158 Climate change and the demand for recreational ecosystem services on public lands in the United States

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Introduction

Cultural ecosystem services represent nonmaterial benefits people derive from the environment; these benefits include outdoor recreation opportunities (Millennium Ecosystem Assessment, 2005). Changes in climatic conditions are likely to shift the spatial and temporal demand for recreational ecosystem services. Climate change has already expanded the length of the peak visitation season for some public lands (Buckley & Foushee, 2012; Monahan et al., 2016), and is expected to change total visitation at nearly all U.S. National Parks (Fisichelli et al., 2015). However, the effects of climate change on visitation to public lands may vary by season, the location of the public land unit (Hewer & Gough, 2018), and its unique microclimatic conditions (Smith et al., 2018; Wilkins et al., 2021). To date, little is known about the magnitude and spatial variability in these shifts across large geographic extents. Here, our goal is to explore how the seasonal demand for recreational ecosystem services may change across U.S. public lands in the future under different climate change scenarios. Understanding potential future shifts in demand can help land managers plan and prepare for possible regional or seasonal shifts in visitation trends.

Methods

We used 14 years of geotagged social media data to explore how average seasonal maximum temperatures affect the demand for recreational ecosystem services by season across all state and federal public lands in the continental United States. We used Flickr posts, a measure of direct use, to represent the demand for recreational ecosystem services, only counting one photograph per user, per day, per 30 km grid cell (photo-user-days). We ran negative binomial regression models to understand the impact of average maximum temperature on the demand for recreational ecosystem services, while controlling for other variables (e.g., local population, km of roads). We ran separate models across ten different U.S. regions, and for all four seasons. We used the incidence rate ratios from the models to project how the seasonal demand for recreational ecosystem services on public lands may change by 2050 under two different climate change scenarios, RCP 4.5 and RCP 8.5.

Results

Overall, the demand for recreational ecosystem services on U.S. public lands is highest in the summer. Demand in the summer months spanning June, July, and August, was double that observed during winter months (December, January, and February). Results indicate that the demand for recreational ecosystem services across U.S. public lands is higher in warmer areas in the winter and spring, but lower in warmer areas in the summer. Across all public lands in the continental U.S., demand in the summer is expected to decrease 18% by 2050 under RCP 4.5, or 28% under RCP 8.5. However, our results project an increase in demand by 12% under RCP 4.5 in the winter, and a 20% increase under RCP 8.5. We expect a 5% increase in demand in the spring by 2050 under RCP 4.5, and 9% under RCP 8.5, with no significant changes in the fall.

There is substantial variation in the magnitude of projected changes by region. In the spring and fall, some regions are likely to see an increase in demand for recreational ecosystem services, while others will see declines (Figure 1). These findings indicate that across the entire U.S., demand for recreational ecosystem services is expected to decline under climate change scenarios, but with large shifts in the demand across seasons and regions. The peak season for visiting public lands is likely to lengthen in the U.S. as the climate continues to warm, with fewer visitors in the summer, but more in the off-season.

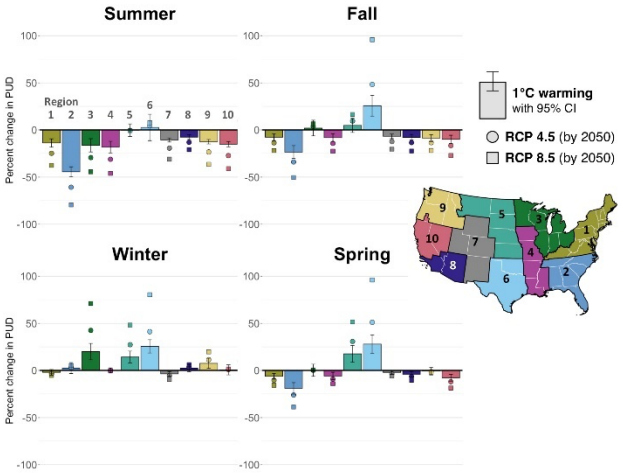

Figure 2. Projected changes in photo-user-days (PUDs) by region under different levels of warming. Bars and standard errors are directly from the negative binomial model results; if error bars cross zero, the change is not statistically significant at α = 0.05. Point estimates represent extrapolations of model results out to 2050, based on the projected temperature anomalies under RCP 4.5 and 8.5.

Discussion

This study shows that average temperature has an impact on the demand for recreational ecosystem services across U.S. public lands, and that demand is likely to shift temporally (across seasons) and spatially (across regions) as the climate warms. In many locations, land managers may want to consider preparing for an increased peak season length, and more visitors in the winter compared to past levels, but fewer in the summer. An expanding peak-season may require that more visitor services are needed in the off-season. For instance, parks and protected areas may want to keep visitors centers, bathrooms, and campgrounds open for longer periods of time to accommodate the rising number of visitors. Future research is still needed to explore how indirect climate change effects, such as shifting seasonal blooms or wildlife distributions, may affect the demand for recreational ecosystem services across public lands.

References

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