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CHARACTERISTICS OF TREES USED BY WHITE-HEADED WOODPECKERS FOR SAP FEEDING IN WASHINGTON

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The White-headed Woodpecker (*Picoides albolarvatus*) is uncommon and non-migratory throughout its geographic range in Washington, where it inhabits forests dominated by Ponderosa Pine (*Pinus ponderosa*). In the northern part of their range, White-headed Woodpeckers rely on Ponderosa Pine seeds as an essential fall and winter food resource (Ligon 1973; Garret and others 1996). Previous studies investigated White-headed Woodpecker foraging in relation to food items consumed (Raphael and White 1984), tree species used for foraging (Raphael and White 1984; Morrison and others 1987), sexual differences (Koch and others 1970; Morrison and With 1987), and competition with other species (Morrison and With 1987). Although previous research revealed that White-headed Woodpeckers do feed on tree sap in California (Raphael and White 1984) and Oregon (Dixon 1995), the characteristics of trees used for sap feeding have not been described in

FIGURE 1. White-headed Woodpecker sap wells in Ponderosa Pine trees along the east-slope of the Cascade Range, Yakima County, Washington, 2008: left) recently excavated in rows and single exploratory holes; and right) recently excavated rows (solid boxes) among old sap wells.

detail. In addition, sap feeding by White-headed Woodpeckers has yet to be described in Washington. In this study, I describe the characteristics of trees used by White-headed Woodpeckers for sap feeding and comment on observations of sap feeding behavior along the east-slope of the Cascade Range, Yakima County, Washington. Information on the use of tree sap as a food resource by White-headed Woodpeckers will add to our understanding of the natural history of this species, much of which remains unknown (Garrett and others 1996).

In 2008, I followed White-headed Woodpeckers through known breeding territories from 15 April until 20 June. Territories were located in stands managed for timber production and dominated by Ponderosa Pine with smaller components of Douglas-fir (*Pseudotsuga menziesii*) and Western Larch (*Larix occidentalis*). For a detailed description of the study area see Kozma (2009). While following White-headed Woodpeckers, I witnessed them feeding on tree sap. At trees where they were observed making and feeding from sap wells (sap trees), I recorded tree species, measured diameter at breast height (dbh) with a logger's tape, recorded tree height with a clinometer, and recorded orientation of the greatest (>50%) concentration of sap wells with a compass. In addition, sap trees that appeared to be used within the last 2 y by White-headed Woodpeckers (well-defined sap holes with dried sap) were also measured because I assumed they had not changed significantly (dbh and height) from when sap wells were first drilled. Sap trees that appeared to be older (no recently excavated wells, bark growth over existing sap holes, and absence of dried sap) were not measured because I wanted to capture characteristics of sap trees when they were first used for foraging. Sap wells excavated by White-headed Woodpeckers (Fig. 1) were differentiated from those made by Red-naped (*Sphyrapicus nuchalis*) and Williamson's Sapsuckers (*S. thyroideus*) based on the size, arrangement, and tendency of White-headed Woodpecker wells to be located on only 1 side of a tree, and not clustered

together in a specific area of the bark. I conducted the same measurements, excluding orientation of sap wells, at an additional non-used tree. Non-used trees were identified as the 1st live tree of the same species containing no sap wells that intersected a line initiated from the tree containing sap wells along a randomly chosen compass bearing. I also measured sap trees that were encountered during point-centered-quarter (PCQ) sampling (Cottam and Curtis 1956) on 9 White-headed Woodpecker territories in 2005 to 2008. However, I only measured dbh and recorded species of sap trees encountered during PCQ sampling. Non-used trees of the same species for each PCQ-sampled sap tree were chosen randomly from all live trees measured on the PCQ transect. I used a paired-sample *t*-test to compare heights of used and non-used trees, and Wilcoxon's Signed-Rank test to compare dbh of used and non-used trees because diameter data were not normally distributed (Steel and Torrie 1980). To determine if orientation of sap wells differed from a uniform distribution, I used a Chi-square goodness-of-fit test (Steel and Torrie 1980). All statistical tests were conducted at $\alpha = 0.05$.

All sap and non-used trees were Ponderosa Pine. I measured height of 32 pairs of used/non-used sap trees and dbh of 74 pairs of used/non-used sap trees. Mean height of sap trees ($\bar{x}$ = 13.5 m, $s_{\bar{X}} = 0.86$, range 3.6 to 22.1 m) was significantly less than ($t = -3.18$, $P = 0.002$) mean height of non-used trees ($\bar{x}$ = 16.5 m, $s_{\bar{X}} = 1.02$, range 2.8 to 29.4 m). Mean dbh of sap trees ($\bar{x}$ = 22.4 cm, $s_{\bar{X}} = 0.79$, range 6.1 to 37.2 cm) was significantly less than ($z = -5.39$, $P \leq 0.0001$) mean dbh of non-used trees ($\bar{x}$ = 31.0 cm, $s_{\bar{X}} = 1.3$, range 5.1 to 59.2 cm). Orientation of sap wells differed from a uniform distribution and strongly favored a southwest aspect ($\chi^2 = 28.8$, $P = 0.0002$, $df = 7$, $n = 35$) (Fig. 2).

My results show that White-headed Woodpeckers used smaller Ponderosa Pine trees for excavating sap wells. Similarly in Oregon, White-headed Woodpeckers foraged for sap exclusively on smaller Ponderosa Pine ($\bar{x}$ = 35 cm, range 12 to 85 cm, $n = 90$; Rita Dixon, Idaho Department of Fish and Game, Boise, ID, pers. comm). Because White-headed Woodpeckers are considered weak excavators (Milne and Hejl 1989; Buchanan and others 2003), it may be easier for them to drill wells in the thinner bark of smaller Ponderosa Pine compared to the thicker, furrowed bark of large diameter pines, even though older trees with larger diameters provide a greater area for feeding and likely greater sap production (Varner and others 2006). This hypothesis is further supported by the fact that on a few larger diameter sap trees that have been used over consecutive years, the newer sap wells were located higher in the tree where the bark is presumably thinner.

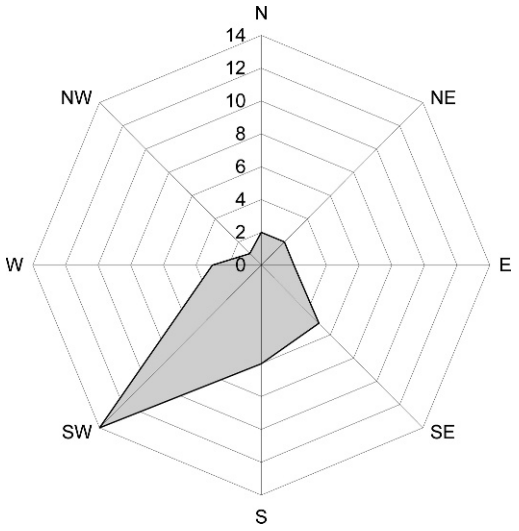

FIGURE 2. Orientation, grouped by 45-degree intervals, of sap wells drilled by White-headed Woodpeckers along the east slope of the Cascade Range, Yakima County, Washington, 2008. Numbers along the axis represent total trees with >50% of sap wells oriented in a particular direction.

I observed foraging White-headed Woodpeckers from late March through early September, 2003 through 2008. When feeding at sap wells, White-headed Woodpeckers dipped their bill into each well and lapped up sap with their tongues. Although arthropod-feeding was not observed at active sap wells, opportunistic capture of insects, particularly ants, probably occurs as it does for sapsuckers (Tate 1973; Dobbs and others 1997; Walters and others 2002). I was also unable to determine if White-headed Woodpeckers ingested inner bark or cambium layers, as do sapsuckers (Dobbs and others 1997; Walters and others 2002). However, quantitative analysis of White-headed Woodpecker stomach contents has not revealed plant

material other than pine seeds (Garret and others 1996). By mid-June, most sap feeding ceased and corresponded to the time when most eggs had hatched (median hatch date 11 June, $n = 35$ nests). White-headed Woodpeckers were not observed feeding on sap or associated with recently excavated or maintained sap wells from July through September. In addition, adults were not observed with fledglings (July) at sap wells as is known among sapsuckers (Ehrlich and Daily 1988). Thus, sap feeding on Ponderosa Pine occurred most extensively during spring. For White-headed Woodpeckers in the northern portion of their range, spring is the time when food supplies are probably at their lowest (Ligon 1973). This is largely due to depletion of Ponderosa Pine seeds and low abundances of many bark-inhabiting insects. In forests where Ponderosa Pine occurs, White-headed Woodpeckers may supplement their diet by sap feeding during a time when other important food resources are depleted. Similarly, Acorn Woodpeckers (*Melanerpes formicivorus*) in California and White-fronted Woodpeckers (*M. cactorum*) in Argentina feed on sap during a time of year when other food items are scarce (MacRoberts 1970; Blendinger 1999).

Unlike deciduous trees, conifers are capable of photosynthesis and phloem transport when outer bark and phloem temperatures are quite low to just above freezing (Tate 1973). This could explain why sap wells excavated by White-headed Woodpeckers were oriented toward a southerly aspect. In spring, the sun in the northern hemisphere is still low in the southern sky. By orienting sap wells in a southerly aspect, White-headed Woodpeckers may be taking advantage of increased sap flow facilitated by a warming sun. This choice differs markedly from Yellow-bellied Sapsuckers, which favored northerly aspects for drilling sap wells while overwintering in Longleaf Pine (*Pinus palustris*) forests of Alabama (Varner and others 2006).

Sap-feeding is well-studied for North American sapsuckers (Kilham 1964; Oliver 1970; Tate 1973; Eberhardt 2000). Sapsuckers frequently select sap trees containing a wound or other visible injury (Kilham 1964; Oliver 1970; Eberhardt 2000). Sap or phloem exudates are thought to accumulate above the wounds as they flow down from leaves following photosynthesis (Kilham 1964). It is hypothesized that sapsuckers cue in on such tree wounds and excavate wells above them to take advantage of accumulating sap; this includes natural and human-caused wounds, as well as those created by sapsuckers (Kilham 1964; Eberhardt 2000). In contrast, trees drilled by White-headed Woodpeckers did not show evidence of pre-wounding except for previously excavated wells. This was due mainly because most sap-well trees were small and relatively young. Furthermore, sap wells excavated by White-headed Woodpeckers were rarely concentrated in one area of a tree, but instead, occurred over the entire length of a tree indicating that birds were likely not cueing in on wounds or visibly defective areas. This is similar to the American Three-toed Woodpecker (*Picoides dorsalis*), which drills sap wells from trunk base to crown (Imbeau and Desrochers 2002). Like sapsuckers, White-headed Woodpeckers tended to drill new rows of sap wells above older ones, gradually working up the tree to potentially take advantage of accumulating sap. Occasionally, new sap wells were excavated among rows of old wells (Fig 1). Apparently, White-headed Woodpeckers did not use visual cues to select sap-feeding trees other than choosing trees having small dbh and thin bark. Trees used for sap feeding could be in better microsites (for example, more light and/or less competition) than non-used trees; could be in poorer health which could lead to higher amino acids and therefore more nutritious sap (Eberhardt 2000); or perhaps could have lower concentrations of monoterpenes or other deleterious compounds contained in their sap (Farentinos and others 1981; Snyder 1992). These hypotheses warrant further investigation.

I witnessed male and female White-headed Woodpeckers drilling sap wells. Although I did not quantify foraging observations, I observed males excavating wells more frequently than females. I most often observed females maintaining sap flow or feeding at previously excavated wells. This may explain why females tended to feed lower on trees, where sap wells excavated earlier in the year occur, when males were present, and may function to reduce intrapair antagonism (Ligon 1973). I did not witness agonistic behavior between male and female White-headed Woodpeckers while they foraged together on the same sap tree.

Sap wells drilled by sapsuckers and other woodpeckers are often used by other species (Ehrlich and Daily 1988; Blendinger 1999; Schlatter and Vergara 2005). On 2 occasions I witnessed a Red-naped Sapsucker feeding at wells drilled by White-headed Woodpeckers. The 1st instance occurred on 29 April 2008, when a Red-naped Sapsucker, feeding at White-headed Woodpecker sap wells, aggressively displaced several times a male White-headed Woodpecker that attempted to feed at the tree. I did not observe the sapsucker making any new wells. Later the same day, I observed a White-headed Woodpecker feeding at the sap wells and the Red-naped Sapsucker was not seen. The 2nd instance occurred at a different tree, and a different territory, on 30 April 2008, when a female White-headed Woodpecker and a Red-naped Sapsucker fed together on the same sap tree, but the White-headed Woodpecker eventually drove off the sapsucker by displacing it on the tree several times before the sapsucker flew away.

White-headed Woodpeckers appear to excavate wells to feed on sap more extensively than other North American woodpeckers in the genus *Picoides*. Of the 9 *Picoides* spp. found in North America, only Downy (*P. pubescens*; Jackson and Ouellet 2002) and American Three-toed Woodpeckers are known to excavate wells for sap feeding (Leonard 2001), with the behavior apparently more developed in *P. dorsalis* (Imbeau and Desrochers 2002). However, only the White-headed Woodpecker relies extensively on pine seeds as a seasonal food source, whereas other *Picoides* woodpeckers primarily forage for arthropod prey year-round or supplement their insect diet with fruit, seeds or mast (Ehrlich and others 1988). Therefore, unlike other *Picoides* woodpeckers, White-headed Woodpeckers may mine tree sap as a nutritious and energy rich alternative food when pine cone crops fail during natural cycles or become seasonally depleted.

Ponderosa Pine sap is an important food resource for White-headed Woodpeckers during spring along the east-slope of the Cascade Range of Washington. Smaller Ponderosa Pine may be favored for drilling sap wells because of their thinner bark, and White-headed Woodpeckers likely orient sap wells in a southwesterly aspect to take advantage of increased sun exposure that facilitates sap flow. Research is needed to further investigate why certain Ponderosa Pine trees are more attractive for sap-well excavation compared to other Ponderosa Pine trees. Foraging observations are needed in fall and winter to determine if sap is an important food resource during these seasons or if reliance on sap increases when Ponderosa Pine seed is in low abundance.

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