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The Impacts of Climate Change on Natural Areas Recreation: A Multi-Region Snapshot and Agency Comparison

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ABSTRACT: Recreation is a fundamental component of human culture and the economy. In this paper, we elucidate ways in which recreation should be reconsidered in discussions of climate change. Ecosystems that support outdoor recreation can be significantly altered, extreme climatic conditions can affect plant and animal health, and extreme weather events can limit human outdoor activity. Projections indicate global temperatures will rise and precipitation will shift from historical conditions to less predictable regimes. These projected changes affect recreation and the economies recreation supports. To encourage the inclusion of recreation as a topic in future assessment synthesis reports, a snapshot of climate change impacts on regional recreation in the US is developed, using the National Park Service and Forest Service as case studies. After examining peer-reviewed and agency literature, we suggest that the impact of projected climate change on US recreation needs further scrutiny. Federal land management approaches to identifying, measuring, and managing climate change-induced recreation impacts are developing, but remain fragmented at the local and regional scale. We identify opportunities to address and improve research efforts at the intersection of climate change and outdoor recreation.

Index terms: climate change, National Climate Assessment, public lands, recreation, tourism

INTRODUCTION

Recreation and tourism are critical components of global economies. In the US, outdoor tourism revenues amount to \$646 billion annually (Outdoor Industry Association 2012). Recreation and tourism represent a diverse sector encompassing varied outdoor activities across the US (Thomas et al. 2014).

Nature-based tourism is especially vulnerable to climate change because of the projected climate change impacts on ecosystems supporting recreation (Hall and Higham 2005; Hobbs et al. 2006). Nature-based recreation is strongly influenced by weather and is vulnerable to climate change impacts such as increased frequency of extreme storms, shifts in precipitation regimes, and elevated maximum temperatures. These projected impacts will alter the experience and the risks faced by recreationists (Hall and Higham 2005; Scott et al. 2005; Monahan and Fisichelli 2014). Warmer temperatures influence human, plant, and animal health, with implications for the quality of recreational opportunities (Knapp et al. 2008; Loarie et al. 2009). Decreased snowpack, which historically supported winter recreation, may cause declines in tourism in winter resort communities (Melillo et al. 2014). Ecosystem shifts resulting from fire and insect infestation limit recreation aimed at experiencing natural beauty (e.g., Hellman et al. 2008; Mawdsley et al. 2009; Swetnam et al. 2010). Natural areas are also an important part of American cultural identity, health, and well-being (Adger et al. 2013).

For these reasons, climate change impacts on tourism need further investigation to plan for an uncertain future. Failure to expand research regarding direct and indirect impacts to nature-based recreation will constrain responses to climate change in this important sector.

Climate impacts to recreation have been noted in recent international (IPCC-AR5; IPCC 2014) and national (Third US National Climate Assessment, NCA3; Melillo et al. 2014) assessments, but not as explicitly as other sectors of roughly equivalent economic impact. This is likely due to the paucity of existing recreation-climate change literature and underscores the need for further research at multiple spatial and decision-making scales (Hameed et al. 2013).

To support the inclusion of recreation in future assessments, we developed a snapshot of climate change impacts on recreation by region in the US and for the National Park Service and Forest Service. Our synthesis suggests that the nexus of projected climate change and US recreation has not been well articulated. We conclude by identifying opportunities to address and improve research efforts on climate change and outdoor recreation.

APPROACH

We structured our approach into four major components. First, recognizing that climate change consequences will involve site-specific issues, we present a

multi-region assessment of climate change impacts on recreation. We used the regional delineations chosen by the NCA3 for the regional overview (Figure 1).

Second, we focus on the US Forest Service (USFS) and the National Park Service (NPS) because of their explicitly recreation-oriented mandate. We compared the different mechanisms and frameworks used by the USFS and NPS in addressing the impact of climate change on these agency-managed lands using both peer-reviewed literature and agency-generated policy documents on climate change adaptation and strategic planning. We then identified gaps and opportunities for the USFS and NPS in preparing for climate change impacts on recreation.

Third, to synthesize the state of current natural areas recreation literature, we generated a summary table to assist with gap identification and information synthesis (Table 1). Finally, we draw from multi-region differences and an agency

comparison perspective to propose future research opportunities.

Our approach is consistent with the method taken by the NCA3, which examined peer-reviewed journals as well as gray literature from civil society and governmental sources (Melillo et al. 2014). We conducted an exhaustive assessment of the state of research through reviewing regional and thematically appropriate journals via online literature databases with common search keywords such as outdoor tourism, outdoor recreation, and climate change impacts. Within gray literature, we assessed the relative contribution, position, and relevancy of the organization publishing the study before including it.

MULTI-REGION ASSESSMENT

Our synthesis revealed how the impacts of climate change on nature-based recreation vary by region across the United States (Table 1). Major regional impacts illustrated in our synthesis include:

(1) In regions with coastal sites, recreation will be threatened by sea level rise (Hammar-Klose and Thieler 2001; Cesar and van Beukering 2004; Marra et al. 2012; Eversole and Andrews 2014). In ice-bound coastal areas, melting permafrost and sea ice are increasingly causing coastal erosion and ecosystem changes (Goldstein et al. 2010).

(2) Fish and aquatic habitats will be affected by elevated inter-seasonal variability in water level and flow with consequences for fishing and boating (Hayhoe et al. 2010). Changes in water temperature and quality affect riverine habitat, affecting sport fishing (Covich et al. 1997).

(3) Within arid lands, recreation will be impacted by extreme weather events in the summer, causing safety concerns (Garfin et al. 2014). If the quality of recreational experiences is differentially affected, some arid regions or sites may see an increase in recreational opportunities and others may experience declines (Scott et al. 2004;

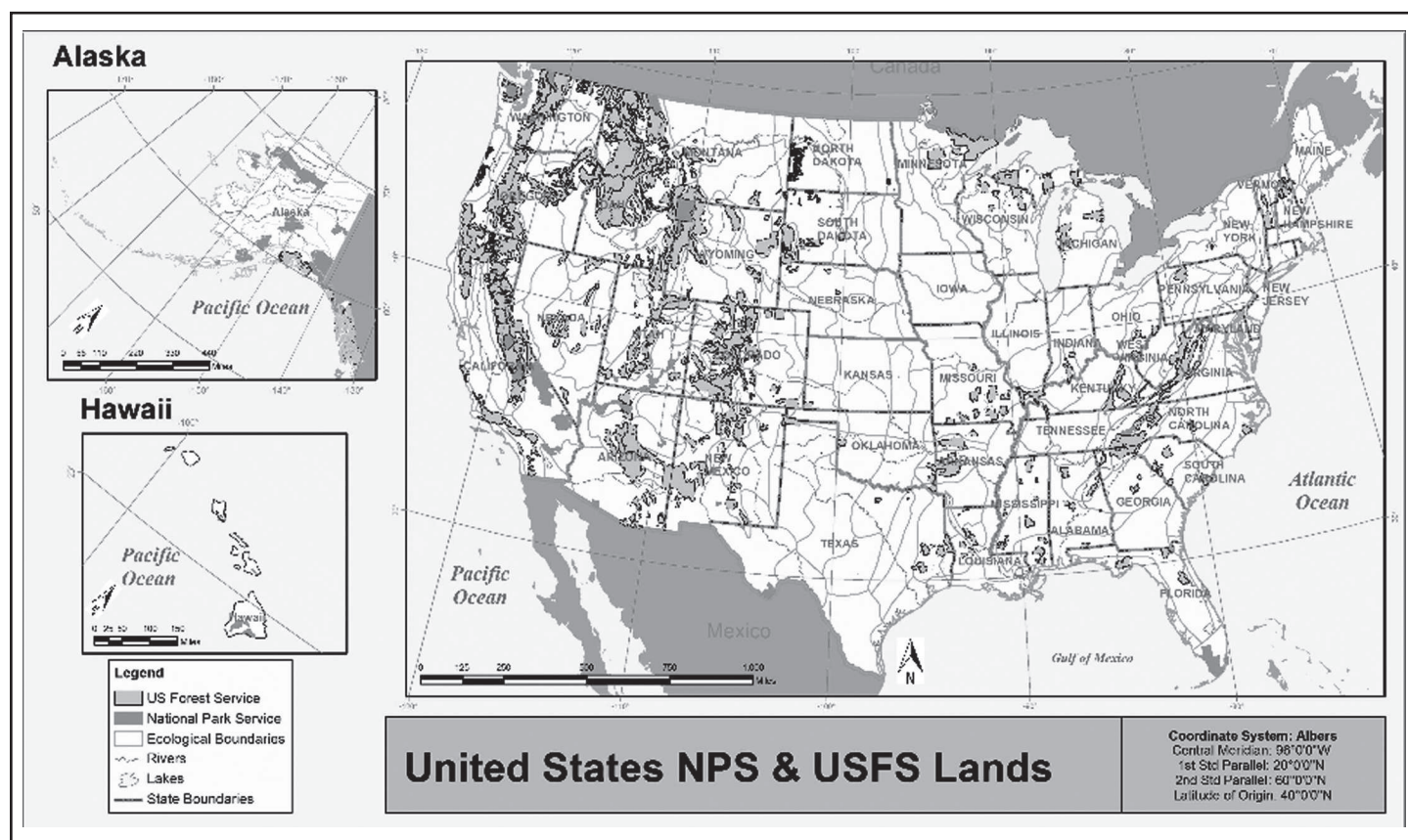


Figure 1. Map of the United States, including designated US Forest Service and National Park Service land management units. (Source: USGS)

Table 1. Literature summary table for climate change impacts on natural areas recreation by region.

Region	Public land (NPS, USFS)	Recreation attractions	Impacts	Supporting literature
Northeast	9 National Parks 4 National Forests	<ul style="list-style-type: none"> • Wildlife viewing • Coastal recreation • Cultural tourism • Snow sports • Water sports 	Sea-level rise, hurricanes, wildfires, heat waves, coastal flooding, river flooding, intense precipitation, fisheries	<p>Beaudin and Huang 2014</p> <p>Dukes et al. 2009</p> <p>Frumhoff et al. 2007</p> <p>Hales et al. 2014</p> <p>Horton et al. 2014</p> <p>Huntington et al. 2004</p> <p>Kunkel et al. 2013b</p> <p>Moser et al. 2008</p> <p>Scott 2003</p> <p>Scott et al. 2006, 2008</p> <p>Shih et al. 2008</p> <p>Siikamäki 2011</p>
Northwest	14 National Parks 23 National Forests	<ul style="list-style-type: none"> • Snow sports • Coastal recreation • Water sports • Alpine sports • Wildlife viewing 	Streamflow change and timing of snowmelt, sea-level rise, wildfire, insect outbreak, forest mortality	<p>Hall et al. 2009a,b</p> <p>Houston et al. 2002</p> <p>Huppert et al. 2003</p> <p>Kakoyannis and Stankey 2002</p> <p>Loomis 2002</p> <p>Ribe 2002</p> <p>Rood et al. 2006</p>
Alaska	8 National Parks 2 National Forests	<ul style="list-style-type: none"> • Alpine sports • Wildlife viewing • Water sports • Snow sports 	Glacial retreat, thawing permafrost, less precipitation as snow, sea level rise	<p>Chapin et al. 2014</p> <p>Førland et al. 2013</p> <p>Goldstein et al. 2010</p> <p>Martin 2006</p> <p>NOAA 2014</p> <p>Policansky 2002</p> <p>Stewart et al. 2013</p>
Hawaii and Islands	2 National Parks	<ul style="list-style-type: none"> • Coastal recreation • Ocean sports • Cultural tourism 	Sea level rise, habitat shifts, coral reef die-off, beach loss, habitat loss	<p>Cesar and van Beukering 2004</p> <p>Cristini et al. 2012</p> <p>Eversole and Andrews 2014</p> <p>Leong et al. 2014</p> <p>Marra et al. 2012</p> <p>Waikiki Improvement Association 2008</p>

Continued

Table 1. *Continued.*

Region	Public land (NPS, USFS)	Recreation attractions	Impacts	Supporting literature
Great Plains	31 National Parks 28 National Forests	<ul style="list-style-type: none"> • Water sports • Snow sports • Wildlife viewing • Trail sports 	Increased rainfall and flooding, increased consecutive dry days, intensification storms,	Covich et al. 1997 Melillo et al. 2014 NOAA 2013a, 2014 Peterson 2003 Shafer et al. 2014 USFS 2006 Wines 2014
Southwest	37 National Parks 10 National Forests	<ul style="list-style-type: none"> • Wildlife viewing • Water sports • Snow sports • Cultural tourism • Trail sports 	Increased frequency of single heavy-precipitation events, decreasing surface water supply reliability for cities, agriculture, and ecosystems, increased wildfires, flooding and erosion in coastal areas, decline in snowpack and streamflow, increased warming, drought, insect outbreaks	Bark et al. 2009 Barnes 2012 Bernard et al. 2001 Crandall et al. 1992 Galbraith et al. 2010 Garfin et al. 2014 Irland et al. 2001 Kunkel et al. 2013a Leones et al. 1998 Loomis and Crespi 1999 Mendelsohn and Markowski 1999 National Academy of Sciences 1992 Owen 2008 Scott et al. 2004 Zierer 1952
Midwest	14 National Parks 10 National Forests	<ul style="list-style-type: none"> • Water sports • Snow sports • Wildlife viewing • Trail sports 	Forest composition and mortality, lake fisheries, algae blooms, declining beach health, reduced ice, increased rainfall and flooding, increased consecutive dry days, intensification of storms	Hayhoe et al. 2010 Pryor et al. 2014 US Travel Association 2012

Continued

Table 1. Continued.

Region	Public land (NPS, USFS)	Recreation attractions	Impacts	Supporting literature
Southeast	29 National Parks 13 National Forests	<ul style="list-style-type: none"> • Coastal recreation • Trail sports • Cultural tourism 	Sea level rise, heat waves, flooding, storm surges	Carter et al. 2014 EPA 1999, 2003 Hammar-Klose and Thielert 2001 Harrington 2013 Ingram et al. 2013 Irland et al. 2001 Kumar 2013 Loomis and Crespi 1999 Loomis 2005 Melillo et al. 2014 Mendelsohn and Markowski 1999 Morris and Walls 2009 National Academy of Sciences 1992 National Parks Conservation Association 2011 Scott et al. 2005

Morris and Walls 2009).

(4) Within mountainous regions, increased temperature and interannual variability in precipitation will affect snowpack and snowmaking capabilities, especially in low-latitude ski areas ([Huntington et al. 2004](#); [Leung et al. 2004](#); [Bark et al. 2009](#); [Hay et al. 2011](#); [Beaudin and Huang 2014](#)). The reduction in snowpack will directly influence water resources and snow-based recreation ([Scott 2003](#); [Scott et al. 2006](#); [Shih et al. 2008](#); [Cervone and Rakestraw 2010](#); [Glennon 2010](#)). Increases in wildfires and tree mortality will directly influence the safety and quality of forest sites hosting significant recreational activities ([Irland et al. 2001](#); [Goldstein et al. 2010](#)).

Among the diverse climate change impacts, the affects of climate change on snow-based recreation such as skiing and associated activities are pronounced and among the most researched ([Scott 2003](#); [Scott et al. 2006](#); [Scott et al. 2008](#); [Dawson et al. 2009](#); [Siikimaki 2011](#); [Beaudin and Huang 2014](#)). Declines in the quality of snow-related recreation will impact not only snow recreationalists, but the communities in which resorts are located ([Butler and Jones 2001](#)). Snow-based recreation in the upper Midwest, Southeast, Northwest, and Southwest will likely be affected. Major ski resorts that could be affected in these regions include Seven Springs Mountain Resort in Pennsylvania (Northeast), Cannon Mountain Ski Area in New Hampshire (Northeast), Sugar Mountain Resort in North Carolina (Southeast), Pine Mountain Ski Resort in Michigan (Midwest), and Aleyeska Ski Resort in Alaska (Alaska/Arctic).

Artificial snow is used to enhance recreation near large urban areas ([Scott et al. 2008](#)). However, water availability is a major issue in snowmaking. The Stone Mountain Park ski resort in Georgia came under heavy censure during a recent drought. Public concern about water quality heightens criticisms ([Cervone and Rakestraw 2010](#); [Glennon 2010](#)). In the Southwest, the use of reclaimed water at the Snowbowl Ski Resort near Flagstaff, Arizona, has angered environmentalists and Native American Nations for ecological and cultural reasons ([Glowacka et al. 2009](#)).

Similar adaptation strategies will likely be explored across many different regions. Nonetheless, those strategies should consider regionally specific contexts. Given that nature-based recreation commonly occurs on or near federal lands (USFS 2006), impact and adaptation responses will require the attention of specific land management agencies.

PUBLIC LAND MANAGEMENT: AN AGENCY CONTRAST

Federal agencies that manage public lands, which host much of the nation's natural areas recreation, will be integral in ensuring that recreation remains viable. The USFS and NPS are major federal institutions with mandates to manage lands for recreation, but differing missions affect their approach to climate change impacts on natural areas recreation.

US Department of Agriculture – Forest Service

The USFS manages a diverse portfolio of forests and grasslands totaling 193 million acres (USFS 2015). Recreation is an important facet of the USFS's multiple-use, sustained-yield land management philosophy. Spending by visitors annually contributes \$13 billion to the US economy (USFS 2014). Between 2000 and 2009, visitor demand for recreation opportunities on USFS land increased by 7%, and the number of visitor-days increased by 40% (Cordell 2012). These upward trends are expected to continue in the next 50 years, especially in the areas of developed skiing (9–31% growth), challenge activities (6–18%), equestrian activities (3–19%), and motorized off-road activities (3–15%) (Cordell 2012). The USFS will need to take a proactive approach to sustain recreation opportunities due to climate change impacts on forest and grassland ecosystems and increasing visitor demand.

How USFS is Addressing Climate Change and Recreation

Under Executive Order (E.O.) 13653, Section 5(a), the Forest Service, along with

all other federal agencies, was charged to “develop, implement, and update comprehensive plans” to meet agency goals based on climate change impacts; such plans include impact, risk, and vulnerability assessments (USFS 2014).

The USFS published a *Climate Change Adaptation Plan* draft in 2014 that showcases a variety of actions taken to integrate climate change considerations into existing and new plans, policies, and programs. These documents are used in managing national forests and grasslands and for collaborating with other federal agencies, states, tribes, and stakeholders to achieve landscape-scale conservation (USFS 2014). As part of this plan, agency-level adaptive management strategies were proposed to build knowledge of appropriate climate change mitigation and adaptation measures to sustain forests and grasslands (USFS 2014). The *Forest Service Climate Change Performance Scorecard* facilitates implementation at the local level, ensuring that standards for organizational capacity, engagement, adaptation, and mitigation and sustainable consumption are met under climate change pressures (USFS 2014).

Potential Implementation Challenges for the USFS

The USFS acknowledges that climate change will impact outdoor recreation. However, assessment of the extent and severity of recreation impacts is limited and at times highly uncertain because forest and grassland ecosystems vary both spatially and temporally (USFS 2012; Vose et al. 2012; Melillo et al. 2014). Major challenges for USFS recreation managers include effectively integrating scientific knowledge into management as well as interpreting available information on climate change impacts to ecosystems (Peterson et al. 2011). Land managers cannot rely on a “one size fits all” research base, and will instead need to adapt management decisions to their agency's circumstances.

The USFS foresees that as ecosystems experience changing conditions, related recreation opportunities will also be affected (USFS 2012, 2014; Vose et al.

2012). Likewise, outdoor recreationists may negatively affect climate-stressed ecosystems by dispersing invasive species' seeds, initiating wildfires, and contributing to soil erosion and degradation, especially where recreation demand is increasing (Vose et al. 2012). Alternatively, reductions in recreation opportunities due to climate change can negatively impact local economies (Vose et al. 2012; USFS 2014).

The USFS has evaluated the impacts of climate change to recreation within the Four Forest Restoration Initiative (4FRI). This collaborative partnership between the Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests in Arizona aims to improve forest health and increase resilience to climate change and other disturbances (Minor 2014). Overgrown forests with high fuel loads are particularly vulnerable to increasing temperatures and reduced precipitation, which may exacerbate drought and wildfires (Minor 2014). According to the Recreation Specialist Report, 4FRI also seeks to improve recreation characteristics of the forests. Recreational values will be preserved and potentially improved if mortality of large, mature trees is minimized. Therefore, 4FRI is restoring these stands and healthy understories to support resilient forests as well as ensure sustainable recreation.

Implementing these efforts depends on funding and staffing at the local, regional, and national levels to address the long-term impacts of climate change on recreation and to preserve recreational opportunities on public lands. Training of USFS personnel, in particular, will drive efficacy of decision-support tools (Ogden and Innes 2009). USFS land managers will also need to address direct climate change impacts on recreation through infrastructure and facility upgrades and increased public outreach about the risks of extreme heat and weather events (Monahan and Fisichelli 2014). Furthermore, early statistical work at the national scale to outline the climate sensitivity of recreation sites found losses in consumer benefits for snow skiing and forest activities with lowered recreation days and economic values (Loomis and Crespi 1999; Mendelsohn and Markowski 1999).

US Department of the Interior – National Park Service

The National Park Service is the caretaker that safeguards all 407 of America's national parks, in addition to national monuments, landmarks, and cultural heritage sites, encompassing over 84 million acres of land (NPS 2015). NPS revenue is highly dependent on visitor fees, especially to support improvements in recreation opportunities and infrastructure (USDI 2010). In 2014 alone, the NPS received 292 million recreation visits and brought in more than \$284 million in recreation fees (Neher et al. 2013; NPS 2014). Local economies are also dependent on national park visits. A 2012 study revealed that within 60 miles of parks, visitors spent \$14.7 billion, supporting 51,000 jobs (Thomas et al. 2014).

How NPS is Addressing Climate Change and Recreation

Like the USFS, the NPS has undertaken extensive efforts to integrate climate change considerations into existing and new management plans. Additionally, the NPS views national parks as leading opportunities for climate change research and education. In the *2010 National Park Service Climate Change Response Strategy*, goals and objectives for climate changes were formulated around four main components: science, communication, mitigation, and adaptation, with major focus placed on reducing carbon emissions within parks and maintaining the integrity of natural ecosystems. Unfortunately, outdoor recreation is only directly acknowledged in a brief statement regarding climate change as putting "visitor experience at risk" (NPS 2010). Within the *Climate Change Action Plan: 2012–2014*, research, education, and flexible management are important features of the agency's high priority actions. Within this plan, however, outdoor recreation is given greater consideration as being vulnerable to climate change, and is described as an important ecological, social, and economic service (NPS 2012).

The National Park Service *Scenario Planning Handbook* is a detailed resource developed to assist in identifying poten-

tial impacts (e.g., ecosystem stress, loss of recreation opportunities and revenue) and craft creative, flexible, scientifically informed management options. During the Assateague Island National Seashore (ASIS) Scenario Workshop, prior to developing potential scenarios, the ASIS park staff created a list of goal-framing questions such as, "How can ASIS provide recreational opportunities when traditional infrastructure is threatened?" The ASIS team agreed on tangible and implementable options, including moving recreation infrastructure to safer areas and developing alternative transportation plans (NPS 2013). This example of planning at the park level with the guidance of agency-level decision-support tools demonstrates the effectiveness of handling recreation impacts at a local level where climate change impacts are site-specific.

Another local park-level example where the NPS has protected recreation opportunities is Mount Rainier National Park. The Nisqually Road, traveled by most of the Park's two million yearly visitors, relies on the stability of the river bank it parallels. Due to glacial retreat, shifts in exposed rock surfaces during major storm events undermined the stream bank. To preserve the historic road, recreational opportunities, and safety, the NPS took action to stabilize the stream bank through the construction of riprap gabions and log jams (NPS 2015).

Potential Implementation Challenges for the NPS

The NPS has made a clear commitment to proactively plan for and adapt to climate change in its publications as well as online presence (Frost 2009; NPS 2012, 2013, 2014, 2015). Planning efforts to date anticipate major challenges in facing the uncertainties of climate change and the park-by-park variability of impacts on ecosystems and recreation opportunities.

For example, a study by Richardson and Loomis (2004) illustrates that willingness of visitors to pay park fees is significantly linked to weather, specifically temperature and precipitation. Given the reliance on recreation fees to improve visitor experi-

ences (USDI 2010), a significant reduction in visitor numbers to national parks due to climate stress would undercut the ability to maintain existing infrastructure and personnel. The economic impacts of reduced NPS visitation to gateway communities was demonstrated during the 16-day federal government shutdown in 2013, when these communities reported \$414 million in lost visitor spending (NPCA 2013).

Economic development opportunities will also suffer if changes in climate reduce visitation to protected areas (Becken and Job 2014). Climate change could also alter the proportions of visitors engaging in different types of activities: some recreation losses (e.g., reduced skiing because of declining snowpack) may be offset by increasing dry- or warm-season recreation (e.g., hiking, water-based activities) in areas where winter access was formerly limited (Richardson and Loomis 2004). Studies have found reduced visitation and economic losses after 26 years following fires in Yellowstone National Park (Duffield et al. 2013) and similar effects following flood damage in Yosemite National Park in 1997 (Duffield and Neher 2000).

Like the USFS, the NPS cannot rely on a "one size fits all" strategy to address climate change in national parks, and instead will have to take a regional to local approach using science and adaptive management strategies to make informed decisions. Our review of the NPS's climate change adaptation and strategic planning efforts demonstrate that the NPS's commitment to using the national parks for climate change research and education will assist in facing climate-induced threats to visitor experiences.

TOWARD INTEGRATING REGION- AND AGENCY-SPECIFIC PERSPECTIVES INTO FUTURE CLIMATE CHANGE ASSESSMENTS

While our approach was not intended to be comprehensive, it illustrates that major knowledge gaps exist. A significant amount of research exists, however much more is needed to provide useful information to land managers working across varied biore-

gions. The impacts of climate change on nature-based recreation are substantial and vary regionally. Consistent with findings in the most recent US assessment for other sectors (Melillo et al. 2014), future research should consider nature-based recreation in a regionally specific context.

With this in mind, there are several important questions still to be addressed. First, we emphasized the ski industry because of the plentiful existing research. However, other economically important recreation sectors should be considered, including rafting, guiding, fishing, and hunting. What specific recreation sectors are affected, how are they affected, and what are their spatial variations? Quantitative economic analysis has proven effective in developing this awareness (e.g., Colby and Smith-Incer 2005).

Second, climate change is not geographically uniform. Negative impacts in one location may be countered with positive impacts elsewhere. How is this imbalance changing visitation and visitor behavior? Local case studies on non-federal land can be conducted following community-based participatory research methods. Geospatial Information Systems (GIS) are an effective tool for evaluating spatial patterns of landscape change.

A multi-region perspective by itself is insufficient because of the differences among land management agencies. Although distinctive in their goals and objectives, the USFS and NPS recognize the importance of outdoor recreation (NPS 2012; USFS 2014). Both agencies have created a specialized framework for integrating climate change impacts into current management strategies, including climate change monitoring, scenario planning, and scientifically informed decision-making (USFS 2014; NPS 2010, 2012). Additionally, both agencies are involved in research, education, and information-sharing regarding best management practices to improve the overall management and use of public lands. Decision-support tools, federal policies, and strategic-planning resources will help regional and local land managers mitigate and adapt to climate change (Ohlson et al. 2005).

However, climate change impacts do not recognize the arbitrary political and geographical boundaries of public lands. Therefore, varied and unpredictable outcomes, complicated by fragmented research at local and regional scales, will present major challenges. Multi-scalar information-sharing among agencies can facilitate better preparedness and response to recreation challenges, as demonstrated by the Department of the Interior's Climate Science Centers and Landscape Conservation Cooperatives.

Federal land management agencies can protect public lands recreation for future generations by adapting management strategies to emerging research and experiences. The fourth NCA can assist this process by synthesizing climate change impacts to outdoor recreation in a context that is meaningful to local, regional, and agency-level public lands managers. Our regionally specific synthesis of climate change impacts on recreation (Table 1) can provide a useful baseline for such an assessment. Alternatively, other regional designations could be more appropriate for future assessment given public land boundaries and the scale of climate signals.

The fourth component of our investigation underscores the need for more targeted research, combined with collaborative management efforts across public land units within and beyond agencies. In conclusion, given its central role in the US economy and its deep-seated influence on American culture, nature-based recreation should be a priority for explicit consideration in future assessments such as the next NCA.

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Wincenty M. Pawlowski's interest in sustainability began during the 1970s oil crises, while in college at Worcester Polytechnic Institute. R. Buckminster Fuller was one of his idols at that time. He thought he would be a solar power engineer, but that career was cut short. After 27 years of other engineering work, he returned to school and graduated with a B.A. in Sustainable Community Development from Prescott College. He recently graduated from the University of Arizona Geography Department's graduate certificate program in Connecting Environmental Science to Decision-making. He is currently a consultant and president at Association for the Tree of Life.

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