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Title: Application of Bioacoustics Monitoring and Artificial Intelligence to study Wolf Population and Communication Dynamics in Yellowstone National Park

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Abstract:

Bioacoustic monitoring methods that link animal communication patterns and population dynamics are becoming an increasingly valuable tool in wildlife conservation and management. Here, we describe a novel interdisciplinary approach that integrates bioacoustics and artificial intelligence (AI) methods as a way to investigate wolf population abundance and communication behaviors in Yellowstone National Park. A primary goal of this study is to validate the use of automatic recording units (ARUs) and an AI wolf classifier model as a lower-cost, non-invasive monitoring tool to model wolf occupancy, distribution, and abundance from acoustic data. As part of this goal, we will evaluate whether AI can help distinguish between vocalization types, as well as identify individual wolves and packs based on unique acoustic signatures which will aid population estimations. A second goal is to integrate bioacoustics data with wolf social dynamics to evaluate behavioral and ecological questions related to the purpose, context, and content of wolf vocalizations. Bioacoustics data collection for this study has been underway since summer 2023 using an array of ARUs deployed in parts of Yellowstone. These ARUs have proven effective at capturing wolf vocalizations including howls, barks, whines, and growls over extended monitoring periods and in some cases howls from over 3 miles away. While early in the study's implementation, we have amassed a preliminary dataset of over 70,000 hours of audio and over 1,500 wolf detection. Combining these data with previously banked recordings of Yellowstone wolf vocalizations, an AI algorithm framework has already been trained to classify wolf vocalizations with high accuracy. Other preliminary results provide insights into the temporal and spatial distribution of wolf vocalizations, revealing variations in communication behavior across seasons and pack territories. Given the detailed understanding of Yellowstone's wolf population, this study will provide a unique opportunity to make advances in non-invasive monitoring techniques that can be applied across wolf
population ranges. This study will also yield a large dataset and framework through which we can investigate the function of wolf vocalizations that provides insights into wolf behavior, social structure, and evolutionary adaptations. This body of work provides opportunities for education and outreach on bioacoustics, animal communication, and its applications for conservation and stewardship.