

Clark's Nutcracker and Whitebark Pine: a Fascinating Partnership

By Bo Crees



In the summer of 2003 I worked in Yosemite National Park and spent much of my free time exploring the high elevation backcountry of the Sierra Mountains. I caught the birding bug only a few months before, so nearly every species I encountered was new, beautiful, and interesting. I observed many montane bird species and appreciated all of them, but one species, the Clark's Nutcracker, quickly became my favorite. I vividly remember sitting on rocky, windswept ridgelines towering over the Grand Canyon of the Tuolumne River and watching groups of Clark's Nutcrackers forage and interact. They seemed fearless, and often landed close by and curiously watched me. That summer I came upon a wonderful old book called "Discovering Sierra Birds" and learned that Nutcrackers are seed-cachers with remarkable memory, and have been known to retrieve seeds from caches buried under 4 feet of snow. Amazing! I wanted to know more.

After three years in Yosemite I moved to Missoula to study wildlife biology at the University of Montana. There, I learned many more things about Nutcrackers and their truly fascinating relationship with the whitebark pine. Several days ago I was surprised to find out that the whitebark pine has been proposed to be listed as "threatened" under the Endangered Species Act. As some of you may know, the whitebark pine is not doing well and may need every protection it can get.

The whitebark pine is a keystone species (meaning, a species that other species in an ecosystem depend on, and that the ecosystem would change drastically if the species was removed) because it creates critical plant and wildlife habitat in mountain landscapes that would otherwise be barren. Unfortunately, the species has experienced a significant die-off, and more than half (!) of all standing whitebark pines in the U.S. are dead. Some areas such as the Greater Yellowstone Ecosystem have experienced more dramatic declines of 80% or more. The primary threats to this species is a fungal disease called white pine blister rust and the mountain pine beetle, a beetle that is becoming more widespread and damaging as winters become warmer due to climate change. The increase in fires and droughts across the west also contributes to the trees decline. A decade ago the U.S. Forest Service estimated that by the end of the century whitebark pine populations will occupy only 3% of their current range.



White pine blister rust damage on a live whitebark pine and a dead whitebark pine. Photos by Vlad Kovalenko

Not surprisingly, the species most dependent on whitebark pine for survival is the Clark's Nutcracker. The whitebark pine and Clark's Nutcracker have a remarkable relationship and the two species have co-evolved over thousands of years. Now that the whitebark pine is proposed to be listed under the Endangered Species Act, we figured it was a good opportunity to share with you some of what I find most interesting about these two interconnected species.



Whitebark pine and Clark's Nutcracker. Photos by Vlad Kovalenko (L) and Bob Martinka

The Clark's Nutcracker is a widespread resident across North America's mountain west, inhabiting high-elevation coniferous forests in all western states. It prefers forests dominated by multiple species of large-seeded pines and depends especially on whitebark pine as its primary food source. This pine species, and several others such as limber pine and Ponderosa pine to a slightly lesser degree, and Nutcrackers have a remarkable mutualistic relationship. This "mutualism", defined as "a biological interaction between individuals of two different species, where both individuals derive a fitness benefit", has existed for many thousands of years, and researchers have demonstrated that nutcrackers were responsible for the repopulation of whitebark pine over much of its range following the most recent glaciation period, more than 10,000 years ago. Clark's Nutcracker dispersal of whitebark pine seeds occurs as follows: after a varying period, usually several years, of low or no cone production, the tree produces a great number of cones for a single season. This phenomenon is called "masting". During these years of large cone production an individual nutcracker can collect and cache 3 to 5 times more seeds than it needs to survive, up to 98,000 seeds per nutcracker per season. It typically caches the seeds under about an inch of soil, retrieving a fraction of the seeds during periods of low food availability, but leaving many excess seeds behind, where they can germinate. Most multi-stemmed trees or tree clusters in the high country are a result of unretrieved nutcracker caches.

Masting appears to be an evolved strategy of bird-dispersed pines to prevent nutcracker populations from becoming too large. When populations become too large the nutcrackers are likely to consume most of the seeds instead of caching them, since there are fewer seeds available per bird.

Nutcrackers have several physiological characteristics that are extremely enhanced, or even unique to them in the avian world, that allow them to survive and thrive in harsh mountain environments while maintaining a mutualism with the pines. One unique adaptive feature is their sublingual pouch



Clark's Nutcracker carrying food. Photo by Bob Martinka.

(sublingual = “under tongue”), which is a seed storage pouch that allows nutcrackers to collect dozens of seeds and transfer them up to 13 miles to be cached. The pouch helps nutcrackers save a considerable amount of energy by letting them carry many seeds on each caching trip, thus lowering the total number of trips required to achieve sufficient food stores.

Since individuals usually cache tens of thousands of seeds every year, and since each cache typically contains an average of 4-5 seeds, nutcrackers must recall the locations of thousands of caches. Several studies showed that nutcrackers are better at remembering hidden cache locations than any other animal, including humans. Another study showed that they can remember cache locations months after the seeds have been cached.

The whitebark pine is so valuable to nutcrackers because it has the heaviest, most energy-rich seeds of any conifer species in Montana. In addition, since the whitebark pine relies on nutcrackers for seed dispersal, the seeds are “naked”, without a thick woody skin and lacking the wing apparatus that wind-dispersed seeds (those of the Ponderosa pine, for example) have. While the seeds do have a thin, easily removed seed coat, that is usually pigmented only when the seeds are viable, the whitebark seeds are edible as soon as they are extracted and require very little additional manipulation to clean. This allows nutcrackers to quickly determine whether a seed is good or bad. The wingless seeds also allow for more efficient packing of greater numbers of seeds in the nutcracker's sublingual pouch.



Whitebark pine pinecone. Photo by V. Kovalenko

The Clark's Nutcracker's long, sharp bill allows them to efficiently extract seeds from whitebark pinecones that have evolved various morphological defenses that thwart other potential seed predators. Whitebark cones, for example, have scales that open just enough for the seeds to be seen, but not enough for them fall out or be extracted by most non-caching predators even when the cone is shaken or is turned upside down. This also prevents seeds from randomly falling on the ground where their chance of germinating is slim.

The examples above only touch the surface of this complex, mutualistic relationship. It's amazing to think that whitebark pines and nutcrackers only exist as we know them as a direct result of their co-evolution.

The Clark's Nutcracker is a species of concern in Montana in large part because its mutualistic partner, the whitebark pine is doing so poorly. The upcoming listing of whitebark pine could benefit not only both of these interconnected species, but the vulnerable montane ecosystem they inhabit as a whole.



Subalpine fir/whitebark pine forest below the Jewel Basin hawkwatch site. Notice the many dead whitebark pines right of center. Photo by Bo Crees.