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Passive acoustic monitoring of gunshot activity in CookingLake-Blackfoot provincial recreation area

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Abstract

In the past, monitoring hunting behavior has been limited to self-reported numbers. However, the ability of autonomous recording units to monitor soundscapes may make them suitable for assessing spatio-temporal shooting patterns. Our goal for this project was to find out if it is possible to use acoustic monitoring to track human activity, and if there were differences in seasonal or daily shooting intensities. We hypothesized that shooting intensity would decrease from September to November and from the afternoon till morning due to people being less likely to go shooting in cooler temperatures. A grid of 91 ARU's were deployed between September 2nd and November 30th, 2018 in Cooking Lake-Blackfoot Provincial Recreation Area. They were set to record continuously between sunrise and sunset with some recording during the night as well. We selected a random subset of 30 minute recordings, visualized them using spectrograms; visual representations of sound with time on the x-axis and frequency on the y-axis, and counted the gunshots in each. We compared differences in gunshot detections between months and different times of day using analysis of variance (ANOVA). There were no statistical differences found in seasonal or daily shooting intensities. One reason for this may be that sample sizes were low, due to the time needed to manually process recordings. We demonstrated that ARU's can be used to provide us with an accurate way of assessing shooting patterns and therefore, be useful for monitoring other human behaviors such as detecting poachers, or assessing compliance with hunting laws.

Key words:
guns, gun shots, frequency, sound, sound recordings, hunting activity, acoustic monitoring, passive acoustic monitoring, ARU, ARU's, Autonomous recording unit, shooting, shooting intensity, shooting patterns, hunting patterns, Cooking Lake-Blackfoot Provincial Recreation Area, spectrograms, shot counts

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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

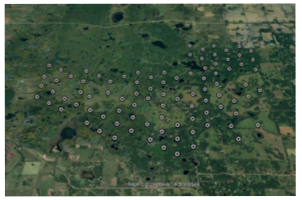


Figure 1: Locations of the recording units deployed in Cooking Lake-Blackfoot provincial recreation area (Google Earth)

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)

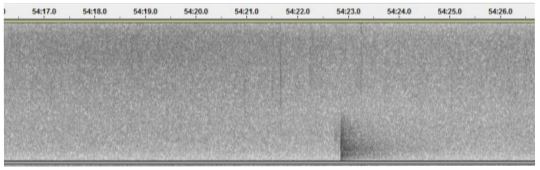


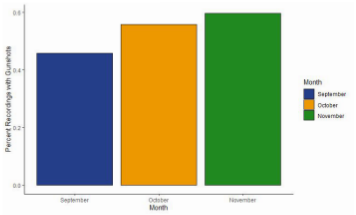
Figure 2: A 10-second visual representation of a single gunshot with time on the x-axis and frequency on the y-axis

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



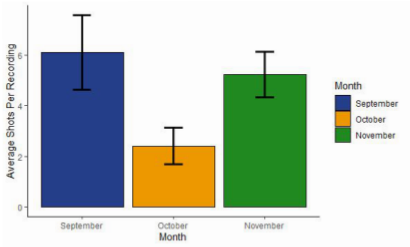
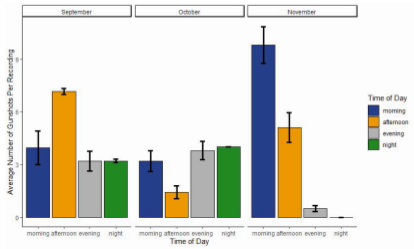


Figure 5: Average number of gunshots per recording and 95% confidence intervals for September (n=72), October (n=61) and November (n=47)

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

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