EXTENSION
UtahStateUniversity
INSTITUTE OF OUTDOOR RECREATION AND TOURISM

THE INFLUENCE OF WEATHER ON THE SPATIAL BEHAVIOR OF VISITORS WITHIN UTAH NATIONAL PARKS

EMILY J. WILKINS, PH.D. & JORDAN W. SMITH, PH.D.

BACKGROUND

Social media has been increasingly used to understand visitor use in parks and protected areas[1]. When people post photos on social media, these photos often contain information on the location, time, and date the photo was taken; all of this information is stored as metadata. Using geotagged images from Flickr, we explored how summer visitors to Utah's national parks may vary their locations within the park based on the daily weather. We specifically looked at the elevations visitors went to within the parks, as well as their distances from roads, waterbodies, parking areas, and buildings.

In the summer months (defined here as May – September), visitors to Utah's national parks were overall more likely to venture farther from roads on colder summer days, and more likely to stay closer to roads on hotter days. Cold days are defined as days that are one standard deviation below the park-specific temperature mean (i.e. colder), while hot days are those that are one standard deviation above the mean (i.e. warmer). On days with precipitation, visitors to Utah parks were overall more likely to stay closer to roads and parking areas.

The sections below detail specific results for each national park in Utah. This is part of a larger project that looks at how daily temperature and precipitation influence visitors' spatial behavior within National Park Service units by ecoregion.

ARCHES NATIONAL PARK

In Arches, visitors went to lower elevations and ventured farther from roads and buildings on colder summer days; there were not many differences in patterns between average and hot days (Table 1, Figure 1). In Arches, colder summer days are defined as those with a high below 26.5 °C (79.7 °F), and hot days are those above 36.5 °C (97.7 °F). On days with precipitation, visitors were closer to waterbodies and buildings (Table 2).

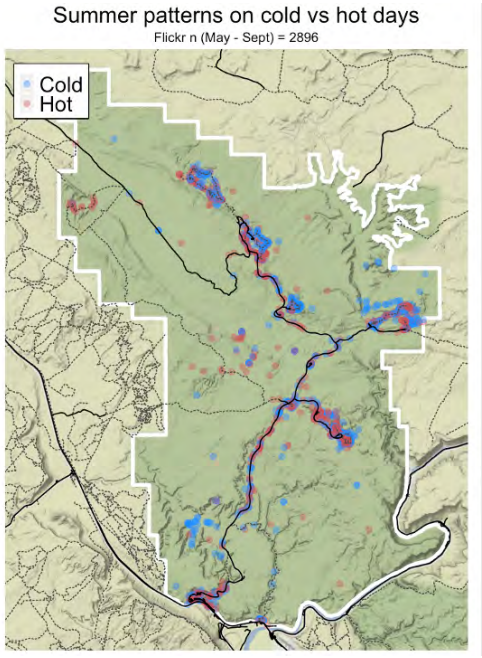

Figure 1. Spatial patters of visitors in Arches National Park on cold and hot summer days.

Table 1. Visitors' mean elevations and distances to features on cold, average, and hot summer days in Arches National Park. The *p* values are from a Welch's ANOVA test with post-hoc tests to determine where the differences between groups are (i.e., hot/cold, cold/average, or hot/average). Cohen's *d* represents effect sizes for results that are statistically significant at $\alpha \leq 0.05$. Total $n = 8{,}101$.

	M Cold (m)	*M* Avg. (m)	*M* Hot (m)	*p* value	*p* value Hot/Cold	*p* value Cold/Avg.	*p* value Hot/Avg	Cohen's *d* Cold/Avg.	Cohen's *d* Hot/Avg.
Elevation	1,505	1,518	1,522	0.00	0.00	0.00	0.30	-0.12	NA
Dist. roads	85	69	65	0.00	0.00	0.00	0.22	0.18	NA
Dist. waterbody	984	1,157	1,103	0.00	0.02	0.00	0.28	-0.14	NA
Dist. parking	594	602	588	0.71	0.96	0.90	0.72	NA	NA
Dist. building	897	931	841	0.01	0.30	0.50	0.01	NA	-0.08

Table 2. Welch's *t*-test results comparing spatial patterns of visitors in Arches National Park on days with precipitation compared to days with no precipitation. Total $n = 8{,}101$.

	M No precip. (m)	*M* Precip. (m)	*p* value	Cohen's *d*
Elevation	1,517	1,516	0.88	NA
Dist. roads	71	69	0.56	NA
Dist. waterbody	1,135	1,043	0.01	0.07
Dist. parking	595	620	0.15	NA
Dist. building	923	842	0.01	0.08

BRYCE CANYON NATIONAL PARK

In Bryce Canyon, the differences in spatial patterns of visitors within the park due to daily temperature are small (Table 3, Figure 3). In Bryce Canyon, colder summer days are defined as those with a high below 18 °C (64.4 °F), and hot days are those above 27.5 °C (81.5 °F). On days with precipitation, visitors stayed at higher elevations (i.e., they did not go down into the canyon), and were closer to parking areas (Table 4).

Figure 2. Bryce Canyon National Park.

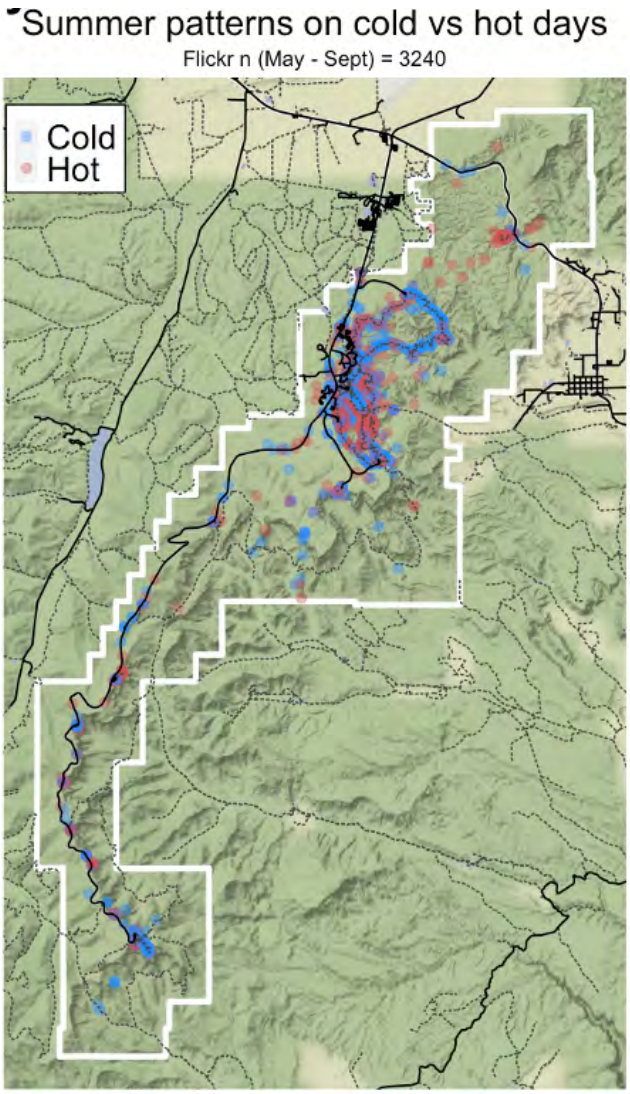

Figure 3. Spatial patterns of visitors in Bryce Canyon National Park on cold and hot summer days.

Table 3. Visitors' mean elevations and distances to features on cold, average, and hot summer days in Bryce Canyon National Park. The *p* values are from a Welch's ANOVA test with post-hoc tests to determine where the differences between groups are (i.e., hot/cold, cold/average, or hot/average). Cohen's *d* represents effect sizes for results that are statistically significant at $\alpha \leq 0.05$. Total $n = 10{,}581$.

	M Cold (m)	*M* Avg. (m)	*M* Hot (m)	*p* value	*p* value Hot/Cold	*p* value Cold/Avg.	*p* value Hot/Avg	Cohen's *d* Cold/Avg.	Cohen's *d* Hot/Avg.
Elevation	2,453	2,442	2,446	0.01	0.44	0.01	0.45	0.08	NA
Dist. roads	36	33	34	0.14	0.56	0.13	0.76	NA	NA
Dist. waterbody	2,659	2,587	2,622	0.01	0.51	0.01	0.40	0.08	NA
Dist. parking	127	117	105	0.00	0.00	0.13	0.04	NA	-0.06
Dist. building	602	586	660	0.01	0.11	0.74	0.00	NA	0.09

Table 4. Welch's *t*-test results comparing spatial patterns of visitors in Bryce Canyon National Park on days with precipitation compared to days with no precipitation. Total $n = 10{,}581$.

	M No precip. (m)	*M* Precip. (m)	*p* value	Cohen's *d*
Elevation	2,440	2,465	0.00	-0.18
Dist. roads	34	32	0.10	NA
Dist. waterbody	2,582	2,706	0.00	-0.13
Dist. parking	120	101	0.00	0.10
Dist. building	601	589	0.58	NA

CANYONLANDS NATIONAL PARK

In Canyonlands, on hot summer days, visitors were more likely to be at higher elevations, farther from waterbodies, and closer to parking areas and buildings (Table 5, Figure 5). In Canyonlands, colder summer days are defined as those with a high below 21.5 ºC (70.7 ºF), and hot days are those above 32.5 ºC (90.5 ºF). On summer days with precipitation, visitors went farther from parking areas and buildings (Table 6).

Figure 4. Canyonlands National Park.

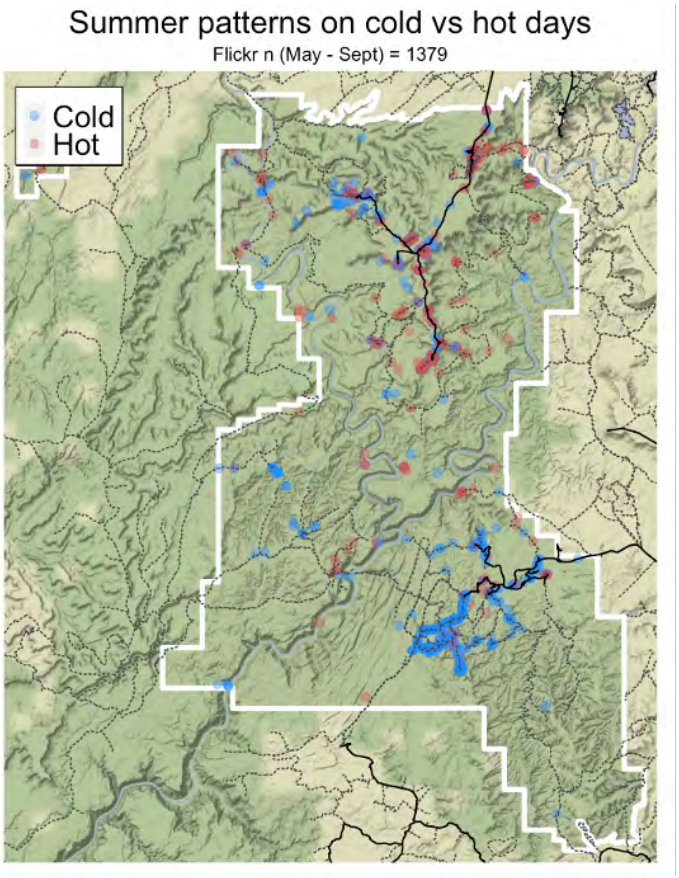

Figure 5. Spatial patterns of visitors in Canyonlands National Park on cold and hot summer days.

Table 5. Visitors' mean elevations and distances to features on cold, average, and hot summer days in Canyonlands National Park. The *p* values are from a Welch's ANOVA test with post-hoc tests to determine where the differences between groups are (i.e., hot/cold, cold/average, or hot/average). Cohen's *d* represents effect sizes for results that are statistically significant at $\alpha \leq 0.05$. Total $n = 4{,}540$.

	M Cold (m)	*M* Avg. (m)	*M* Hot (m)	*p* value	*p* value Hot/Cold	*p* value Cold/Avg.	*p* value Hot/Avg	Cohen's *d* Cold/Avg.	Cohen's *d* Hot/Avg.
Elevation	1,701	1,708	1,752	0.00	0.00	0.57	0.00	NA	0.25
Dist. roads	362	297	302	0.44	0.68	0.42	1.00	NA	NA
Dist. waterbody	1,191	1,437	1,637	0.00	0.00	0.00	0.02	-0.16	0.12
Dist. parking	2,669	1,139	854	0.00	0.00	0.00	0.00	0.66	-0.14
Dist. building	2,179	1,170	934	0.00	0.00	0.00	0.00	0.47	-0.12

Table 6. Welch's *t*-test results comparing spatial patterns of visitors in Canyonlands National Park on days with precipitation compared to days with no precipitation. Total $n = 4{,}540$.

	M No precip. (m)	*M* Precip. (m)	*p* value	Cohen's *d*
Elevation	1,712	1,716	0.49	NA
Dist. roads	321	257	0.11	NA
Dist. waterbody	1,439	1,362	0.18	NA
Dist. parking	1,260	1,734	0.00	-0.20
Dist. building	1,239	1,571	0.00	-0.16

CAPITOL REEF NATIONAL PARK

In Capitol Reef, on hot summer days, visitors were more likely to be at higher elevations, closer to roads and parking areas, and farther from waterbodies (Table 7, Figure 7). In Capitol Reef, colder summer days are defined as those with a high below 23.5 °C (74.3 °F), and hot days are those above 33 °C (91.4 °F). On days with precipitation, visitors were more likely to be at lower elevations, and closer to roads, parking areas, and buildings (Table 8).

Figure 6. Capitol Reef National Park.

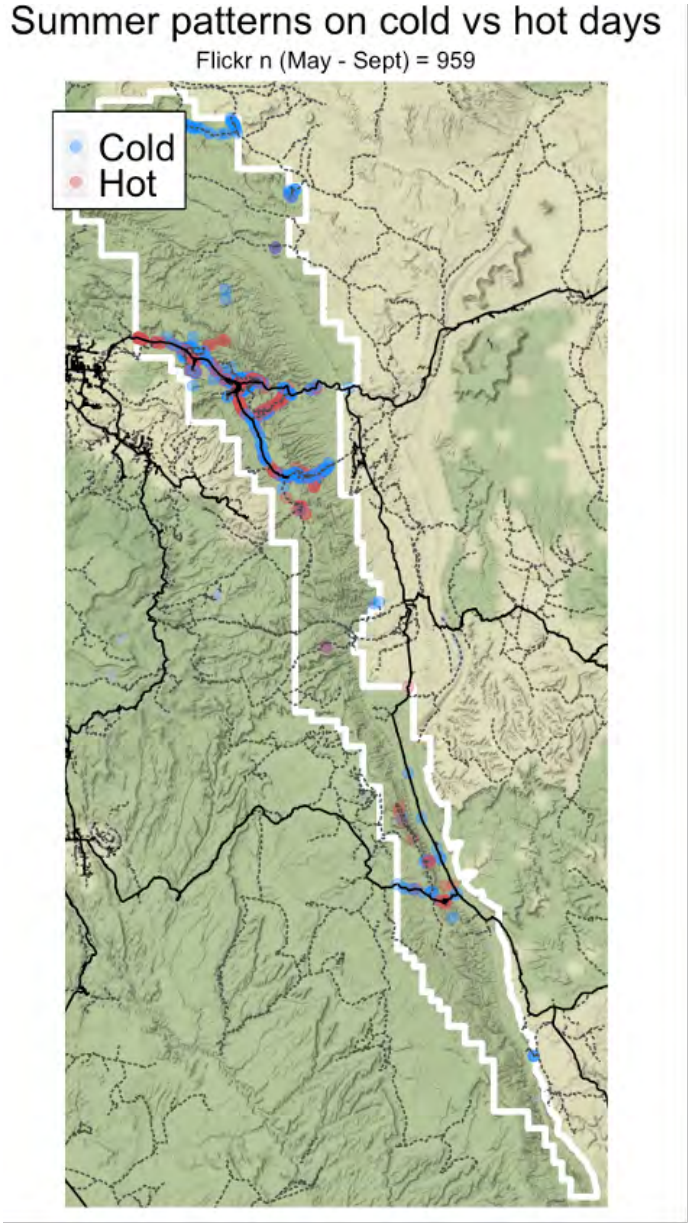

Figure 7. Spatial patterns of visitors in Capitol Reef National Park on cold and hot summer days.

Table 7. Visitors' mean elevations and distances to features on cold, average, and hot summer days in Capitol Reef National Park. The *p* values are from a Welch's ANOVA test with post-hoc tests to determine where the differences between groups are (i.e., hot/cold, cold/average, or hot/average). Cohen's *d* represents effect sizes for results that are statistically significant at $\alpha \leq 0.05$. Total $n = 3{,}394$.

	M Cold (m)	*M* Avg. (m)	*M* Hot (m)	*p* value	*p* value Hot/Cold	*p* value Cold/Avg.	*p* value Hot/Avg	Cohen's *d* Cold/Avg.	Cohen's *d* Hot/Avg.
Elevation	1,763	1,736	1,762	0.00	0.99	0.00	0.00	0.24	0.23
Dist. roads	408	171	112	0.00	0.00	0.00	0.00	0.49	-0.15
Dist. waterbody	427	394	458	0.01	0.49	0.25	0.01	NA	0.15
Dist. parking	3,346	986	629	0.00	0.00	0.00	0.01	0.63	-0.12
Dist. building	427	421	361	0.11	0.18	0.98	0.11	NA	NA

Table 8. Welch's *t*-test results comparing spatial patterns of visitors in Capitol Reef National Park on days with precipitation compared to days with no precipitation. Total $n = 3{,}394$.

	M No precip. (m)	*M* Precip. (m)	*p* value	Cohen's *d*
Elevation	1,748	1,721	0.00	0.24
Dist. roads	221	80	0.00	0.30
Dist. waterbody	413	378	0.09	NA
Dist. parking	1,480	279	0.00	0.33
Dist. building	426	349	0.00	0.13

ZION NATIONAL PARK

In Zion, on hot summer days, visitors were more likely to be at lower elevations, closer to roads, waterbodies, and buildings, but farther from parking areas (Table 9, Figure 9). In Zion, colder summer days are defined as those with a high below 26.5 °C (79.7 °F), and hot days are those above 37 °C (98.6 °F). On days with precipitation, visitors were at higher elevations and closer to roads and parking areas (Table 10).

Figure 8. Zion National Park.

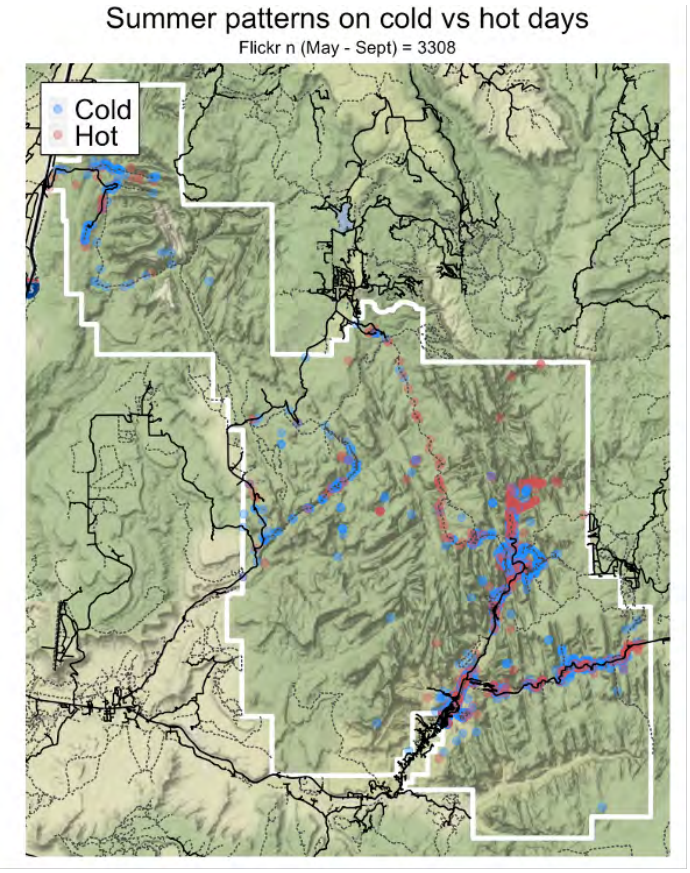

Figure 9. Spatial patterns of visitors in Zion National Park on cold and hot summer days.

Table 9. Visitors' mean elevations and distances to features on cold, average, and hot summer days in Zion National Park. The *p* values are from a Welch's ANOVA test with post-hoc tests to determine where the differences between groups are (i.e., hot/cold, cold/average, or hot/average). Cohen's *d* represents effect sizes for results that are statistically significant at $\alpha \leq 0.05$. Total $n = 10{,}622$.

	M Cold (m)	*M* Avg. (m)	*M* Hot (m)	*p* value	*p* value Hot/Cold	*p* value Cold/Avg.	*p* value Hot/Avg	Cohen's *d* Cold/Avg.	Cohen's *d* Hot/Avg.
Elevation	1,529	1,520	1,492	0.00	0.00	0.33	0.00	NA	-0.12
Dist. roads	59	64	52	0.00	0.05	0.15	0.00	NA	-0.12
Dist. waterbody	275	269	202	0.00	0.00	0.86	0.00	NA	-0.15
Dist. parking	253	263	237	0.00	0.21	0.37	0.00	NA	-0.09
Dist. building	329	339	314	0.05	0.44	0.60	0.05	NA	-0.06

Table 10. Welch's *t*-test results comparing spatial patterns of visitors in Zion National Park on days with precipitation compared to days with no precipitation. Total n = 10,622.

	M No precip. (m)	*M* Precip. (m)	*p* value	Cohen's *d*
Elevation	1,515	1,534	0.00	-0.08
Dist. roads	64	47	0.00	0.17
Dist. waterbody	259	272	0.30	NA
Dist. parking	262	233	0.00	0.10
Dist. building	334	333	0.97	NA

REFERENCES

[1] Wilkins, E. J., Wood, S. A., & Smith, J. W. (2020). Uses and limitations of social media data to inform visitor use management in parks and protected areas: A systematic review. Environmental Management. doi: 10.1007/s00267-020-01373-7