



COVID-19 Impacts on the Yellowstone National Park Soundscape

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Objectives

- Quantify changes in Yellowstone NP soundscape between 2018 and the COVID-19 shutdown of 2020.
- Explore differences in human activity between 2018 & 2020.

Background

- COVID-19 shutdowns are thought to have wide-ranging effects on soundscapes due to changes in human and wildlife behavior.
- Initial findings show shutdowns quieted urban areas¹ and caused urban birds to sing differently² due to decreased vehicle and air traffic patterns, and overall noise levels.
- National Parks across the United States closed to visitors from March-May/June 2020 creating an opportunity to study the impacts of these shutdowns.
- We looked at how the COVID-19 shutdown impacted patterns of air and vehicle traffic, and overall soundscape in Yellowstone National Park, WY, U.S.A.

Methods

Acoustical Monitoring

- Continual acoustical monitoring using remote audio recorders has occurred in Yellowstone NP for >7 years, allowing us to compare audio data from the 2020 shutdown to previous years.

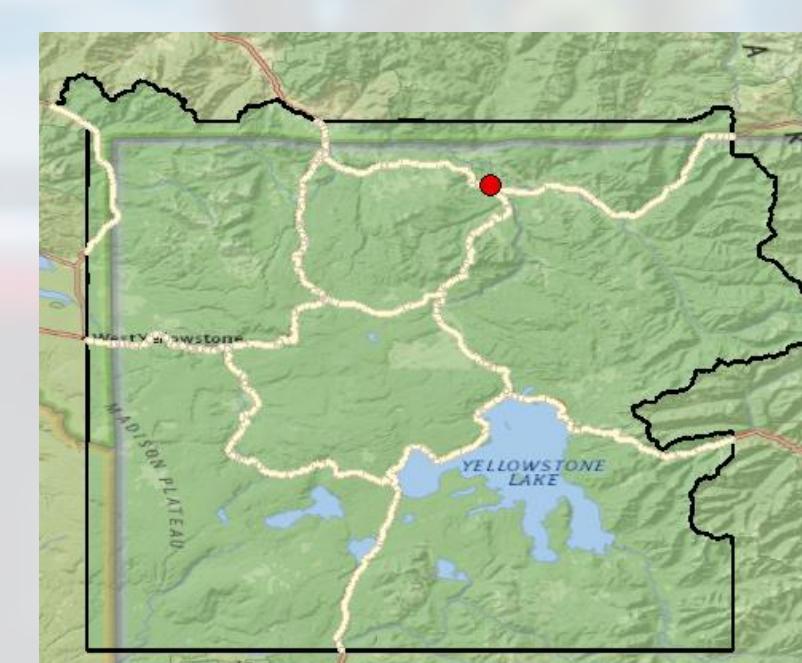


Figure 1: The red point marks the location of the study site near the junction of the Grand Loop Road and the Northeast Entrance Road.

Acoustical Data Analysis

- To quantify changes in overall loudness, we compared noise levels between years after removing unrepresentatively loud hours caused by winds, rain/hail, or animal proximity to the microphone.
- Audio recordings from April 5 – April 21, 2018 and March 27 – May 10, 2020 were analyzed through visual analysis of spectrograms (see below).
- From spectrograms, we completed counts of vehicle and aircraft presence across the study period in both years.

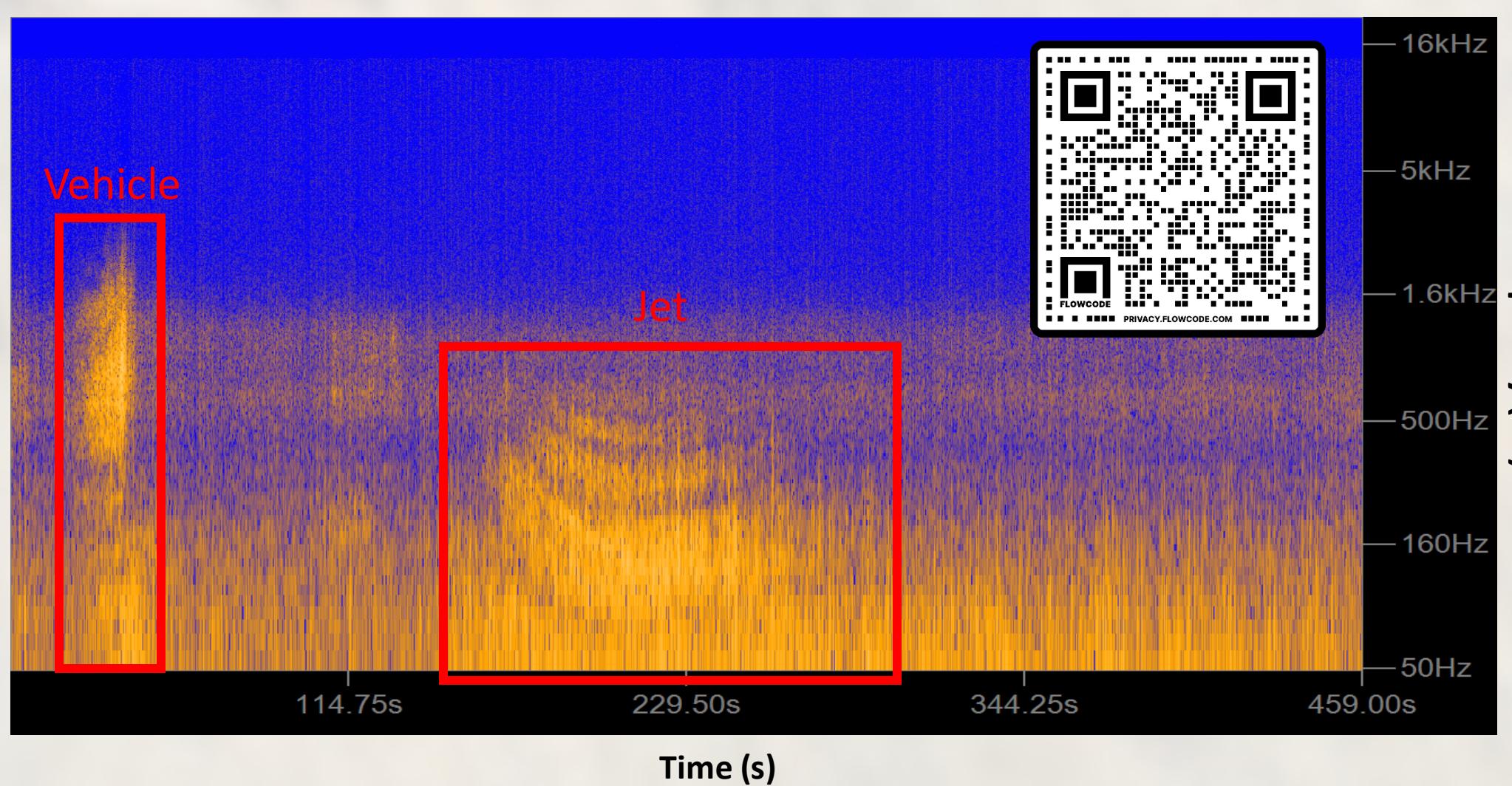
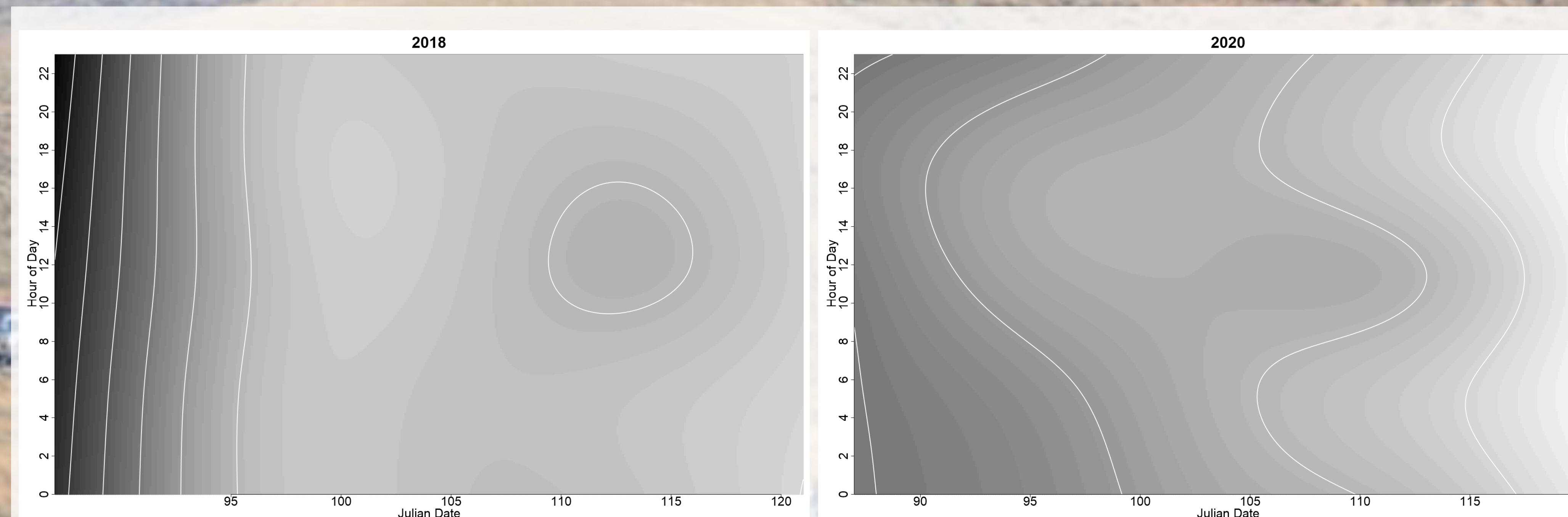
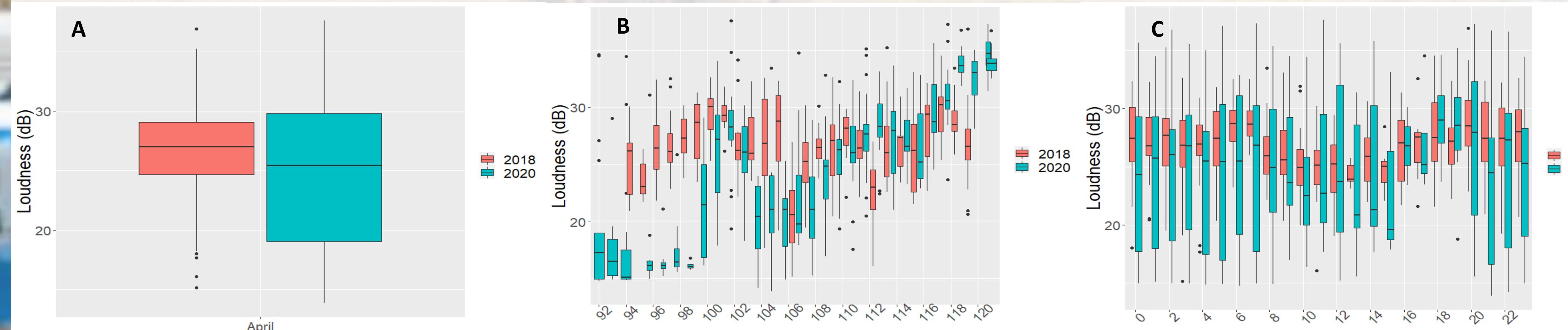


Figure 2: Spectrogram depicting instances of a vehicle and jet. Louder sounds are indicated by bright yellow. The QR code contains associated audio.

Results: Overall Loudness

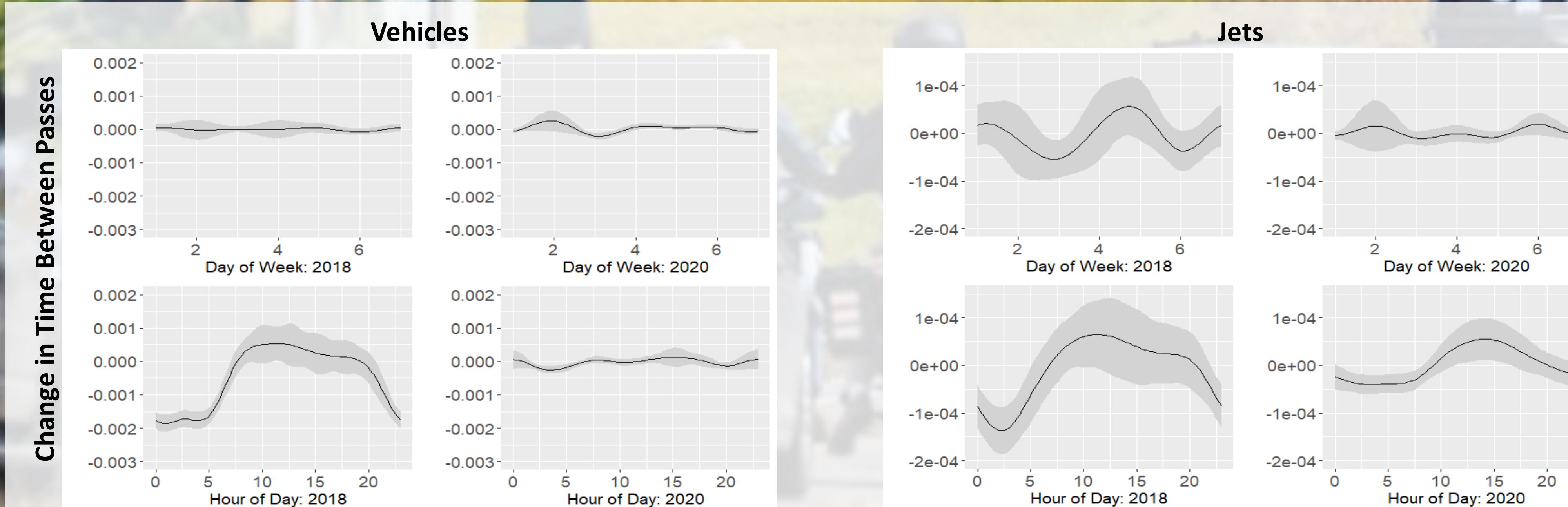


Figures 3 & 4: Generalized additive model (GAM) 2D noise smoothing maps depicting loudness (dB) by Julian date and by hour of day. Darker colors represent quieter loudness, and both maps are scaled to the same loudness levels. For reference, Julian date 105 is April 15.

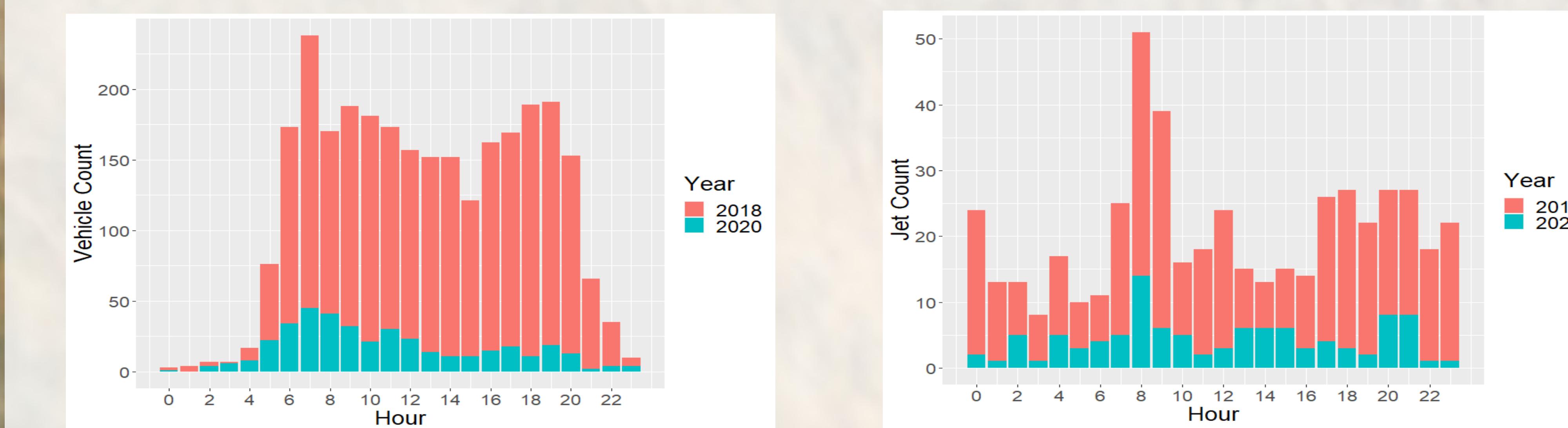


Figures 5: A series of histograms comparing loudness (dB) by year (Panel A), Julian date (Panel B), and hour of the day (Panel C) between 2018 (red) and 2020 (blue). April 2018 was significantly louder than April 2020 (Welch's two-sample t-test: $p < 0.001$).

Results: Vehicle and Jet Counts



Figures 6 & 7: Generalized additive model (GAM) splines for effect size of time (s) between successive vehicles and jets by day of week and hour for 2018 & 2020. Sunday is day 1 and Saturday is day 7.



Figures 8 & 9: Histograms of vehicle and jet counts by hour of day and year day.

Discussion

Loudness

- 2018 is an example of a typical year in Yellowstone NP with respect to loudness and human activity. Loudness increases throughout the spring in a very even pattern over both hourly and daily dimensions.
- April 2020 was quieter than April 2018, and 2020 had a greater capacity for the loudest and quietest moments (see Figure 5C).
- Reasons for increased loudest moments in 2020 may be due to the start of a large construction project in the area.
- In 2020, administrative decisions to allow park officials and employees into the park can be seen in Figure 4 at about Julian date 107.

Vehicle and Jet Counts

- Vehicle and air traffic counts greatly decreased during the 2020 COVID-19 shutdown (see Figures 8 & 9).
- Daily and hourly patterns of vehicle and air traffic counts were similar between years, but normal patterns of human activity were far more recognizable in 2018 (see Figures 6 & 7) For instance, airline commuting was largely restricted to Monday and Friday.

Implications

- As National Parks become busier than ever³ it is important that we look for ways to be cognizant of how our activity impact parks, visitors, and wildlife.
- Management decisions are being enacted to curb daily visitation and its impacts. The differences in overall loudness and traffic counts between 2018 and 2020 offer a glimpse as to how new permit systems might work to reduce these measures.
- How changes in overall loudness and traffic counts impact visitors and wildlife remains to be seen, but the impacts of noise on both are well documented^{4,5}.

References

1. Caniato, M., Bettarello, F. & Gasparella, A. 2021. Indoor and outdoor noise changes due to the COVID-19 lockdown and their effects on individuals' expectations and preferences. *Scientific Reports* 11: 16533. <https://doi.org/10.1038/s41598-021-96098-w>
2. Derryberry E.P., Phillips J.N., Derryberry G.E., Blum M.J., & Luther D. 2020. Singing in a silent spring: Birds respond to a half-century soundscape reversion during the COVID-19 shutdown. *Science* 370: 6516. doi: 10.1126/science.abb5777.
3. NPS Stats. 2021. Yellowstone National Park Total Recreational Visitors. [https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20Graph%20\(1904%20-%20Last%20Calendar%20Year\)?Park=YELL](https://irma.nps.gov/STATS/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20Graph%20(1904%20-%20Last%20Calendar%20Year)?Park=YELL)
4. Shannon et al. 2015. A synthesis of two decades of research documenting the effects of noise on wildlife. *Biological Reviews* 91: 982-1005.
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