding climate effects on recreation participation and use can be observed in tables 7–23. No specific probabilities were assigned to either the individual RPA Assessment scenario or any of the three climate alternatives associated with them (Joyce and others, in press). However, the general effects of climate change on each of the 17 outdoor recreation activities examined in this report can be inferred by comparing columns 4 and 6 in table 24 (for participant numbers) and table 25 (for total days). Column 4 in table 24 lists the average difference in participant numbers from 2008 to 2060 across the three RPA Assessment scenarios with no reference to climate. Column 6 in table 24 does likewise but includes the averaged effects of the climate alternatives. Thus, for developed site use, there is expected to be, on average, 4 million fewer participants in 2060 when accounting for the expected effects of climate change. Overall, 14 of 17 activities are expected to experience fewer participants when climate change is included into the projection estimates. Two activities, snowmobiling and undeveloped skiing, which are expected to see increased participant numbers in the absence of climate change, actually decline from 2008 to 2060 when climate change is taken into account.

The general effects of climate change on projections of total days can be similarly observed. Column 4 in table 25 lists the average difference in total days of each activity from 2008 to 2060 across the three RPA Assessment scenarios without accounting for climate. Column 6 does likewise but includes the averaged effects of the climate alternatives. Thus, for developed site use, there is an expected 109 million fewer activity days in 2060 when accounting for the expected effects of climate change. Overall, 14 of 17 activities showed declines in total days of participation when accounting for climate change. For three activities, snowmobiling, undeveloped skiing, and hunting, taking climate into account resulted in fewer activity days in 2060 than in 2008. Activities that could show an increase in total days under projected climate changes include interpretive site use, challenge sports, and off-road driving.

Finally, while the effects of climate change are averaged across scenarios for both participant numbers (table 24) and days of participation (table 25), the effects of climate change are the most pronounced for RPA scenarios A1B and A2 under the Climate 3 alternative (tables 7–23), which employs the MIROC3.2 climate forecasts (Joyce and others, in press). The MIROC3.2 climate projections reflect both higher temperatures and lower precipitation, by a wide margin, than do any of the other climate projections (fig. 5).

Factors

An examination of model results and odds ratio estimates in Web appendices A, B, C, and D reveals findings similar to previous research into outdoor recreation participation behavior. First, males are more apt to participate in backcountry activities, hunting and fishing, motorized activities, non-motorized winter activities, and floating than are females, while females are more likely to participate in the viewing activities, swimming, equestrian, and visiting developed sites.

Ethnicity is an important influence on participation but it is less a factor on the annual days of participation once an individual has chosen to participate. Minorities, including African-Americans, Hispanics, and Asians, were almost always less likely than Whites to participate in the various activities examined in this report. A notable exception occurred with hiking, where, controlling for other socioeconomic and supply factors, Hispanics were more likely than Whites to participate. Respondents claiming American Indian, non-Hispanic identity were often more likely than Whites to participate in the remote activities, such as hunting and fishing, motorized off-road, motorized snow, hiking, equestrian, and viewing.

Education beyond high school generally resulted in higher participation rates for most activities. However, the level of education varied somewhat. For example, the greater the education level, the more likely participation in birding, non-motorized winter activities, backcountry activities, and viewing activities. However, for fishing and hunting, motorized off-road use, and motorized snow activities, education beyond high school lowered the probability of participation.

Income was positively associated with participation and use across all activities. However, for some activities, such as birding, hiking, and hunting, the effect was small, while for others, such as developed skiing and motorized water use, the effect was large. The higher growth rate of income under assessment scenario RPA A1B was noticeable across the remaining activities. An important aspect of income growth omitted from the analysis in this report should also be mentioned. RPA Assessment scenarios used in this study accounted only for aggregate income growth and omitted any consideration of changing income distribution. This omission is potentially serious and may overlook that outdoor recreation access could become more partitioned by income class.

Relevant land and water availability per capita generally correlated positively with activity participation. Hence, declines in overall forest and rangeland per capita, Federal land per capita, and in National Wilderness Preservation System lands per capita induced declines in spatially intensive activities, such as equestrian, hunting, motorized off-road driving, visiting primitive areas, and viewing. Similarly, participation in water-based activities, such as swimming, motorized boating, and non-motorized boating, was positively correlated with the per capita availability of water area. Fishing was positively correlated with both water area and forest and rangeland availability. A seemingly counterintuitive result occurred with the variable indicating whether the respondent lived in a coastal community: participation in fishing, hunting, and viewing were negatively correlated with residence in a coastal county, a result that might be driven by the urban dominance of the Nation's coastal population.

Finally, the model results and projections in this chapter do not account for such factors outside the range of available data as climate change, new technology, changes in relative costs, new infrastructure, and changes in tastes and preferences.

CONCLUSIONS

Under nearly all of the considered demographic, land use, and climate conditions, recreation participant numbers and days in the field will grow over the next 50 years. Thus, the general outlook for recreation resources is for declining opportunities and access per person. Assuming the public land base for outdoor recreation remains stable, an increasing population will result in decreasing opportunities for recreation per person across most of the United States. While many other factors are involved in recreation supply, recreation resources, both natural and man-made, likely will become less "available" as more people compete to use them. In the case of privately owned land, this increased competition for recreational resources could mean rising access prices, due to increased demand relative to supply. On public lands, where access fees cannot be adjusted easily to market or quasi-market conditions, increased congestion and possible declines in the quality of the outdoor recreation experience are likely to present important challenges to management.

A major challenge for natural resource managers and planners will be to ensure that recreation opportunities remain viable and grow along with the population. This challenge will probably have to be met through creative and efficient management of site attribute inputs and plans, rather than through any major expansions or additions to the natural resource base for recreation. Trends toward more flexible work scheduling and telecommuting may well allow recreationists to allocate their leisure time more evenly across the seasons and through the week, thus facilitating less concentrated peak demands. On the other hand, such technological innovations as GPS units and plastic kayaks will allow more people to find and get to places more easily and quickly perhaps lead to overuse pressures not previously considered a threat.

Overall, it is hard to imagine that the infrastructure supporting the Nation's outdoor recreation opportunities will not be severely tested. For activities like developed site use and day hiking, fewer acres or trail miles per participant could begin to strain existing infrastructure as biological and social carrying capacities are exceeded. Activities such as birding and hiking may or may not require expansive contiguous areas for quality experiences, because they are often "edge dependent" or along linear corridors. However, activities typically considered space intensive—horseback riding on trails, hunting, and motorized off-road use—are likely to actually "feel" more congested given the nature of the activity, despite relatively slow growth.

Measures of use per acre or other units of infrastructure are not comparable across recreation activities, and some may actually have a social component—with more congestion yielding increased user utility—up to a point. Nevertheless, for activities that may be near carrying capacity from a recreation user perspective, or infrastructure carrying capacity, large increases in use per acre could be a concern, both for the land and for the user. Increased congestion in Wilderness and primitive areas could present difficult challenges to land managers. For example, an important motivation for visiting Wilderness is to "get away from civilization" or experience nature "untrammeled by humans." Having this type of experience will be challenging if Wilderness visitor density continues to increase, albeit at a rate somewhat less than population growth. To accommodate visitor satisfaction and comply with Wilderness legislation, future managers may be faced with the potentially unappealing prospect of regulating access.

Because general forest area recreation use, including hunting, motorized off-road use, and horseback riding on trails, generally require more space per user for high-quality (and safe) experiences, an increase in use density would undoubtedly be of concern to national forest managers. For example, conflicts arising from congestion may increase not only within an activity (such as motorized off-road users running into each other figuratively and literally) but also across activities (such as motorized off-road users scaring away game sought by hunters and spooking horses). As with congestion issues in Wilderness areas, managers of general forest areas could be faced with having to choose among potentially unpopular access regulation schemes to mitigate conflicts. Managers may also need to consider sectioning general forest areas into special use areas for specific activities—such as motorized off-road use, horseback riding on trails, and hunting—to reduce cross-activity congestion conflicts. Needless to say, the increased congestion can only increase the impacts of recreation on the forest environment.

Choices in outdoor recreation activities have changed over time in response to changing tastes and preferences, demographics, technological changes, economic conditions, and recreation opportunities. Overall, the number of nature-based outdoor recreation participants has increased since the last RPA Assessment, continuing a long-term trend. At the same time, recreation visitation to State parks and Federal lands has not increased at similar rates, indicating that recreationists are also using other recreation resources. The change in recreation preferences at least partly reflects changing demographics in the American public. As the population ages and becomes more racially and ethnically diverse, it is unclear how future recreation demand and supplywill adjust. Based on the available data, we nevertheless project future growth for most recreation activities. Future demand, of course, can be expected to change as scarcity factors such as relative costs and competition for access change and affect people's choices for recreation activities, times, and locations.

Climate can affect willingness to participate in recreation activities as well as recreation resource availability and quality. The climate variables used in the recreation models were limited to those from the RPA Assessment climate projections, or variables derived from those basic variables. Generally, the climate variables used in these recreation models were presumed to affect willingness to participate and frequency of participation directly. However, even without existing data, climate change might be expected to affect resource availability, directly and indirectly. For example, for hunting and fishing, increasing temperatures will likely affect the distribution of plant and animal species fundamental to maintaining fish and game populations. Moreover, changes in precipitation may influence local snow cover and thus affect seasonal availability for such activities as snowmobiling and undeveloped skiing. Walls and others (2009) assert that the single most important new challenge to recreation supply will be mitigating the adverse effects of climate change, particularly in coastal areas and on western public lands. Disentangling the effects of the climate variables on recreation participation is difficult. Further exploration of these direct and indirect relationships, at both local and macro levels, will be fundamental to improving forecasts of recreation behavior in the future.

A number of previously unmentioned caveats and limitations should be acknowledged. First, despite having up to 10 years of data for model development, this body of data was insufficient to establish any meaningful or statistically significant time-varying parametric relationships. Thus, the participation and days models are static, which is a substantial limitation when projecting demand over such long time intervals. Second, simulated projections are limited by the quality of the projected exogenous variables. Third, the sample of respondents is limited to adults (16 years and older), thus the effects of recreation demand by youth are omitted. For activities that are traditionally adult in nature, such as challenge activities, visiting primitive areas, and hunting, omitting children is likely not a serious problem. However, for more family-oriented activities, such as developed site use, swimming, fishing, and visiting interpretive areas, the results presented herein could be biased downward. Finally, by performing the analyses at the national level, important regional and sub-regional changes and resulting implications are overlooked.

ACKNOWLEDGMENTS

We thank Karen Abt, Ross Arnold, Donald English, Linda Langner, Evan Mercer, Neelam Poudyal, Eric White, and Carol Whitlock for helpful suggestions toward the development of this report. Linda Joyce and David Wear are also acknowledged for supplying climate and land use data, respectively. Ken Cordell and Carter Betz provided recreation participation and supply data, as well as 2005–09 averages for participant and days numbers by activity. Shela Mou provided valuable assistance in all phases of manuscript preparation.

LITERATURE CITED

Alcamo, J.; Ash, N.J.; Butler, C.D. [and others]. 2003. Ecosystems and human well-being. Washington, DC: Island Press:. 245 p.

Bowker, J.M. 2001. Outdoor recreation participation and use by Alaskans: projections 2000-2020. Gen. Tech. Rep. PNW–GTR–527. Portland, OR: U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station. 28 p.

Bowker, J.M.; Bergstrom, J.C.; Gill, J. 2007. Estimating the economic value and impacts of recreational trails: a case study of the Virginia Creeper rail trail. Tourism Economics. 13: 241–260.

Bowker, J.M.; Bergstrom, J.C.; Starbuck, C.M. [and others]. 2010. Estimating demographic and population level induced changes in recreation demand for outdoor recreation on U.S. national forests: an application of National Visitor Use Monitoring Program data. Fac. Ser. Work. Pap. FS 1001. Athens, GA: The University of Georgia, Department of Agricultural and Applied Economics. 147 p.

Bowker, J.M.; English, D.B.K.; Cordell, H.K. 1999. Outdoor recreation participation and consumption: projections 2000 to 2050. In: Cordell, H.K.; Betz, C.J.; Bowker, J.M. [and others]. Outdoor recreation in American life: a national assessment of demand and supply trends. Champagne, IL: Sagamore Press, Inc.: 323–350.

Bowker, J.M.; Leeworthy, V.R. 1998. Accounting for ethnicity in recreation demand: a flexible count data approach. Journal of Leisure Research. 30: 64–78.

Bowker, J.M.; Murphy, D.; Cordell, H.K. [and others]. 2006. Wilderness and primitive area recreation participation and consumption: an examination of demographic and spatial factors. Journal of Agricultural and Applied Economics. 38(2): 317–326.

Cameron, C.A.; Trivedi, P.K. 1998. Econometric society monographs: regression analysis of count data. New York: Cambridge University Press. 412 p.

Cicchetti, C.J. 1973. Forecasting recreation in the United States. Lexington, MA: D.C. Heath and Co. 200 p.

Cordell, H. Ken. 2012. Outdoor recreation trends and futures: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-150. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station, 167 p.

Cordell, H.K.; Bergstrom, J.C. 1991. A methodology for assessing national outdoor recreation demand and supply trends. Leisure Sciences. 13(1): 1–20.

Cordell, H.K.; Bergstrom, J.C.; Hartmann, L.A.; English, D.B.K. 1990. An analysis of the outdoor recreation and wilderness situation in the United States: 1989-2040. Gen. Tech. Rep. RM–189. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station. 112 p.

Cordell, H. Ken; Betz, Carter J.; Zarnoch, Stanley J. [In press.] Recreation and protected land resources in the United States: A technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Dale, D.; Weaver, T. 1974. Trampling effects on vegetation of the trail corridors of north Rocky Mountain forests. Journal of Applied Ecology. 11: 767–772.

Englin, J.E.; Shonkwiler, J.S. 1995. Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation. Review of Economics and Statistics. 77(1): 104–112.

English, D.B.K.; Betz, C.J.; Young, J.M. [and others]. 1993. Regional demand and supply projections for outdoor recreation. Gen. Tech. Rep. RM–230. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station. 44 p.

English, D.B.K.; Kocis, S.M.; Zarnoch, S.J.; Arnold, J.R. 2002. Forest Service national visitor use monitoring process: research method documentation. Gen. Tech. Rep. SRS–57. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 14 p.

Greene, W.H. 2009. NLOGIT 4.0. Plainview, NY: Econometric Software, Inc.

Hagerty, D.; Moeltner, K. 2005. Specification of driving costs in models of recreation demand. Land Economics 81(1): 127-143.

Hall, C.M.; Page, S.J. 1999. The geography of tourism and recreation. New York: Routledge. 309 p.

Hall, T.E.; Heaton, H.; Kruger, L.E. 2009. Outdoor recreation in the Pacific Northwest and Alaska: trends in activity participation. Gen. Tech. Rep. PNW–GTR–778. Portland, OR: U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station. 108 p.

Hof, J.G.; Kaiser, H.F. 1983a. Projections of future forest recreation use. Resour. Bull. WO–2. Washington, DC: U.S. Department of Agriculture Forest Service. 12 p.

Hof, J.G.; Kaiser, H.F. 1983b. Long term outdoor recreation participation projections for public land management agencies. Journal of Leisure Research. 15(1): 1–14.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007, the fourth IPCC assessment report. http://www.ipcc.ch/ipccreports/index.htm. [Date accessed: December 10, 2008].

Joyce, L.A.; Price, D.T.; Coulson, D.P. [and others]. [In press]. Projecting climate change in the United States: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. RMRS. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station.

Leeworthy, V.R.; Bowker, J.M.; Hospital, J.D.; Stone, E.A. 2005. Projected participation in marine recreation: 2005 & 2010. Report prepared for U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Division, Silver Spring, MD: 152 p. http://www.srs.fs.usda.gov/pubs/ja/ja_leeworthy002.pdf. [Date accessed: August 31, 2010].

Manning, R.E. 1997. Social carrying capacity of parks and outdoor recreation areas. Parks and Recreation. 32(10): 32-38.

Nakićenović, N.; Alcamo, J.; Davis, G.; de Vries, B. [and others]. 2000. Emissions scenarios. a special report of working group III of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA. Cambridge University Press. 599 p. http://www.grida.no/climate/ipcc/emission/index.htm. [Date accessed: August 31, 2011].

Ovaskainen, V.; Mikkola, J.; Pouta, E. 2001. Estimating recreation demand with on-site data: an application of truncated and endogenously stratified count data models. Journal of Forest Economics. 7(2): 125–144.

Poudyal, N.C.; Cho, S.H.; Bowker, J.M. 2008. Demand for resident hunting in the Southeastern United States. Human Dimensions of Wildlife. 13: 154-178.

SAS Institute Inc. 2004. SAS/STAT 9.1 user's guide. Cary, NC: SAS Institute Inc. 5,121 p.

Souter, R.A.; Bowker, J.M. 1996. A note on nonlinearity bias and dichotomous choice CVM: implications for aggregate benefits estimation. Agricultural and Resource Economics Review. 25(1): 54–59.

U.S. Census Bureau. 2004. U.S. interim projections by age, sex, race and hispanic origin. http://www.census.gov/population/www/projections/usinterimproj/natprojtab01a.pdf. [Date accessed: May 8, 2008].

U.S. Department of Agriculture (USDA) Forest Service. 2009. National survey on recreation and the environment [Dataset]. www.srs.fs.usda.gov/trends/nsre/nsre2.html. [Date accessed: September 15, 2010].

USDA Forest Service. 2010. National Visitor Use Monitoring Program: FY 2009 NVUM national summary report. www.fs.fed.us/recreation/programs/nvum/. [Date accessed: October 6, 2010].

USDA Forest Service. 2012. Future scenarios: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. RMRS-GTR-272. Fort Collins, CO: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station. 34 p.

U.S. Department of Commerce Bureau of Economic Analysis. 2008a. National and income product accounts table 1.15. Gross domestic product. Version January 30, 2008. http://www.bea.gov/national/nipaweb. [Date accessed: September 15, 2010].

U.S. Department of Commerce Bureau of Economic Analysis. 2008b. National and income product accounts table 2.1. Personal income and its disposition. Version January 30, 2008. http://www.bea.gov/national/nipaweb. [Date accessed: September 15, 2010].

Walls, M.; Darley, S.; Siikamaki, J. 2009. The state of the great outdoors: America's parks, public lands, and recreation resources. Washington, DC: Resources for the Future. 97 p.

Walsh, R.G.; Jon, K.H.; McKean, J.R.; Hof, J. 1992. Effect of price on forecasts of participation in fish and wildlife recreation: an aggregate demand model. Journal of Leisure Research. 21: 140–156.

Wear, David N. 2011. Forecasts of county-level land uses under three future scenarios: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-141. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 41 p.

Zarnoch, S.J.; Cordell, H.K.; Betz, C.J.; Langner, L. 2010. Projecting county-level populations under three future scenarios: a technical document supporting the Forest Service 2010 RPA assessment. e-Gen. Tech. Rep. SRS–128. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 8 p.

Zawacki, W.T.; Marsinko, A.; Bowker, J.M. 2000. A travel cost analysis of economic use value of nonconsumptive wildlife recreation in the United States. Forest Science. 46(4): 496–505.

Bowker, J.M.; Askew, Ashley E.; Cordell, H. Ken; Betz, Carter J.; Zarnoch, Stanley J.; and Seymour, Lynne. 2012. Outdoor recreation participation in the United States—projections to 2060: a technical document supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-160. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 34 p.

We developed national projections through 2060 of participation for 17 outdoor recreation activities. The projections were made under futures that vary by population growth, socioeconomic conditions, land use changes, and climate. We used a two-step approach to project the number of participants and the days of participation. The estimation step yielded national-level statistical models of adult participation rate and days of participation by activity. The simulation step combined the models with external projections of explanatory variables at 10-year intervals to 2060. Per capita estimates for participation and days were then combined with population projections to derive estimates of participants and days of participation by activity. Results were derived across three 2010 Resources Planning Act Assessment scenarios that each feature three associated climate futures. Findings indicated that outdoor recreation will remain a key part of the social and economic fabric of the United States. In the absence of climate change, the number of participants in the 17 recreation activities is projected to increase over the next 5 decades. In some cases, the participation rate will decline, but population growth will ensure that the number of participants increases. Some climate futures led to projected declines in participants, e.g., snowmobiling and undeveloped skiing showed declines in participant numbers up to 25 percent, despite population growth. Climate was also shown to have disparate effects on projections of annual days of participation, particularly for snowmobiling, undeveloped skiing, and hunting.

Keywords: Climate change, double-hurdle model, outdoor recreation, participation rate, recreation demand, recreation projections

How do you rate this publication?

Scan this code to submit your feedback or go to www.srs.fs.usda.gov/pubeval

You may request additional copies of this publication by email at pubrequest@fs.fed.us
Number of copies is limited to two per person.

United States Department of Agriculture

Forest Service

Southern Research Station

General Technical Report SRS-160

July 2012