Passive Acoustic Monitoring of Gunshot Activity in Cooking Lake-Blackfoot Provincial Recreation Area

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Introduction

- Monitoring hunting behavior has been historically limited to self-reported numbers[2]
- Autonomous recording unit (ARU) arrays can be used to monitor soundscapes
- ARU's could provide us with a more accurate way of assessing spatio-temporal shooting patterns

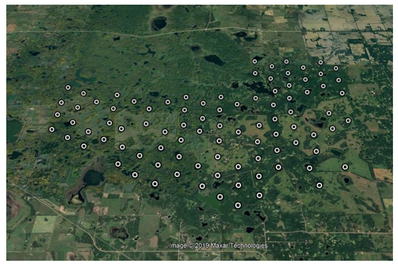

Figure 1: Locations of the recording units deployed in Cooking Lake-Blackfoot provincial recreation area (Google Earth)

Questions/Hypothesis

Q: Can you use acoustic monitoring to track human hunting activity? Are there differences in seasonal or daily shooting intensities?

H: Shooting intensity will decrease from September to November and from the afternoon till morning

Methods

- ARU's (Fig. 3) were deployed between Sept. 2nd and Nov. 30th, 2018 in Cooking Lake-Blackfoot Provincial Recreation Area (Fig.1)
- They were set to record continuously between sunrise and sunset with some recording all night as well
- We selected a random subset of 30 minute recordings, visualized them using spectrograms (Fig. 2), and counted the gunshots in each
- We compared differences in gunshot detections between months and different times of day using analysis of variance (ANOVA)

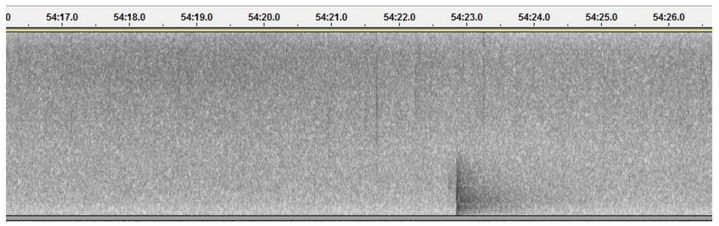

Figure 2: A 10-second visual representation of a single gunshot with time on the x-axis and frequency on the y-axis

Figure 3: An acoustic monitoring device set up to record sounds in Cooking Lake-Blackfoot Provincial Recreation Area (photo: Jeremiah Kennedy)

Results

- We found no significant difference in number of gunshots between months (p=0.302) (Fig. 5) or time of day (p=0.916) (Fig. 6)
- There was a decrease in gunshots from September to October then an increase to November (Fig. 5)
- But, the percent recordings with gunshots (Fig. 4) showed a different pattern: an increase from September (46%) to October (56%) to November (60%)
- The presence of nocturnal gunshot activity suggests illegal shooting (discharge of firearms between one-half hour after sunset and one-half hour before sunrise)

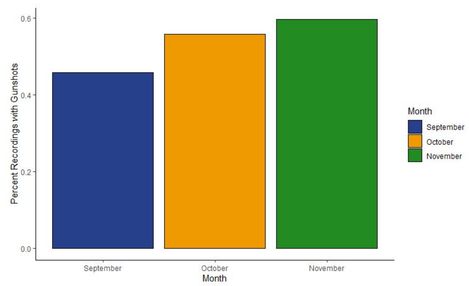

Figure 4: Percentage of recordings containing gunshots for September, October and November

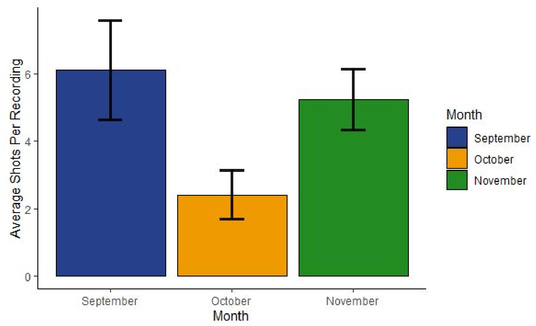

Figure 5: Average number of gunshots per recording and 95% confidence intervals for September (n=72), October (n=61) and November (n=47)

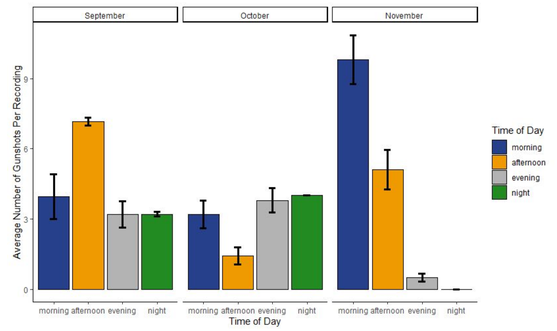

Figure 6: Average number of gunshots per recording and 95% confidence intervals for mornings (n=48), afternoons (n=88), evenings (n=19) and nights (n=7) within three months in the fall

Conclusions

- There were no statistical differences found in seasonal or daily shooting intensities
- When shot counts are broken down into time of day and month (Fig. 6) we find fluctuations between months, therefore, it may take a finer time scale to observe patterns in shooting activity
- We demonstrated that ARU's can be used to provide us with an accurate way of assessing shooting patterns and so we advise the use of acoustic monitoring in other human behaviors
- Manually listening to sound recordings is time-consuming, so further analysis will use automatic scanning of recordings to extract gunshots with manual analysis to check the accuracy of the automatic scanning algorithm

Literature Cited

[1] Gibb, Rory, et al. "Emerging Opportunities and Challenges for Passive Acoustics in Ecological Assessment and Monitoring." British Ecological Society, 4 Oct. 2018, besjournals.onlinelibrary.wiley.com/doi/full/10.1111/2041-210X.13101. Accessed 23 July 2019.

[2] Hrubes, Daniel, et al. "Predicting Hunting Intentions and Behavior: An Application of the Theory of Planned Behavior." Leisure Sciences, www.tandfonline.com/doi/abs/10.1080/01490400131689685 5. Accessed 8 Aug. 2019.

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