

The impact of whitebark pine (*Pinus albicaulis*) mortality on Clark's Nutcracker (*Nucifraga columbiana*) demography and habitat selection
2014-2021 Field Research: Multiscale landscape patterns of habitat selection and resource tracking by the Clark's nutcracker, an avian seed disperser

Project Report/Executive summary

Clark's nutcrackers are obligate mutualists of whitebark pine, and facultative mutualists of multiple conifers, playing an important role in forest regeneration and seed dispersal for at least ten conifer species. Whitebark pine, a candidate for the Endangered Species List, is a critical component of the Greater Yellowstone ecosystem, where it contributes to biodiversity and ecosystem function. Evidence suggests that declining whitebark pine communities are leading to reduced local Clark's nutcracker populations, which would lead to reciprocal whitebark pine declines. Because Clark's nutcrackers are highly mobile, facultative migrants, it is difficult to accurately monitor local population trends. Therefore, information on landscape scale space use is essential for more accurate predictions of Clark's nutcracker metapopulation stability, and local and range-wide resilience of the Clark's nutcracker-whitebark pine mutualism. To address this information gap, as part of my larger study of Clark's nutcracker behavior, I began the first study to attempt satellite-tagging Clark's nutcrackers.

In fall 2014, I satellite-tagged seven Clark's nutcrackers in Wyoming. Then, in February 2018, I expanded the research into Washington's Northern Cascades, and successfully satellite-tagged an additional seven nutcrackers. Three of the Wyoming satellite-tagged nutcrackers continued to transmit data into 2018, but no transmissions have been received since August 2018, almost four years after the first nutcrackers were satellite-tagged. I continue to collect and maintain the satellite data from the Washington satellite-tagged nutcrackers. I am currently analyzing the final data from the Wyoming birds and preliminary data from the Washington birds, in collaboration with Dr. Peter Singleton, US Forest Service. Satellite-tracking Clark's nutcrackers in two geographically distinct regions, northwest Wyoming and the North Cascades, enables comparisons, for the first time, of Clark's nutcracker resource tracking, landscape scale long distance movements, and habitat selection in regions with different habitat types and health. These analyses will allow for better predictions of population stability and resilience locally and throughout their range.

Results of this study will be directly applicable to researchers and managers involved with the conservation of subalpine communities in whitebark pine ecosystems. The results improve managers' ability to identify and manage Clark's nutcracker habitats, as well as identify connectivity between distant habitats. Additionally, the data will provide definitive information on Clark's nutcracker habitat selection and use, which is critical for designing effective management strategies.

Outreach:

In 2018, I created, then regularly updated a website for this project, www.thenutcrackerecosystemproject.com. I have also conducted outreach on Clark's nutcracker conservation, contributing a chapter to the Atlas of the Absaroka-Beartooth Wilderness, and writing a blog for the Jackson Hole Conservation Alliance. I presented this research at the Yakima Valley Audubon Society in Yakima, WA, and the Canadian Society for Ecology and Evolution conference. Additionally, I taught a series of classes related to the Clark's nutcracker research at both Country Classroom in Middleburgh, NY, and the Bethlehem Children's School in Slingerlands, NY. Videos of the related Wyoming portion of the Clark's nutcracker research are included in the documentary *Far Afield: A Conservation Love Story*, which is still regularly shown on American Public Television stations. This outreach increases public awareness of this important conservation issue.

Additionally, I have continued to collaborate with Anya Tyson, on her nutcracker citizen science project. She completed her M.S. on this project at the University of Vermont in fall 2017, but NOLS continued to collect additional data in 2018. In collaboration with Anya, I am also currently seeking a M.S. student to continue this project in both Wyoming and Washington, to aid our goal of continuing this citizen science effort as part of the long-term Clark's nutcracker research. This citizen science gives participants a sense of ownership and personal responsibility, as it encourages people to engage more deeply with the landscape through in-depth, firsthand observation.

I will include my research results in a future presentation to the Jackson Hole Bird Club, sponsored by the Jackson Hole Wildlife Foundation and the Northern Rockies Conservation Cooperative.

How grant money was used:

All remaining funds, \$530.37, from the Meg and Bert Raynes Wildlife Fund award were used to pay for 2018 satellite usage costs for satellite-tagged Clark's nutcrackers.