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FINDINGS

INSIDE

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"Science affects the way we think together."
Lewis Thomas

Clark's Nutcracker and Whitebark Pine: Can the Birds Help the Embattled High-Country Pine Survive?

"I saw today a Bird of the woodpecker kind which fed on Pine burs its bill and tale white the wings black every other part of a light brown, and about the size of a robin."
–William Clark, Lemhi Pass, Aug. 22, 1805.

Whitebark pine (*Pinus albicaulis*) is found on the cold, steep, wind-lashed ridges of the high northern Rockies, Cascades, Olympics, and eastern Sierra Nevada. Its gnarled forms are a familiar sight to mountain climbers and high-country backpackers. Whitebark pine requires full sunlight to germinate and thus is an early colonizer of burns and other disturbed sites. At lower elevations, it is found intermixed with lodgepole pine and Douglas-fir. Near treeline, it occurs in small, scattered, nearly pure stands.


Teresa Lorenz

Researchers fitted Clark's nutcrackers with radio tags to study their role in distributing seeds from whitebark pine and caching the seeds in sites where they might germinate.

"Whitebark pine is a sentinel species in the high-mountain ecosystem," says Martin Raphael, research wildlife biologist at the Pacific Northwest (PNW) Research Station. Raphael recently collaborated on a study examining how the food-gathering efforts of Clark's nutcracker (*Nucifraga columbiana*), a crow-sized bird with a strong, sharp beak, help whitebark pine regenerate. "The tree plays a major role in mediating microclimates for other plants and animals, and its seeds are tremendously important in the diets of not only the nutcracker, but grizzly bears, ground squirrels, and jays," Raphael explains.

The tree has never been important commercially, and because it grows in the remote reaches of the West's high country, it has been sheltered from direct human influence. Yet whitebark pine is in trouble—it's experiencing declines of 45 percent across some of its range, says Raphael. "We're seeing tremendous mortality from the mountain pine beetle, which seems to be associated with climate change. The two go hand in hand: because warmer temperatures are putting stress on the trees, that makes them more susceptible to beetle attack."

IN SUMMARY

Whitebark pine inhabits some of the most pristine high-elevation areas of the West. Despite being protected from direct human influence, the tree is declining from indirect effects of fire suppression and climate change. As a keystone species, its decline has widespread ramifications. Successful restoration requires understanding the behavioral ecology of Clark's nutcracker, a bird that plays a key role dispersing whitebark pine seeds.

Until now, little quantitative information existed about the nutcracker's home ranges, seed transport habits, and caching behaviors. A team led by Teresa Lorenz, a master's student at Utah State University, and collaborators Martin Raphael and Carol Aubry of the USDA Forest Service, used radio telemetry to track the movements of 54 Clark's nutcrackers in the Olympic and Cascade Mountains over three seasons. They found that about half of the birds gathered seeds from outside their home ranges and that some flew up to 20 miles to forage, much farther than previously reported. Most seed was cached in microsites where it could not germinate. Nutcrackers also collected ponderosa pine seeds and were more effective in dispersing these to suitable sites than they were in dispersing whitebark pine seeds. This information can be used to focus restoration efforts, and may help managers refine seed-zone boundaries and identify the likeliest regeneration sites.

Fire suppression is the underlying dynamic that set the tree on its current course. Historically, whitebark pine thrived in the mixed-severity wildfire regime that once prevailed. Severe stand-replacing fires enabled the pine to colonize burned lands; light surface fires killed understory spruces and firs and gave the young pines a competitive advantage. With less frequent fires, spruce and fir gained a toehold, and they are now on their way toward supplanting whitebark pine across much of its lower elevation range. White pine blister rust and mountain pine beetle are attacking the stands that remain.

The pine's large, nourishing seeds feed many wildlife species, notably the Clark's nutcracker, which propagates the tree by caching its seeds in the ground. Other species that eat the seeds include woodpeckers, jays, ravens, chickadees, nuthatches, finches, chipmunks, tree and ground squirrels, and mice. The seeds also provide autumn food for grizzly bears and black bears, especially in the Rockies; whitebark pine communities near Yellowstone National Park and in northeastern Washington are designated as critical grizzly bear habitat.

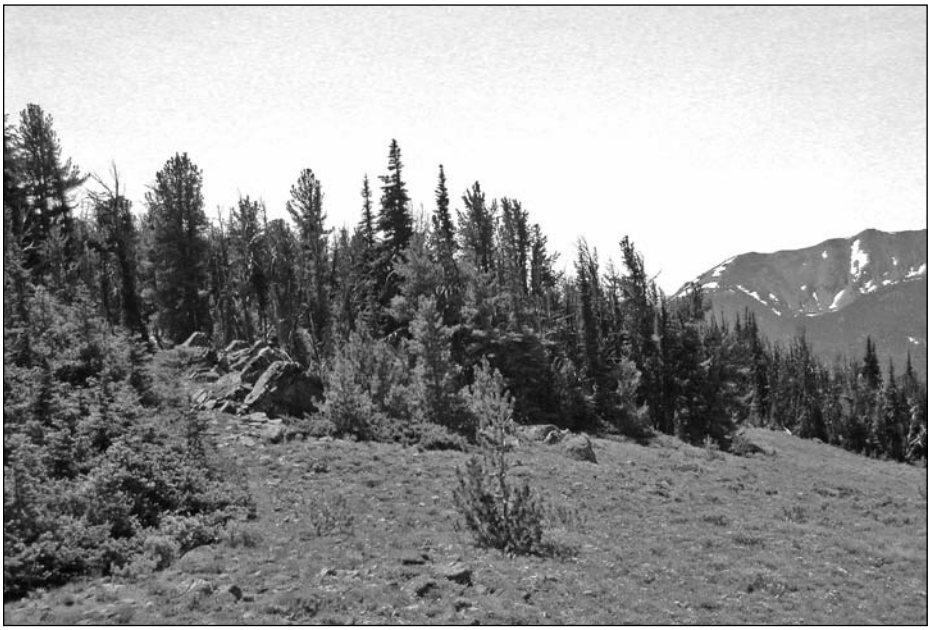
The tree's cones are indehiscent—they don't open in the fall as do the cones of most other pines. In a fascinating co-evolved relationship, whitebark pines are propagated by the Clark's nutcracker. The nutcrackers flock around whitebark pine stands in autumn as the cones ripen and use their sharp, strong bills to hammer into the tightly closed cones and dig out the seeds. "You can see the cone chips flying," says wildlife biologist Teresa Lorenz, who has uncovered valuable new information on the bird's foraging and seed-caching habits. Advised by Raphael, Lorenz conducted her research while a master's student at Utah State University.

To cache their seeds in the ground, the birds swipe a shallow trench with their bills and deposit them. They also cache seeds aboveground next to rocks, among tree roots, near fallen logs or branches, and under slips of bark. The nutcrackers can cache thousands of seeds in a season and use their remarkable spatial memory to retrieve them. After a year or two, some of the ground-cached seeds that aren't retrieved germinate, initiating the next generation of whitebark pine.

The bird's range is about three times as large as that of the trees, and its varied diet includes other conifer seeds (nutcrackers are particularly fond of ponderosa pine), insects, spiders, and even small mammals and amphibians. So the nutcracker apparently doesn't need the whitebark pine to survive, but the tree does seem to depend on the bird. Although other wildlife feed on whitebark pine seeds (squirrels can pose major competition to the nutcrackers), the caching of seeds by nutcrackers is the primary way—perhaps the only way in nature—that whitebark pine seeds encounter soil in which they can germinate.

KEY FINDINGS

- Clark's nutcrackers foraged widely for whitebark pine seeds but transported nearly all of them back to the home ranges for caching. Thus natural regeneration should be more abundant within nutcrackers' home ranges than outside them.
- Nutcrackers transported seeds over much longer distances than previously observed. The caching and germination of seeds from distant trees might produce even more genetic mixing in whitebark pine populations than previously known, resulting in greater homogeneity across the landscape.
- Nutcrackers also collected and cached ponderosa pine seeds. In fact, the birds were more effective dispersers of ponderosa pine than whitebark pine, placing more ponderosa pine seeds in habitats and microsites where they were likely to grow.
- Nutcrackers cached most seeds of both whitebark pine and ponderosa pine in unsuitable habitats for germination.



Teresa Lorenz

Whitebark pine is facing multiple threats across its range. In lower elevations, fire suppression has allowed spruce and fir to edge out whitebark pine. At higher elevations, white pine blister rust and mountain pine beetles are taking a toll on the pine.

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HOW EFFECTIVE ARE THE BIRDS?

Given the pine's precarious status, the Clark's nutcracker is a high-priority study topic. Lorenz began her research in 2006, conducting the first quantitative study of Clark's nutcracker habitat use and cache-placement preferences.

The question that guided her research, Lorenz says, was, How effective are these birds in regenerating whitebark pine? "If we have stands that are dead or dying, should we plant seeds? Or plant seedlings? Or do nothing and let the birds take care of it? Evolutionarily, the birds' job was to reseed whitebark pine. How much can we rely on birds to do this work of restoring?"

From April 2006 to September 2009, Lorenz and her team captured and radio tagged 54 nutcrackers at eight sites in the Olympic and Cascade Mountains, and tracked the spatial patterns of their foraging, caching, and nesting. They found that half of the birds remained year round near the capture site on fairly discrete home ranges, leaving these ranges only in autumn to harvest seeds from distant pine stands. These the researchers classed as resident birds. The other half left the study area within a month or two of capture and were classed as emigrants.

Nutcrackers do all their seed foraging and caching during late summer through autumn, as cones ripen. During this time, Lorenz's team spent up to 7 hours a day, 4 days a week, watching individual birds, learning where they collected their seeds and where they cached them.

STRONG HOME TIES

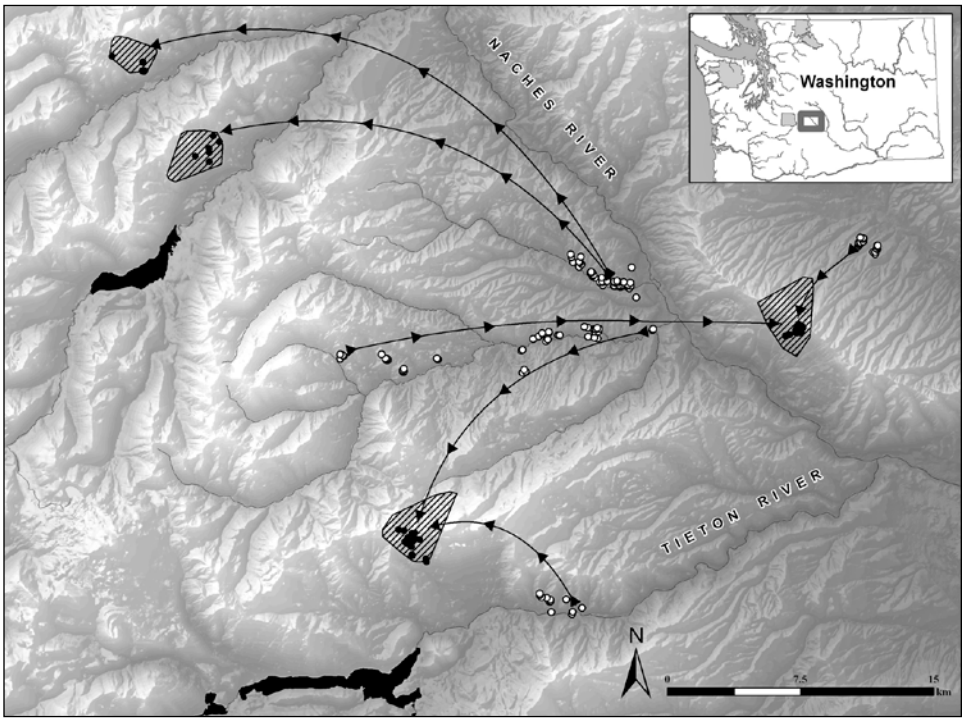
The team was the first to demonstrate that resident nutcrackers are strongly tied to a single home range. Previous studies had suggested that the birds followed the ripening cone crop uphill in the summer and fall, caching their seeds near the parent trees, and then moved back downhill to a winter range and lived there until spring.

"We didn't find that at all," says Lorenz. "I remember on Labor Day 2006, one of my birds collected seeds and went back to its home range to cache them. I thought, My gosh, he's taking the seeds back! They're not migrating; they're going back to their home ranges with the seeds! I watched that bird closely for a week to be positive he was really doing that."

The team watched the birds fetch seed multiple times a day from as far away as 20 miles—much farther than the previously reported 8 miles. The birds worked tirelessly, flying up to 5 hours a day and sometimes topping several ridges on each trip. "It's as if they're going to the grocery store," Lorenz explains. "They're going out and buying their groceries and bringing them home. They're not living where the groceries are."

The birds in this study cached their seeds in protected places at the driest, lowest elevation sites within their range. In contrast to previous observations, the birds placed their seeds more often in aboveground than in belowground sites. They avoided caching seeds on exposed places such as burns.

A bird's choice of a cache site, explains Lorenz, may represent a tradeoff between the risk of losing the cache to squirrels or mice (which argues for placing seeds out in the open) and the risk of being killed by a predator (which argues for placing them in protected sites). "These nutcrackers selected sites that compromised the safety of their food stores but secured their personal safety," Lorenz says.



This map shows flights by Clark's nutcrackers as they transported ponderosa pine seeds from harvest sites (white circles) to cache sites (black circles). The arrows indicate direction of seed transport to the birds home range (striped polygons). Seed harvest stands occurred between 2,100 feet and 2,600 feet in elevation while home ranges were located between 4,000 feet and 6,100 feet in elevation.

Some birds clearly do cache seeds on bare or exposed sites, says Raphael, but it's notable that Lorenz didn't see it in her study. "While this would be statistically rare, even a rare event can have ecological consequences. The birds cache so many seeds that some do end up on exposed ground, and some of these establish and grow."

The value of Lorenz's finding, he says, is that it demonstrates the low likelihood that seeds will end up in a good germination spot. All told, birds placed only about 15 percent of whitebark pine seeds in places where germination was possible. The rest they either buried in lower elevation habitats (notably ponderosa pine stands) or cached above ground in the whitebark pine canopy.

Their propensity to cache seeds in relatively snowfree places (making food accessible year round) meant that the birds were more effective seed dispersers for ponderosa pine than for whitebark pine. They cached more than half their ponderosa pine seeds in the ponderosa pine zone, and more of the seeds were cached in the ground at these lower elevations.

This is not good news for the whitebark pine. Of whitebark pine seeds cached in soil, none apparently germinated. As whitebark pine declines in the Northwest, ponderosa pine may

Teresa Lorenz

Researchers observed that Clark's nutcrackers tended to cache seeds aboveground rather than belowground.

Teresa Lorenz

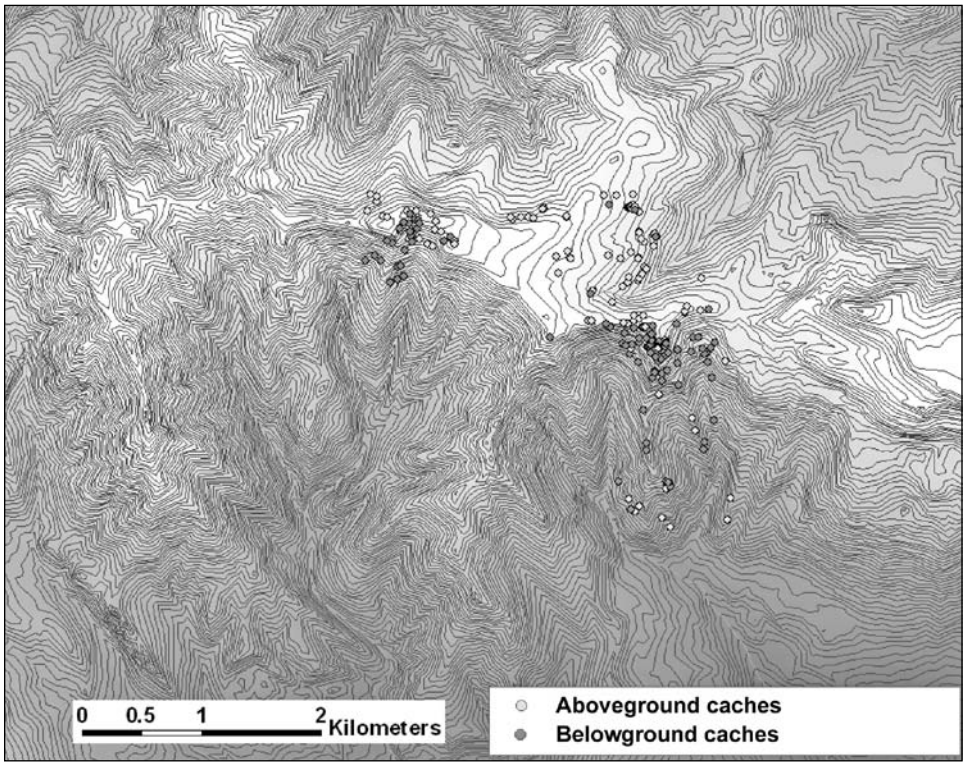
The seeds that the nutcrackers did cache belowground tended to be at lower elevation sites, frequently in stands of ponderosa pine.

become more important food for nutcrackers, which might make them more likely to select home ranges in ponderosa pine stands, resulting in even fewer whitebark pine seeds maturing into trees.

Moreover, birds don't always go out of their way to gather whitebark pine seeds. "Some of my birds didn't harvest whitebark pine even if it was there," says Lorenz. "They focused on ponderosa pine probably because it was closer to their home range." Because both trees are "masting" species, producing a big cone crop every few years and lean crops in between (in fact, whitebark pine in Lorenz's study area didn't make a cone crop at all in 2008), a broad diet is a survival advantage for the birds, but it makes them less efficient in regenerating whitebark pine because they don't focus exclusively on it.

The nutcracker isn't the only one eating whitebark pine seeds. Squirrels cut the cones from pine trees and hoard them in piles called middens. Squirrel middens are unlikely places for seeds to germinate and grow. But chipmunks and deer mice may pilfer seeds from both squirrel middens and nutcracker caches and re-cache them in the ground near shrubs, where they may germinate. This secondary dispersal, say the researchers, may be more important than previously thought.

Lorenz, now working on her doctorate, plans to test this hypothesis by burying whitebark pine seeds (she'll pry open the cones with a sharp knife) and seeing whether chipmunks dig them up and re-cache them. "I'm going to act like a nutcracker for the next 2 years," she says with a smile. "I have 1,500 cones in my living room right now that I stole from the squirrels, and it's taking me forever to extract the seeds."



This map shows above- and belowground seed caches of three Clark's nutcrackers over 3 years at the Cash Prairie site in the Cascade Range, Washington.

HELPING THE BIRDS

The nutcracker's caching behavior makes it clear that nutcrackers alone probably can't bring whitebark pine back from the brink. The system is being stressed by bark beetles, blister rust, and a warming climate, says Raphael. "Nutcrackers probably can't overcome these trends. The birds' caching of seeds is absolutely necessary, but it's not sufficient to recover the pine."

The nutcrackers' fidelity to their home ranges suggests that natural regeneration will be most abundant in areas where nutcrackers live. Knowing this, managers might target their restoration efforts in other areas where stands are smaller and more isolated.

The study confirms previous findings that seed zones for whitebark pine are relatively large. Because of natural selection, trees growing within a given area—a seed zone—will produce offspring that grow best within that area. Generally, the farther seeds are naturally dispersed, the larger the seed zone. Larger seed zones make it easier and cheaper to collect seed for regeneration.

The nutcrackers' surprisingly long foraging distances suggest that whitebark pine has spread its genes widely, resulting in a relatively homogeneous landscape-wide population (although it may show diverse local genetic patterns). The birds' long-distance seed dispersal may also help whitebark pine adapt more quickly to a warming climate.

The study was also the first documented evidence of the role of Clark's nutcrackers in disseminating seeds of ponderosa pine, which are also dispersed by wind and rodents—suggesting that ponderosa pine may be regenerating in yet-unknown spatial patterns. Moreover, say the researchers, because ponderosa pine seeds are important food for nutcrackers in Washington and Oregon, "the success of whitebark pine restoration may be irrevocably linked to the conservation of low-elevation ponderosa pine," says Lorenz.

Lorenz's study, says Raphael, provides important new information on an ecosystem that needs urgent attention. "Before Teresa did this work," he says, "we had no radio-telemetry information that told us how far these birds move. What she found alters our thinking on the genetics of this tree—it mixes up locations to a much greater degree than we appreciated before. That's a big thing, and it has important implications for restoration efforts."

LAND MANAGEMENT IMPLICATIONS

- Most seeds cached by nutcrackers will not germinate. Relying on nutcracker dispersal alone for restoring the whitebark pine ecosystem is not likely to be effective.
- Nutcrackers cached most of their seeds within their home ranges, suggesting restoration of whitebark pine outside nutcracker home ranges may be an appropriate priority.
- Seed zones for whitebark pine may be even larger than previously assumed. This could simplify and lower the cost of collecting seeds for artificial regeneration.
- Conserving lower elevation ponderosa pines—an important food source for Clark's nutcrackers—may be essential to restoring whitebark pines, which depend on the nutcrackers for regeneration.

Teresa Lorenz

Researchers learned ponderosa pine seeds are an important food source for the nutcracker. Conserving lower elevation ponderosa pine stands may be instrumental to conserving higher elevation whitebark pines, which depend on the nutcracker for seed dispersal.

"Alpine or backcountry skiing among the whitebark pine stands conveys a special thrill; you are indeed in the highest place, otherwise inaccessible, where survival in winter is a challenge to every plant and animal."

—Diana Tomback, Stephen Arno, and Robert Keane, in *Whitebark Pine Communities: Ecology and Restoration*

FURTHER READING

Aubry, C.A.; Goheen, D.J.; Shoal, R. [et al.]. 2008. Whitebark pine restoration strategy for the Pacific Northwest Region. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 90 p.

Lanner, R.M. 1996. Made for each other: a symbiosis of birds and pines. New York: Oxford University Press. 180 p.

Lorenz, T.J.; Sullivan, K.A. 2009. Seasonal differences in space use by Clark's nutcracker in the Cascade Range. Condor. 111: 326–340.

Lorenz, T.J.; Aubry, C.A.; Shoal, R. 2008. A review of the literature on seed fate in whitebark pine and the life history traits of Clark's nutcracker and pine squirrels. Gen. Tech. Rep. PNW-GTR-742. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 62 p.

Tomback, D.F.; Arno, S.F.; Keane, R.E. 2001. Whitebark pine communities: ecology and restoration. Washington, DC: Island Press. 328 p.

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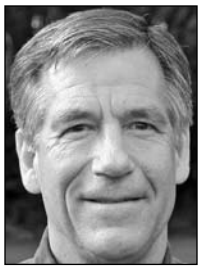

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