

Sugar Pine Seed Harvest by Clark's Nutcracker: Annual Use of a Transient Resource in Crater Lake National Park, Oregon

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Introduction

Clark's nutcrackers (*Nucifraga columbiana*) are well known for using conifer seeds as their principal nutriment source. Seeds are primarily harvested from whitebark (*Pinus albicaulis*), piñon (*P. edulis*), limber (*P. flexilis*), southwestern white (*P. strobiformis*), Jeffrey (*P. jeffreyi*), and ponderosa (*P. ponderosa*) pine as well as Douglas-fir (*Pseudotsuga menziesii*) (Tomback 1998). However, prior to our studies, sugar pine (*Pinus lambertiana*) seed harvest by Clark's nutcrackers was not documented. Sugar pine seeds, which bear long seed wings, are among the largest of pine seeds (average of 0.216 g; Tomback and Linhart 1990) and the cones are the longest among all pines (up to 66 cm, Kinloch and Scheuner 1990). Observations over several years in Crater Lake National Park (CLNP), Oregon, indicate that Clark's nutcrackers harvest sugar pine seeds, but only for about a week in late September when most cones open. The first observations of nutcrackers using sugar pine seeds in CLNP were made by Michael Murray from 2004 to 2006, and then more detailed studies were conducted by Taylor Turner, Brad Van Anderson, and Diana F. Tomback in 2008 and 2009, working in the old-growth sugar pine forest.

We predicted that the timing of use of sugar pine seeds by nutcrackers coincided with rapid cone opening. We also predicted that the use of sugar pine seeds varies with the availability of other pine seed resources. In Crater Lake National Park, the sugar pine stand under study is located at 1375 m elevation and about 14 km straight-line distance from the rim of the crater, which supports extensive whitebark pine communities.

Here, we describe the behavior used by nutcrackers while harvesting seeds from sugar pine cones, the timing of cone opening, stage of cone opening preferred by nutcrackers for seed harvest, and seed harvest rates by nutcrackers.

Methods

Our study area was located in the southern panhandle of CLNP, and covered about 50 hectares. Study dates were 21 to 26 September, 2008, and 20 to 25 September, 2009. We patrolled this section of forest everyday from 08:00 to 15:00 in search of nutcrackers by listening for vocalizations and watching the treetops; observations were made with binoculars. The forest was comprised primarily of sugar

pine, ponderosa pine, and occasional lodgepole pine (*P. contorta*), red cedar (*Thuja plicata*), white fir (*Abies concolor*), and Douglas-fir. The height of the old growth sugar pines surpassed the surrounding canopy, and most sugar pines had a minimum diameter of one meter. Upon seeing a nutcracker land on a sugar pine cone, we would observe its behavior for the duration of each cone visit. This included the position the bird assumed while harvesting, the number of seeds extracted, and the amount of time spent harvesting. We observed whether each seed was swallowed or placed in the sublingual pouch of each nutcracker, and any post-harvest activity was subsequently observed. In addition, the cone opening stage (scales separating, partially open, or open) was recorded for each cone visited. Seed extraction rates were examined by cone opening stage in order to determine if there was any correlation. In 2009 we recorded the total number of cones as well as distribution of cone opening stages for each of 13 sugar pines in addition to every sugar pine visited by a nutcracker.

Results

Nutcrackers assumed an inverted position for harvesting sugar pine seeds, requiring that they swing forward and hang upside-down parallel to the cone. They then removed one or more seeds from the cone while maintaining this upside down posture before returning to the upright. The seed wing was always removed prior to the nutcracker either consuming or pouching the wingless seed, often while still in the inverted position. Oftentimes, nutcrackers harvested seeds while in groups of three to six, which may have represented family units consisting of parents and juveniles. After harvesting, the group would leave simultaneously and fly in the same direction to cache seeds.

Steller's jays (*Cyanocitta stelleri*) were also observed taking sugar pine seeds. However, in contrast to nutcrackers, they utilized a "smash and grab" method in which they collided with a cone feet-first, and then gathered the dislodged seeds mid-air or on the ground.

At the start of the study week in 2009, sugar pine cones in all opening stages were observed on each tree, demonstrating asynchronous cone ripening. The cones opened rapidly during the five-day period that we were present, and nearly all cones that were counted and classified by phenology opened by September 25. Furthermore, the distribution of

cone opening stages on September 20 was significantly different than on September 25, illustrating the speed at which cones progressed to the open stage.

In 2008, we recorded 316 total sugar pine cone visits by nutcrackers with an average overall seed extraction rate of 6.5 sec per seed. Open cones (O) were most frequently visited, followed by partially open cones (PO), with the fewest visits to cones with scales separating (SS). O cones had an average extraction rate of 6.5 sec per seed, but nutcrackers harvested seeds from PO cones most rapidly at 5.8 sec per seed, and pouched the most seeds per cone visit. In 2009, we recorded only 35 total cone visits, all to O cones, also with an average seed extraction rate of 6.5 sec per seed. Extraction rates for O cones in 2009 were not statistically different from those in 2008. On average more seeds were harvested per cone visit in 2009 even though fewer birds were visiting cones.

On one occasion in 2009, we observed a nutcracker burying three caches. Each cache consisted of 7 to 10 sugar pine seeds and was placed in soil and duff among woody debris within 35 meters of the sugar pine from which the seeds originated. In addition, nutcrackers routinely flew off to unknown caching locations with full throat pouches in both 2008 and 2009. There were sufficient sugar pine cone crops in both 2008 and 2009, but the birds were more numerous and easy to locate within the study site in 2008. In contrast, whitebark pine cone production in CLNP was extremely high in 2009, and we observed many more nutcrackers harvesting whitebark pine seeds at the higher elevations around the crater rim than sugar pine seeds.

Discussion

Clark's nutcrackers harvest sugar pine seeds directly from the cone during the week when the cones open rapidly, in late September. Nutcrackers collect seeds using an inverted, or downward pointing body position, while perched atop the cone. Completely open cones represent the most commonly visited cone opening stage, while partially open cones offer the most efficient seed extraction rates and highest number of seeds per cone visit.

The high availability of whitebark and sugar pine cones, and the low number of nutcrackers observed in the sugar pine forest in 2009 suggests that nutcrackers supplement their diets with sugar pine seeds, although whitebark pine seeds are preferred. Hundreds of nutcrackers were observed

harvesting, eating, and caching whitebark pine seeds around the rim of the crater, which was in stark contrast to the few sightings of nutcrackers in the sugar pine forest below. The relatively long flight distance and substantial elevation change required to access sugar pine stands may not represent an energetically optimal foraging technique for most birds. However, in the event of an inadequate whitebark pine cone crop the sugar pine may become an important alternative seed source for the CLNP nutcracker population.

Pouched seeds and the caching observation suggest nutcrackers are caching the seeds within and possibly outside the sugar pine forest. Furthermore, numerous sugar pine seedling clusters were seen growing throughout the study area, although all cannot be attributed to nutcracker caches, since some rodents may cache sugar pine seeds as well (Vander Wall 2008). Nutcrackers generally bury 1-15 seeds per cache site, placing seeds 1-3 cm deep in forest litter, mineral soil, gravelly soil, or volcanic pumice sometimes near the parent tree (Tomback 1998). In accordance with this description, the clusters observed in the sugar pine stand were most often in small clearings surrounded by sugar pines with up to nine seedlings emerging from the forest litter. These observations together suggest that nutcrackers may at least disperse some seeds of sugar pine.

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