

# The Relationship Between Whitebark Pine Health, Cone Production, and Nutcracker Occurrence Across Four National Parks

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## Background

Whitebark pine (*Pinus albicaulis*) is declining in the central and northern Rocky Mountains from infection by the exotic pathogen *Cronartium ribicola*, which causes white pine blister rust, and from outbreaks of mountain pine beetle (*Dendroctonus ponderosae*). White pine blister rust has been present in Glacier and Waterton Lakes National Parks (NP) about two decades longer than in the Greater Yellowstone Area, but both Grand Teton and Yellowstone NP are currently experiencing major outbreaks of mountain pine beetle. McKinney and Tomback (2007) and McKinney and others (2009) demonstrated that as whitebark pine stands are progressively damaged by blister rust or trees are killed, Clark's nutcrackers (*Nucifraga columbiana*) make fewer stand visits when seeds are ripe. Our goals were to determine what variables best predict the occurrence of nutcrackers in whitebark pine stands in Grand Teton, Yellowstone, Glacier, and Waterton Lakes NP, and to compare the relationship we determine between cone production and nutcracker occurrence to that determined by McKinney and others (2009).

## Experimental Design

In 2008, we established ten 30 m x 1000 m (1 km) transects for nutcracker point counts and two 10 m x 50 m plots per transect to examine forest health and cone production in Yellowstone, Grand Teton, Glacier, and Waterton Lakes National Parks (NP). In July and again in late August and early September in 2008 and 2009, we gathered data from these transects and plots to determine whitebark pine infection levels and canopy damage from blister rust; recent mortality from mountain pine beetle; living basal area; cone production; and, Clark's nutcracker occurrence and seed foraging activities through point counts. One-way MANOVA was used to examine differences in forest health variables, cone production, and nutcracker occurrence among parks. We used simple linear regression and correlation analysis to examine relationships between the number of cones and number of nutcrackers observed per year. Logistic regression analyses were used to look at the relationship between the multiple response variables, described above, and the dependent variable nutcracker presence and absence. For each explanatory variable in turn, we summed the AIC (Akaike's Information Criterion) scores of every model in which it

appeared and normalized these sums to determine the relative importance weight for each variable. To compare our data to the linear regression model of nutcracker occurrence and cone production of McKinney and others (2009), we transformed our data from the number of nutcracker observations per point count to the proportion of total point count observation hours with at least one nutcracker observed.

## Health Variables

Whitebark pine health differed greatly between the southern parks (Yellowstone and Grand Teton) and northern parks (Glacier and Waterton Lakes). No recently dead trees from blister rust infection were found on our health plots in Yellowstone and Grand Teton NP. These two parks had the lowest blister rust infection levels (1.4 and 20% overall, respectively). However, mountain pine beetle infestation levels were moderate to high in Yellowstone and Grand Teton NP (17.9 and 48.1%, respectively). Glacier and Waterton Lakes NP had more whitebark pine dying from blister rust (4.3 and 8.3%, respectively), and high levels of blister rust infection (32.5 and 70%, respectively). Pine beetle infestation was much lower in Glacier and Waterton Lakes National Parks (0 and 15.5%, respectively). MANOVA indicated that *park* was a significant predictor of variation in stand health; each park had a unique set of whitebark pine forest conditions.

## Cone Production and Nutcracker Sightings

Cone production was low in all parks in 2008. In Yellowstone and Grand Teton, cone production rose dramatically in 2009, but not in Glacier and Waterton Lake NP. Nutcracker sightings were highest in Yellowstone and Grand Teton National Parks where whitebark pine was healthiest and cones were most abundant. Nutcrackers were observed breaking into cones and actively caching whitebark seeds on one Yellowstone transect. The fewest nutcrackers were observed in Glacier and Waterton Lakes NP. We obtained significant correlations between numbers of nutcrackers observed and cones counted (per year) for both 2008 and 2009. MANOVA indicated that *park* was a significant predictor of variation in nutcracker occurrence. However, AIC analysis failed to isolate a single variable or multivariate model responsible for nutcracker occurrence. All models included

most of the following variables: total healthy trees, total trees infected with blister rust, total infested with mountain pine beetle, total dead trees, total cones, live basal area, and total squirrels. Whereas McKinney and others (2009) found that nutcrackers occurred reliably with cone production above ~130 cones/ha, our study found nutcrackers occurring reliably above the lower value of ~70 cones/ha.

## Management Implications

The lower number of cones per hectare (cone threshold) corresponding to reliable nutcracker occurrence that we found offers more potential for nutcracker visitation in whitebark pine communities with fewer living trees or heavily damaged trees. However, if nutcrackers stop visiting whitebark pine stands with high mortality, natural regeneration will diminish greatly. This has particular relevance to stands near areas burned by wildfire. If nutcrackers are not dispersing seeds from damaged stands, then planting may be a highly appropriate management strategy for these areas.

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