Allegheny Portage Railroad National Historic Site: How might future warming alter visitation?

Background

Climate change will affect not only natural and cultural resources within national parks, but also visitation patterns. Where, when, and how many people visit parks is likely to change with continued warming. For example, visitors may avoid extremely warm months in low-latitude parks and the visitation season may extend across additional weeks to months at northern parks. Whether park visitors track climate change and shift their behavior will depend on multiple environmental and socioeconomic factors. However, understanding potential change in visitation based on historical trends and future patterns of temperature change is a crucial first step for park managers and local communities to anticipate, plan for, and proactively affect future visitation. Recent research (Fisichelli et al. 2015) examined the relationship between park visitation and temperature across 340 NPS units. Here, we summarize and interpret results for Allegheny Portage Railroad National Historic Site. Park-specific briefs for all parks in the study are available at the National Park Service Science and Nature website.

Methods

To assess the relationship between temperature and park visitation at Allegheny Portage Railroad National Historic Site, we evaluated historical monthly average air temperature and visitation data (1979-2013) and modeled potential future visitation (2041-2060) based on two warming-climate scenarios (decreased future greenhouse gas emissions [low emissions RCP 4.5] and business as usual [high emissions RCP 8.5]) and two visitation-growth scenarios (maximum growth within +5% [low] and +25% [high] of average historical visitation of the busiest month). We averaged each month's total recreation visits across all available years in order to capture historical long-term averages in temperature and visitation. We use these data and future climate projections to estimate potential future long-term average visitation. Using a single explanatory variable, air temperature, we assume others factors as constant (e.g., income, population size, demography, and leisure time availability). See Fisichelli et al. (2015) for a detailed explanation of methods.

Results

Historical relationship between visitation and temperature

Across the national park system, parks varied widely in the historical relationship between long-term average monthly visitation and temperature. Temperature was a significant predictor of visitation at 95% of parks (324 of 340), and temperature explained 12-99% (mean = 79%) of the variation in visitation at these individual parks. The historical visitation-temperature relationship at Allegheny Portage Railroad National Historic Site was Very strong (F-test = 157.9, p-value < 0.0001). Temperature explained 97% of the variation in visitation in a 2nd-order polynomial model. Observed historical monthly visitation, air temperature, and their association are shown in Figures 1 and 2.

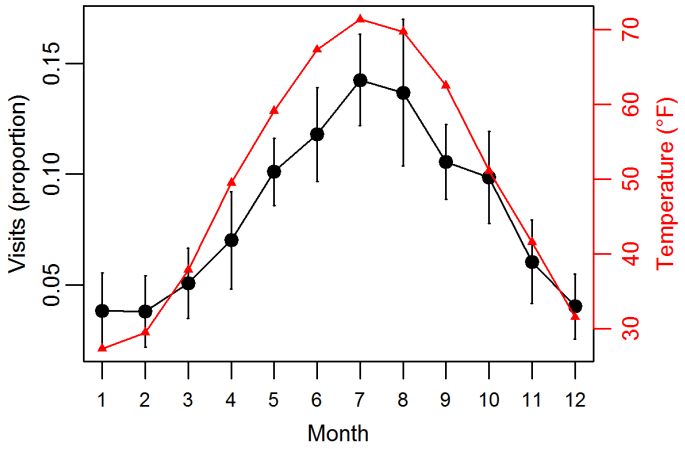

Figure 1. Observed (1979-2013) long-term average monthly visitation (black circles) and temperature (red triangles) at Allegheny Portage Railroad National Historic Site. Historical (black) error bars are +/- one standard error. Each month's visitation is expressed as a proportion of the annual total.

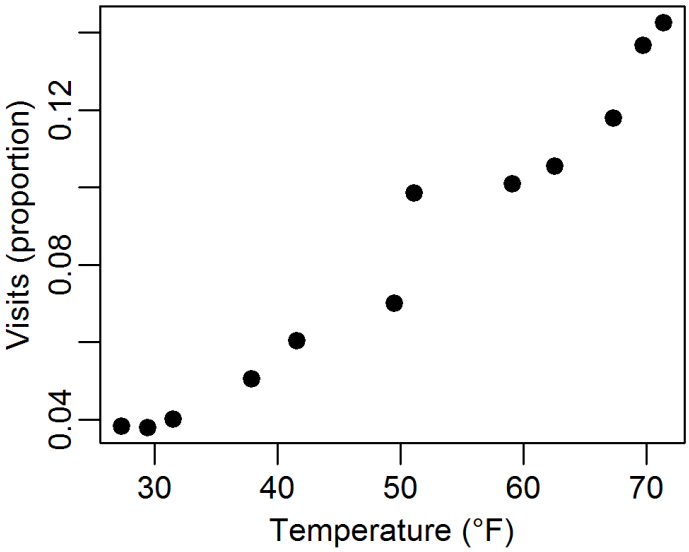

Figure 2. Bivariate scatterplot showing the relationship between observed (1979-2013) long-term average monthly visitation and temperature at Allegheny Portage Railroad National Historic Site. Each month's visitation is expressed as a proportion of the annual total.

Future potential visitation

We used the Very strong historical relationship between temperature and visitation at the park to project potential visitation changes by mid-century (2041-2060). Initial mid-century temperature projections were based on changes from the 1960-1990 baseline time period. In certain months, most notably at coastal parks, the rate of warming over the past 2+ decades (the historical visitation period) has been more rapid than projected rates, especially under low emissions (RCP 4.5). Thus, the lower rates of projected climate change should generally be treated as conservative. Monthly warming, compared with the historical visitation period (1979-2013), is +2.8 °F (+1.6 °C) under low emissions (RCP 4.5) and +6.8 °F (+3.8 °C) under high emissions (RCP 8.5). Potential visitation changes, based only on air temperature and a potential growth maximum are shown in Figure 3 and summarized as follows (values below show the maximum range of future potential visitation projections across the four scenarios):

- 8-20% increase in annual visitation
- 6-18% increase in peak season visitation (3 busiest contiguous months)
- 7-18% increase in shoulder season visitation (2 months prior and 2 months after peak season)
- 11-25% increase in low season visitation (3 contiguous months with least visitation)
- 11-23 day expansion of the visitation season (defined as beginning on the date when 10% of historical cumulative visitation was achieved and ending on the date when 10% of historical cumulative visitation remained for the year)

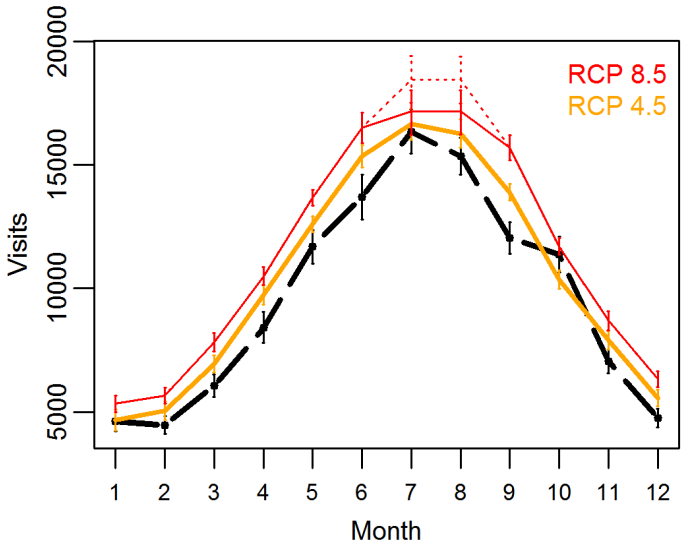

Figure 3. Observed (1979-2013) and potential future visitation (2041-2060) patterns at Allegheny Portage Railroad National Historic Site. Historical average values are black circles and error bars (black) are +/- one standard error. Red solid lines are estimates for high emissions (RCP 8.5) and orange solid lines are for low emissions (RCP 4.5) low maximum growth projections, dashed lines show high maximum growth projections when different from low maximum growth of the corresponding (same color) emissions scenario. Future projection error bars (orange, red) show +/- one standard error of the prediction estimates.

Interpreting Output

The research presented here is not a forecast of what the future will look like but rather a projection of how visitation may change based on (1) its historical relationship with temperature, and (2) how temperature is expected to change in the future. These models are not crystal-ball prophecies but rather tools to help managers envision potential future changes and their management implications. This study uses a single explanatory variable, monthly average air temperature, and yet captures a large amount of the variation in visitation patterns across the system as a whole and at many individual parks. Many factors will alter and constrain actual future visitation patterns, including population changes, economic trends, travel costs, leisure time availability, future disposable income, and the capacity of parks and local communities to expand or alter services to meet

changing visitor needs. Additional questions for managers to explore in the context of visitation:

- What other non-modeled factors are driving visitation at your park?
- When does the temperature model perform poorly and what else is occurring in those months?
- What other factors might change in the future and further affect visitation?
- How might you combine the climate projections with other factors to develop future visitation scenarios?

Implications – Adapting to Change

The National Park Service is about to begin its second century of preserving America's natural and cultural heritage and providing for visitor enjoyment. A changing climate is likely to have cascading and complex effects on park visitation, management, and local economies. Parks and surrounding communities will need to adapt to both the challenges and opportunities posed by changing visitation. Understanding the relationship between visitation and temperature presents an opportunity to plan for the future. Increased efforts to measure human visitation trends, the analyses provided here, and further research into short-term visitation patterns and other drivers of visitation can help park managers adapt to the effects of climate change and remain effective resource stewards while promoting visitor experience.

More Information

This project is part of ongoing work of the National Park Service Climate Change Response Program and collaborators to support park adaptation to changing conditions. View more information online for NPS managers and for the public.

Source Publication

Fisichelli, N.A., Schuurman, G.W., Monahan, W.B., and Ziesler, P.S. 2015. Protected area tourism in a changing climate: will visitation at US national parks warm up or overheat?. PLOS ONE doi: 10.1371/journal.pone.0128226.

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