AN ABSTRACT OF THE THESIS OF

EVELYN LOUISE BULL for the Degree MASTER OF SCIENCE
(Name) (Degree)

in Fisheries and Wildlife presented on February 24, 1975
(Major Department) (Date)

Title: HABITAT UTILIZATION OF THE PILEATED WOODPECKER, BLUE MOUNTAINS, OREGON

Abstract approved: Redacted for privacy
E. Charles Meslow

In the spring and summer of 1973 and 1974, a study of habitat utilization by pileated woodpeckers (*Dryocopus pileatus picinus*) was conducted on the Starkey Experimental Forest and Range in the Blue Mountains of northeastern Oregon.

Pileated woodpeckers are dependent on a forest habitat for feeding and nesting. The alteration of this habitat through intensive timber management is detrimental to the species, particularly because of the elimination of dead wood, both standing and downed.

Nests were excavated in large (>58 cm dbh), tall (> 12m), ponderosa pine (*Pinus ponderosa*) and larch (*Larix occidentalis*) snags in areas with mean densities

of 494 stems and 50 snags per ha. These nest trees were in forest sites containing the highest densities of stems and snags found on the study area.

Pileated woodpeckers fed primarily in dead wood in snags, logs, and naturally created stumps. Feeding occurred in a variety of tree species of various sizes and physical characteristics. Forest sites containing the highest densities of stems and snags on the study area were preferred by the pileated woodpecker for feeding.

In 1974, there were at least 13 pairs of pileated woodpeckers on the 11,400 ha study area. This translated to 665 ha of forested habitat per pair. During spring and summer, nesting territories were estimated at 250 to 500 ha.

The critical components in pileated woodpecker habitat are: snags, particularly large snags, logs, large trees, diseased trees, dense timber, and high densities of snags. The requisite attributes of size, density, and decadent trees are most common in mature, uncut forests. These elements can be maintained at a satisfactory level with moderate modifications of current forest management practices.

Habitat Utilization of the Pileated Woodpecker,
Blue Mountains, Oregon

by

Evelyn Louise Bull

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1975

APPROVED:

Redacted for privacy

Assistant Professor of Fisheries and Wildlife
in charge of major

Redacted for privacy

Head of Department of Fisheries and Wildlife

Redacted for privacy

Dean of Graduate School

Date thesis is presented February 24, 1975

Typed by Evelyn L. Bull for Evelyn L. Bull

ACKNOWLEDGMENTS

I wish to thank Dr. E. Charles Meslow, my major professor, for his help and constructive criticism throughout the duration of the field work and thesis preparation.

Special thanks are given to the many Forest Service personnel at the LaGrande Ranger District and the Pacific Northwest Range and Wildlife Habitat Lab for their technical assistance and advice; special thanks go to Dr. Jack W. Thomas.

I am grateful to Keith Miles who assisted me during a portion of the field work.

This study was conducted through the auspices of the Oregon Cooperative Wildlife Research Unit and funded by the U.S.D.A. Forest Service, Pacific Northwest Forest and Range Experiment Station, Range and Wildlife Habitat Research Project, LaGrande, Oregon. The Forest Service also provided the study area, living quarters, and laboratory facilities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

HABITAT UTILIZATION OF THE PILEATED WOODPECKER BLUE MOUNTAINS, OREGON

INTRODUCTION

The intensity of timber management is increasing throughout most of the Pacific Northwest. Such intensified forest management for timber production alters the forests in several ways: virgin timber stands are rapidly disappearing, and the second growth stands replacing them are harvested long before they reach a comparable size; the utilization of snags and logs for wood chips is increasing; attempts are made to eliminate diseased and other undesirable trees. Silviculturally the forest stands are being improved but at the expense of diversity of the forest.

Whenever a forest is altered the effects are transmitted to the species resident in that area. The alterations in forest stands mentioned above are basically detrimental to woodpeckers, particularly the pileated woodpecker (Dryocopus pileatus picinus), the largest woodpecker species in the Pacific Northwest. The pileated woodpecker is a cavity nester, selecting large snags as nest and roost sites. In addition, the majority of feeding is in snags, logs, and diseased trees. Intensive forest management eliminates the very components of the forest that pileated woodpeckers depend on: downed logs, diseased trees, snags, and particularly large trees that become large snags.

The pileated woodpecker has an ecological value as an insect predator (Hoyt 1957) and as an agent in creating holes that eventually serve as nest cavities for other birds and mammals (Lawrence 1970). It was these attributes, as well as a concern for the bird itself, that led to this investigation of habitat utilization by pileated woodpeckers. The objectives of the study were to identify habitats utilized by pileated woodpeckers during the spring and summer for feeding and nesting and to determine population densities. Once the specific habitat requirements of the species are known, steps can be taken to maintain critical habitat components in an intensively managed forest.

Life History

The pileated woodpecker is dependent on a forest environment for feeding and nesting (Tanner 1942). It is a permanent resident of Oregon, found most commonly in forests of the Wallowa Mountains and ranges bordering the Rogue River Valley; it is less common in the Cascades, Coast range, and wooded portions of the Willamette Valley (Gabrielson and Jewett 1940).

Woodpecker size is related to nest cavity size and therefore to the size of snags required for construction of cavities. Because of the pileated woodpecker's large size (36 cm), it excavates a cavity up to 76 cm deep (Bendire 1892) and 15 to 25 cm wide (Bent 1939).

Pileated woodpeckers excavate a new nest cavity each spring, usually in the same vicinity and occasionally in the same tree as the previous year's nest (Conway 1957). Thus the bird requires a continual supply of suitable snags. Species of snags selected for nesting varies with the forest type; both deciduous and coniferous snags are used (Bent 1939; Hoyt 1957).

Several roost holes are used by a pileated woodpecker in the course of a year. These cavities are excavated in snags and used at night and during adverse weather conditions (Hoyt 1941; Tanner 1942).

Drumming is a means of communication produced by rapidly striking an object (usually a snag) with the bill. A single pileated woodpecker can have a series of trees (drum trees) which are used repeatedly for drumming (Vickers 1914; Wetmore 1964).

The majority of the pileated woodpecker's diet is animal matter, primarily carpenter ants (Formicidae) and woodboring beetle larvae (Cerambycidae, Buprestidae, Elateridae) (Beal 1911). Most of the feeding is done in decayed wood (Tanner 1942). Characteristic feeding excavations are large rectangular cavities with the long axis parallel to the tree trunk.

Both nesting and feeding habitat of the pileated woodpecker are generally typified by dense timber of deciduous, coniferous, or mixed types. Conner (1973) and Tanner (1942) found the greatest feeding and nesting activity in mature virgin timber stands.

From a review of the literature several hypotheses were developed and tested in this study. Nests and roosts should require snags at least 38 cm diameter at breast height (dbh) (McLaren 1962; McGowan 1967; Gale 1973), at least 5 m tall (Conner 1973), and occurring in the densest forest stands on the study area (Tanner 1942; Conner 1973). Feeding should occur primarily in snags and logs in the densest forest stands on the study area; little selection for species or size of feeding sites was anticipated (Tanner 1942; Conner 1973).

STUDY AREA

The study was conducted on the Starkey Experimental Forest and Range (Starkey) located in the Wallowa-Whitman National Forest 13 km south and 30 km west of La Grande, Oregon. Basic to the selection of Starkey as a study area was the presence of adequate numbers of pileated woodpeckers. A history of research on Starkey provided a wealth of data regarding such important bases as vegetation and soils. This past research when coupled with the facilities and accessibility made Starkey a prime study area.

Starkey is approximately 16 km long, 5 to 13 km wide, and includes 11,400 ha. Topography varies from gently rolling hills to steep canyons; elevation ranges from 1070 to 1525 m. Annual precipitation averages 51 cm with two-thirds accumulating as snow; the remainder falls as rain in the spring and fall. The growing season is 120 days, though no month is considered frost free. Mean minimum January temperature and mean maximum July temperature are -4.6 C and 26 C, respectively (elevation 1234 m) (U. S. Dept. of Commerce 1970).

Seventy-five percent of the study area is forested; scattered open grasslands comprise the remainder (Driscoll 1955). Of the forested area two-thirds is open ponderosa pine (_Pinus ponderosa_) or a mixture of ponderosa pine, Douglas-fir (_Pseudotsuga menziesii_), and larch (_Larix occidentalis_). The remaining third consists of dense stands of white fir (_Abies grandis_), Douglas-fir, and lodgepole pine (_Pinus contorta_). Strickler (1965) presents a detailed vegetational analysis of Starkey.

METHODS

Forest and "tree" characteristics (here tree refers to snag, log, and stump) (Table 1) were sampled according to two schemes; 1) a random sampling of the forest and tree characteristics on the study area (random sample), and 2) forest and tree characteristics of habitats used by pileated woodpeckers (habitat utilized).

Random Sample

A random sample of forest and tree characteristics was collected on 48 transects. Each transect was 805 m long. Data were collected at ten points along each transect. The first point was located 20 m from the transect end, the other nine were at 75 m intervals.

An 805 m grid was superimposed on a map of the study area using a randomly selected base point. Rows and columns were numbered; a random numbers table was used to select 48 transect start points. Transects ran in a cardinal direction.

Forested areas on the study area were assigned to one of five forest sites (Burr 1960) (Table 2). The two open ponderosa pine forest sites (203 and 204) were combined because of the structural similarity in the woody vegetation (herafter referred to as forest site 204). The re-

Table 1. Forest and tree characteristics of points on transects and sites with pileated woodpecker use.

Characteristics	Active Nest	Old Nest	Roost	Drum Tree	Feed Site	Points on Transects
Forest Characteristics						
Landform	x	x	x	x	x	x
Slope gradient	x	x	x	x	x	x
Slope aspect	x	x	x	x	x	x
Log density	x	x	x	x	x	x
Log size	x	x	x	x	x	x
Snag density	x	x	x	x	x	x
Stump density	x	x	x	x	x	x
Percent ground cover	x	x	x	x	x	x
Height-ground cover	x	x	x	x	x	x
Species-ground cover	x	x	x	x	x	x
Canopy height	x	x	x	x	x	x
Canopy closure	x	x	x	x	x	x
Stem density	x	x	x	x	x	x
Forest site	x	x	x	x	x	x
Tree Characteristics						
Species	x	x	x	x	x	x
dbh	x	x	x	x	x	x
Height of tree	x	x	x	x	x	x
Branch condition	x	x	x	x	x	x
Bark condition	x	x	x	x	x	x
Hole height	x	x	x		x	
Bird height				x		
Exposure	x	x	x		x	
Top condition	x	x	x	x	x	x
Hardness	x	x	x	x	x	x
Number of pileated cavities	x	x	x			
Snags per ha	x					

Table 2. Measurements in forest sites on the Starkey Experimental Forest and Range. Forest sites are a modification of Burr's (1960) classification.

Forest Sites[a]	Percent of Area (ha)	Percent of Sample (n)	Mean Stem per ha	Snag Abundance Index[b]	Pileated Woodpecker Nest Trees
204	12(1008)	11(43)	324	8.9	0
214	40(3487)	39(146)	417	9.1	4
305	25(2123)	23(87)	476	13.1	5
315	23(1988)	26(99)	589	17.8	4
Total	100(8606)	100(350)			13

[a] 204 Open ponderosa pine - bunchgrass and elk sedge [includes Burr's (1960) site 203]
214 Ponderosa pine - Douglas-fir - pinegrass
305 Douglas-fir - white fir - ponderosa pine
315 Mixed white fir - Douglas-fir - larch

[b] Number of snags visible within 36 m radius.

sultant sample of the four forest sites was in approximate proportion to their occurrence. Any transect points falling in a clearing larger than 0.2 ha were excluded, because I did not observe use of open areas by pileated woodpeckers.

A log was defined as any piece of wood on or near the ground greater than 5 cm in diameter and greater than 50 cm in length. A stump was any standing dead wood greater than 8 cm in diameter and less than 3.5 m in height. A snag was any standing dead wood greater than 8 cm dbh and greater than 3.5 m in height. These definitions were adopted as a combination of usage developed by Gale (1973) and Conner (1973).

At each point on the transects forest characteristics were measured (Table 1). Landform was classified as a slope, draw, or ridge. Slope gradient was measured in percent using an Abney level. Slope aspect was measured in degrees using a compass. In some situations(eg. some ridgetops and draw bottoms) gradient and aspect were not recorded because they did not adequately characterize the location. Log diameter was measured 1.3 m from the base. The relative abundance of snags, logs, and stumps was determined by counting those visible within a 36 m radius. Ocular estimates were made of the average height and percent of ground cover present. Ground cover was recorded as grass, forbs, or shrubs. Average canopy height was measured with a range finder. Canopy closure was measured with a densiometer and expressed as a percent (Strickler 1959). Stem density (any live tree greater than 8 cm dbh) was calculated with the use of a forester's prism (Bruce 1955; Conner 1973).

At each transect point the tree characteristics of the nearest log, stump, and snag were recorded (Table 1). Height (length) was measured with a range finder or metric tape. A diameter tape was used to measure dbh. Limb condition was categorized on the basis of the presence or absence of branches longer than 50 cm. Bark condition was recorded in one of two classes: more than or less than 50 percent of the bark intact. Snag tops were recorded as either broken off or intact; logs were recorded as broken off, intact, or cut; stumps were recorded as broken off or cut.

Habitat Utilized

Active Nest Sites

Active nests were identified on the basis of observed excavation and completed nest cavities. Active nests were located by first finding a pair of pileated woodpeckers and then searching the area for the nest.

In the spring, pairs were located by systematically searching the entire study area on foot and horseback. Approximately 520 ha could be covered in 8 hours on horseback, zig-zagging through an area and coming within 400 m of all points. A vocalized imitation of a pileated woodpecker call was given every 400 m. Under ideal conditions a call carried at least 400 m. To the best of my knowledge, any pileated woodpecker within hearing range responded either by calling or drumming.

Tree characteristics of nest trees were measured in the same manner as for the random sample (Table 1). Additional data were collected on snag "hardness", angle of inclination of the nest tree (lean), diameter at nest hole, size of cavity, and size of hole. The number of snags within a 17 m radius of the nest tree was recorded.

Hardness of wood of nest trees was determined with a torque wrench attached to an increment borer. Readings, expressed in inch/lbs, were taken at breast height at depths of 5, 10, and 15 cm. These torque readings were positively correlated ($P < 0.01$) with the specific gravities of the same 58 trees (Fig. 1). Torque readings were employed to estimate specific gravity because the mechanics

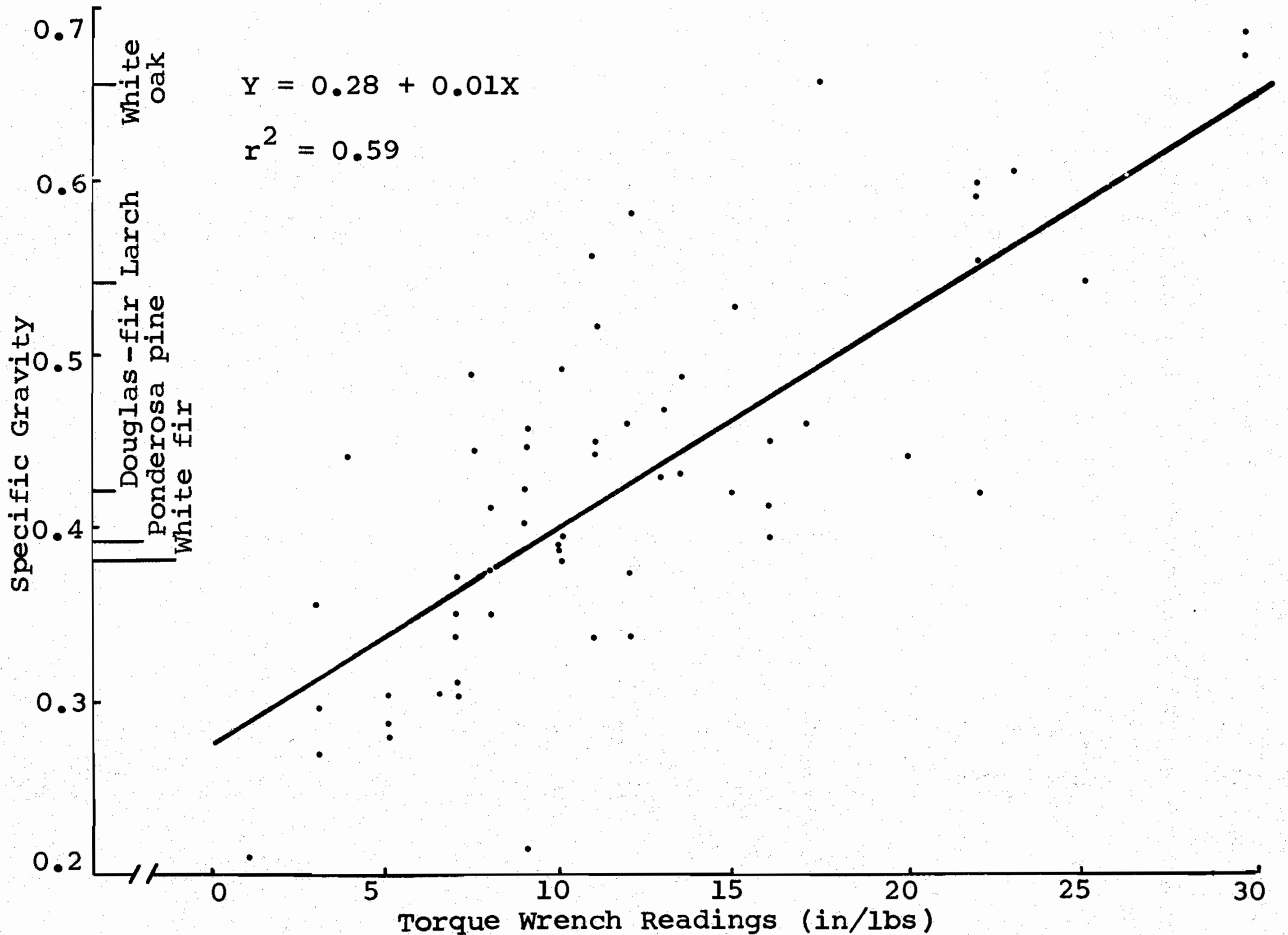

Fig. 1. Correlation between torque wrench readings and specific gravities of increment cores taken from live and dead trees (n=58). Specific gravities of trees are from U. S. Department of Agriculture (1952).

of determining specific gravity do not lend themselves to field situations. Herafter hardness will be expressed as specific gravity.

Old Nest Sites

An old nest tree was identified by the presence of at least one dome-shaped hole approximately 9 x 14 cm in the tree and the absence of fresh chips. Old nests were sampled nonrandomly due to both visibility and accessibility factors (eg. roads) associated with the different forest sites.

Old nest trees were measured using the same forest and tree characteristics described for the random sample (Table 1.)

Roost Trees

Roost holes were found by chance and verified when a pileated woodpecker was observed entering or emerging from a cavity. Data were collected in the same manner as for old nests (Table 1).

Drum Trees

Drum trees were defined as any tree or snag on which a pileated woodpecker was observed drumming; forest and tree characteristics were measured (Table 1).

Feeding Locations

I recorded all feeding excavations in snags, logs, and stumps located within 10 m on either side of the transect line. Feeding locations were credited to a pileated woodpecker based on the size and shape of the holes, length of the chips, and/or the presence of droppings. The forest and tree characteristics described for the random sample were recorded for all feeding locations (Table 1).

Density

Density of pileated woodpeckers was determined from known nesting pairs and sightings of pairs suspected of nesting but for which a nest was never found.

Territory size of nesting pairs was estimated on the basis of sightings, calls, and drummings in relation to a known nest location.

Analysis

Chi square analysis were performed to determine if forest and tree characteristics occurred in the same proportion at sites used by pileated woodpeckers (active nests, old nests, etc.) as those characteristics occurred in the forests on Starkey. A significant difference indicates a selection by pileated woodpeckers either for or against a specific characteristic. Differences were accepted as significant at $P \leq 0.05$. The appendix is a compilation of measurements obtained during the study and tests of significance of these data.

Forest and tree characteristics of nest sites (n=13) were tested against forest and tree characteristics of potential nest trees. Potential nest trees were a random sample of ponderosa pine and larch snags (n=17) greater than 38 cm dbh. The species and size restrictions resulted because only ponderosa pine and larch snags were used for nest trees, and 38 cm dbh was the minimum size defined for potential pileated woodpecker nest use. Ponderosa pine and larch nest trees were pooled and treated as one group because there was no apparent selection between the two; the lack of a significant difference existing ($P > 0.05$) between ponderosa pine and larch nest trees when tested against the potential nest trees supports this apparent lack of selection.

Selection of nest tree species was tested by comparing ponderosa pine and larch snags greater than 38 cm dbh (n=17) against all other snag species greater than 38 cm dhh (n=15). The separation point for testing dbh and height selection were 38 cm and 12 m respectively. These were the minimum size and height considered to be suitable for pileated woodpecker nest use. The remaining tree characteristics were analyzed as measured.

Forest and tree characteristics of drum trees were tested against a random sample of ponderosa pine and larch snags greater than 28 cm dbh which were the only species and size used for drumming by pileated woodpeckers. Ponderosa pine and larch drum trees were pooled on the basis of similar functional characteristics even though statistically larch was preferred over ponderosa pine ($P < 0.01$).

Forest characteristics of 152 feeding locations were tested against the forest characteristics collected at 350 points along the transects. Bark, limb, and top conditions of feeding locations in snags, logs, and stumps were tested against the same three conditions occurring in a random sample of snags, logs, and stumps respectively.

RESULTS

Active Nest Sites

Thirteen active pileated woodpecker nests were located and characterized during the 1973 and 1974 field seasons. Chi square analysis expressed a significant difference in the selection of: nest tree species ($P < 0.01$), nest tree dbh ($P < 0.01$), nest tree top condition ($P < 0.01$), forest sites ($P < 0.05$), and snag densities ($P < 0.01$) between nests and a random sample of ponderosa pine and larch snags greater than 38 cm dbh (potential nest trees). No significant differences existed between tree and forest characteristics of nests and potential nest trees with regard to: tree height, limb and bark condition, landform, ground cover, or any of the other forest characteristics measured at the nest locations. The seeming lack of any nest tree height selection must be qualified by establishing a minimum height; the shortest nest tree used by pileated woodpeckers on Starkey was 12 m (Table 3).

On Starkey the minimum height of the nest entrance was 7 m, averaging 12.9 m. Jackman (1974) reported a mean nest height of 14.9 m (n=61) from the literature. In West Vir-

Table 3. Forest and tree characteristics at 13 active pileated woodpecker nests on the Starkey Experimental Forest and Range, 1973 - 1974.

	Mean	Standard Deviation	Range Low	Range High
dbh nest tree(cm)	75.3	11.7	58	99
Diameter nest tree at cavity (cm)	54.4	12.4	43	76
Height of nest tree(m)	20.9	7.11	12	36
Height of nest(m)	12.9	4.07	7	19
Stem density per hectare	494	188.	227	914
Snag density per hectare	50.4	38.5	10	128
Nest cavity depth(cm)	54.7	6.54	42	61
Nest cavity diameter(cm)	21.7	2.44	19	28
Nest opening length(cm)	12.0	1.54	9	15
Nest opening width(cm)	9.7	0.87	9	11

ginia, Conner (1973) found the minimum nest height used was 5.5 m; the mean was 12 m.

Ponderosa pine and larch snags were the only species used for nesting on the study area. Gale (1973) found woodpeckers nesting extensively in ponderosa pine but also in Douglas-fir and white fir; both of the later two tree species were present on Starkey with no evidence of past or present nest use by pileated woodpeckers. My casual observations in the Willamette Valley indicate that pileated woodpeckers do nest in Douglas-fir and white fir.

A significant difference ($P < 0.01$) existed between nest tree dbh and dbh of existing available snags. Snags greater than 38 cm dbh were selected for nest trees by pileated woodpeckers (Fig. 2). The minimum nest tree dbh used on Starkey was 58 cm; the mean was 75.3 cm.

A study in northern California (Gale 1973) reported a preferred nest tree dbh of 38 cm. McLaren (1962) working in British Columbia, found a mean nest tree dbh of 63.5 cm (n=12), while Conner(1973) found a minimum dbh of 33cm(n= 18).

A selection for snags with broken tops was apparent ($P < 0.01$). Of 13 nest trees, 12 had at least a sixth of the original height broken off the top.

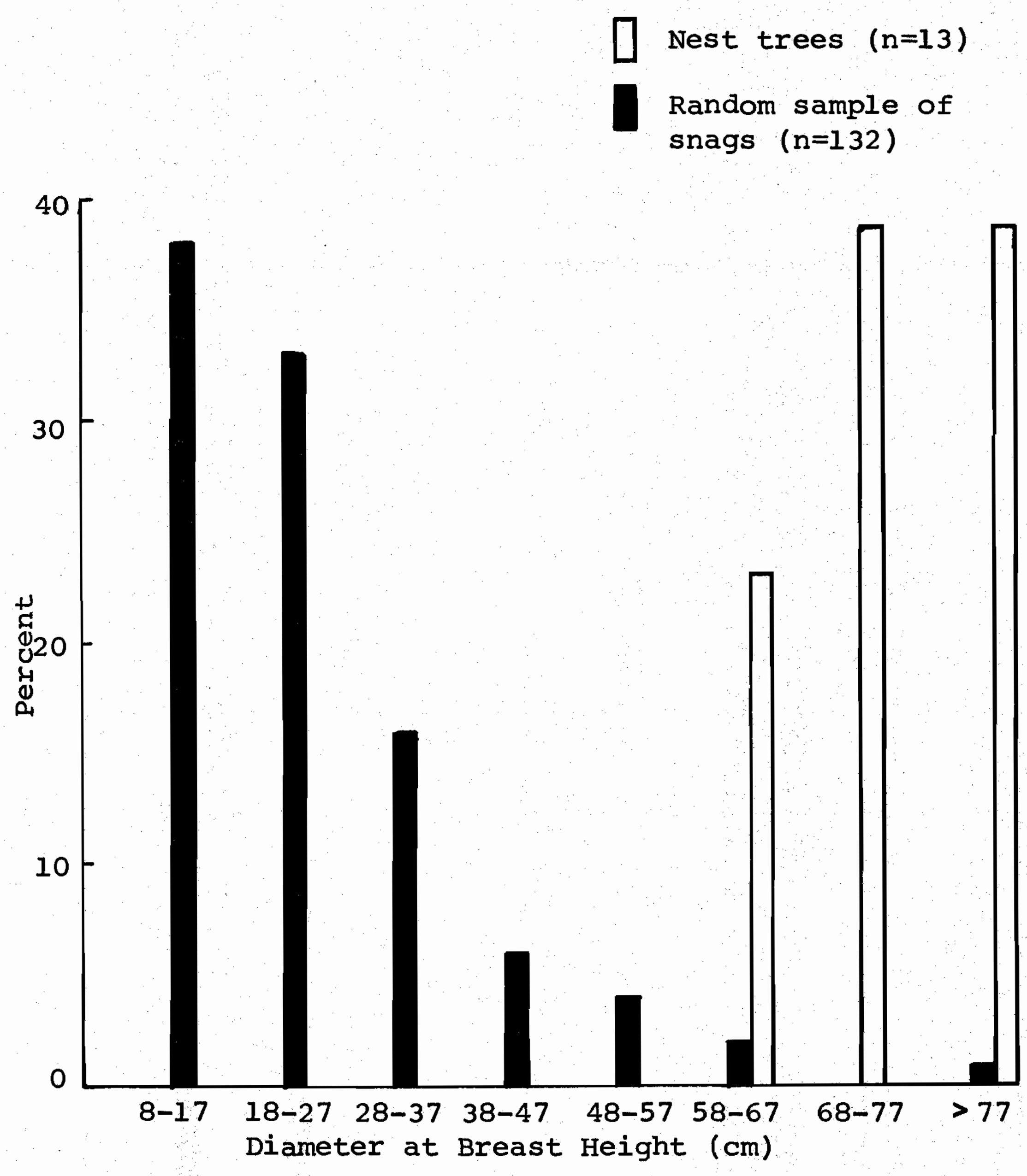

Fig. 2. Distribution of dbh of pileated woodpecker nest trees and a random sample of ponderosa pine and larch snags on the Starkey Experimental Forest and Range, 1973-1974.

A significant selection ($P < 0.01$) was expressed for high densities of snags when indices to snag abundance at nest sites (Fig. 3) were tested against indices to snag abundance at potential nest trees. The mean number of snags per ha around nest trees was 50.4 (Table 3).

Nest trees were located in three of the forest sites (Burr 1960) on Starkey: 1) ponderosa pine - Douglas-fir (site 214), 2) Douglas-fir - white fir - ponderosa pine (site 305), and 3) mixed white fir - Douglas-fir - larch (site 315). A nest site preference for the latter two (305, 315) was shown when compared with 1) the existing amount of each forest site available, and 2) the forest sites containing potential nest trees (Fig. 4). Forest sites 305 and 315 had higher densities of trees and snags than the ponderosa pine sites (204, 214) (Table 2).

The mean density of stems around nest trees was 494 trees per ha which falls between the mean densities of forest sites 305 and 315 (Table 2). Conner (1973) reported that pileated woodpeckers preferred stands with the greatest density of stems. He determined an average stem density around nest trees of 412 trees per ha.

Specific gravities of chips from ten nest cavities averaged 0.34 and ranged from 0.23 to 0.41; the range sug-

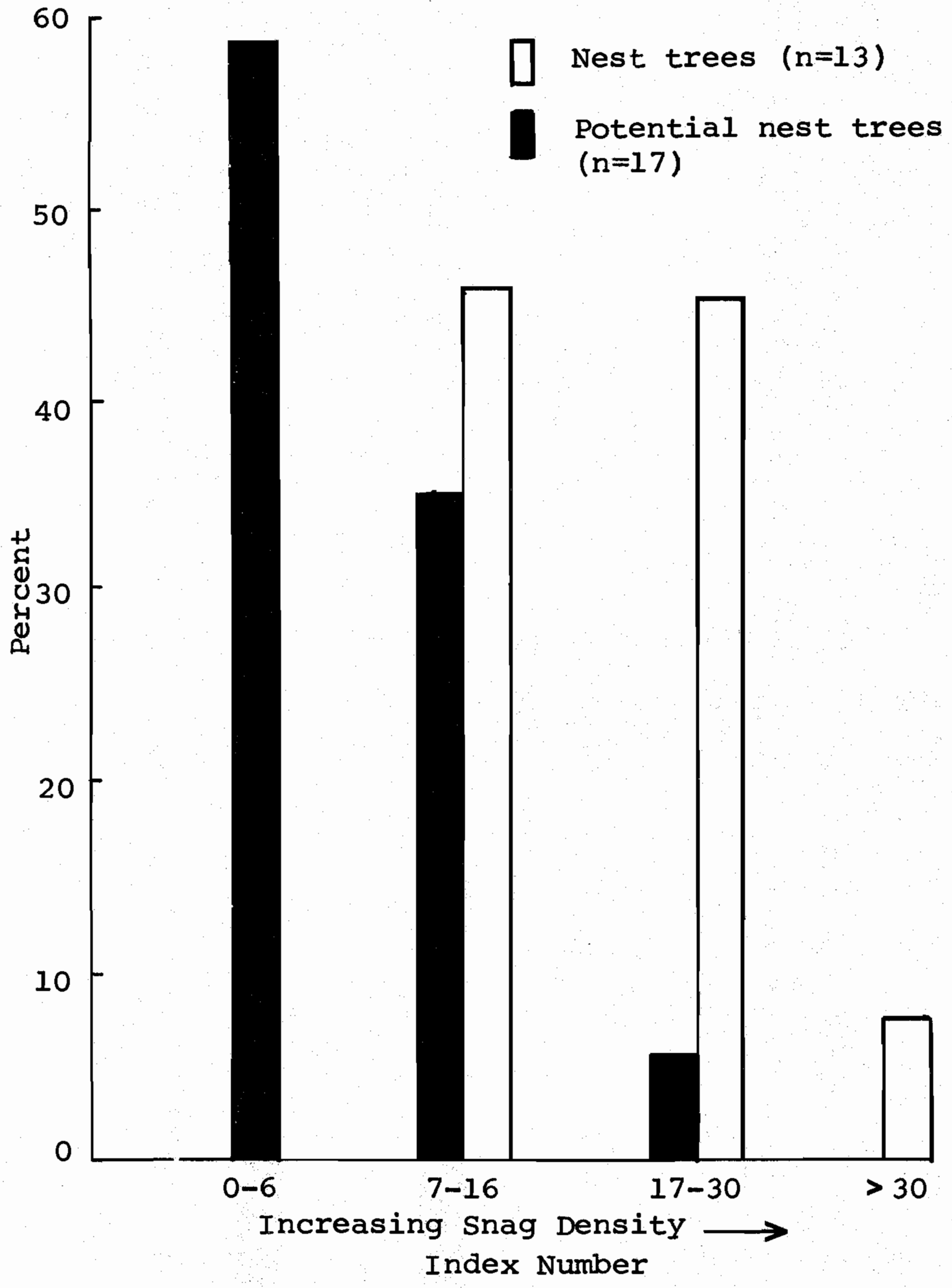

Fig. 3. Indices to snag abundance at pileated woodpecker nest trees and potential nest trees. Potential nest trees are ponderosa pine and larch snags greater than 38 cm dbh.

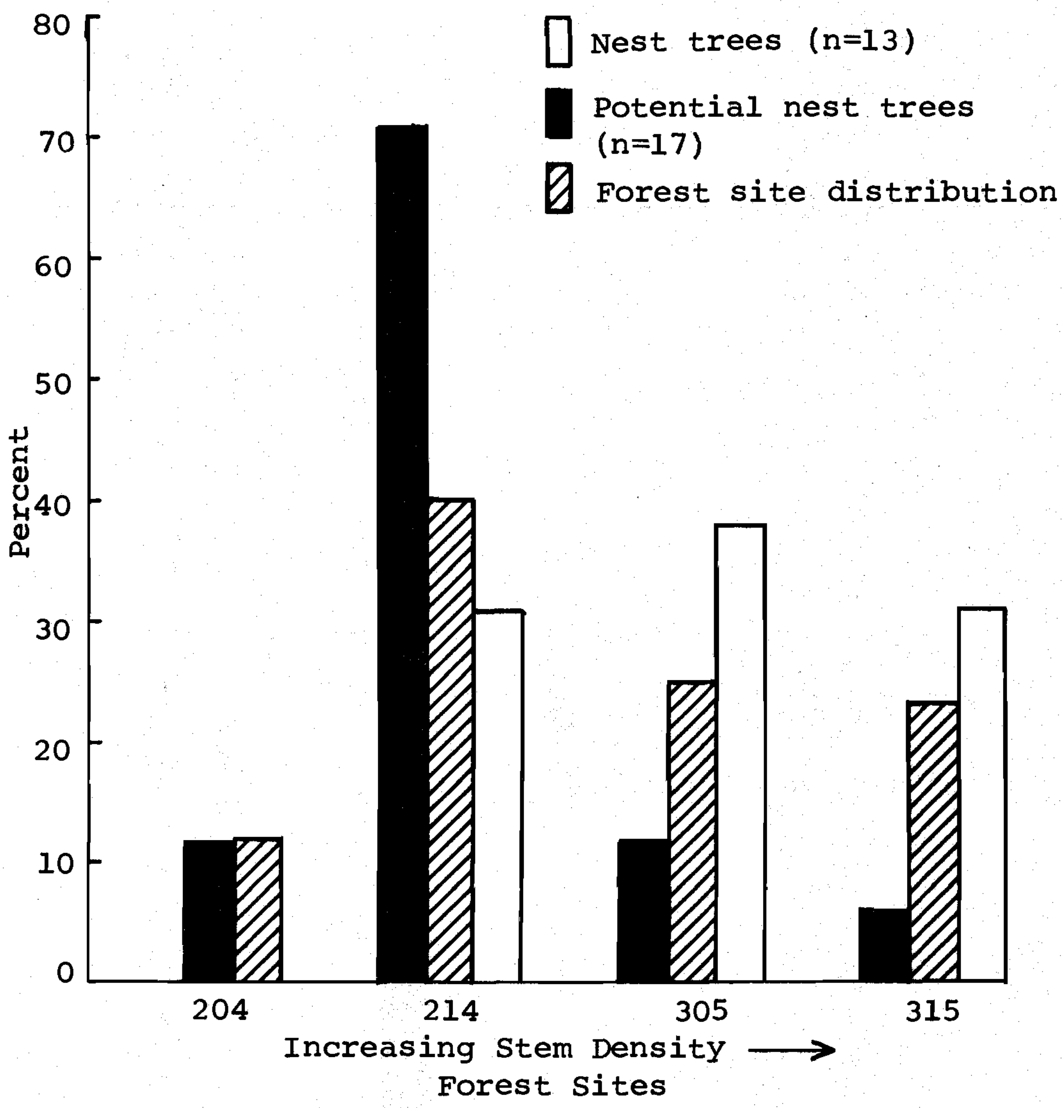

Fig. 4. Comparative distribution of forested areas, potential nest trees, and pileated nest trees by forest sites on Starkey Experimental Forest and Range, 1973-1974. Potential nest trees are ponderosa pine and larch snags >38 cm dbh. Forest sites are a modification of Burr's (1960) classification.

gests that the hardness of the wood at most of the cavities was similar. The mean specific gravity of nest trees (0.34) was just slightly lower (softer) than the specific gravity of a living white fir (Fig. 1).

Nest openings faced a variety of directions; selection was not shown for a cardinal direction ($P > 0.05$). The one factor which seemed to determine which direction the nest opening faced was the direction the nest tree leaned. All nest openings were on the underside of the leaning nest tree. Conner (1974) also found nest openings occurred on the underside of a leaning snag.

Old Nest Sites

Many of the forest and tree characteristics measured at old nest sites were subject to change with time, and as I could not determine how old nest cavities were or if they had actually been used as nests, a statistical analysis of certain characteristics would be meaningless.

Significant differences ($P < 0.01$) were exhibited in nest tree species and dbh selection when old nest sites were tested against the sample of potential nest trees. All 36 old nests occurred in ponderosa pine or larch and all occurred in trees greater than 38 cm dbh; the mean dbh was 60 cm. Eleven percent of the old nest trees were live, but the nests were excavated in dead wood. Even though parts of the trees were live, they functioned as snags because of physical characteristics.

Roost Trees

Only two roost trees, one larch and the other a ponderosa pine, were located. From these two examples I have no reason to believe that pileated woodpeckers select for different characteristics in roost locations than in nest locations.

Drum Trees

Of 21 drum trees, two were live trees but were treated as snags on the basis of physical characteristics (ie. dead snag tops) that made them more functionally similar to a snag than a live tree.

When tree characteristics of drum trees were tested against the random sample of ponderosa pine and larch snags greater than 28 cm dbh, significant selection was expressed for ponderosa pine and larch ($P < 0.01$), greater than 28 cm dbh ($P < 0.01$), tall height classes ($P < 0.05$), without bark ($P < 0.05$), and without branches ($P < 0.05$).

Significant differences in forest characteristics of drum trees and the random snag sample indicated selection for dense forest sites (305, 315) ($P < 0.01$), dense canopy closures ($P < 0.05$), and high stem ($P < 0.05$), snag, and log densities ($P < 0.01$). These characteristics were typical of dense forest stands on Starkey.

Feeding Locations

Within 10 m on either side of the transect line, any feeding excavation in dead wood judged to have been done by a pileated woodpecker was characterized. Forty-five percent of these feeding locations were in snags, 43 percent in logs, and 12 percent in stumps.

The greatest percentage of feeding locations occurred in Douglas-fir (Fig. 5). The woodpeckers apparently preferred Douglas-fir and larch while ponderosa pine was not preferred as a feeding location; lodgepole pine and white fir were used in approxiamte proportion to their occurrence.

The smaller dbh classes were not preferred feeding locations (Fig. 6). Dead wood greater than 18 cm dbh was typically used in proportion to its occurrence.

Specific gravities of wood sampled at 89 feeding loca-

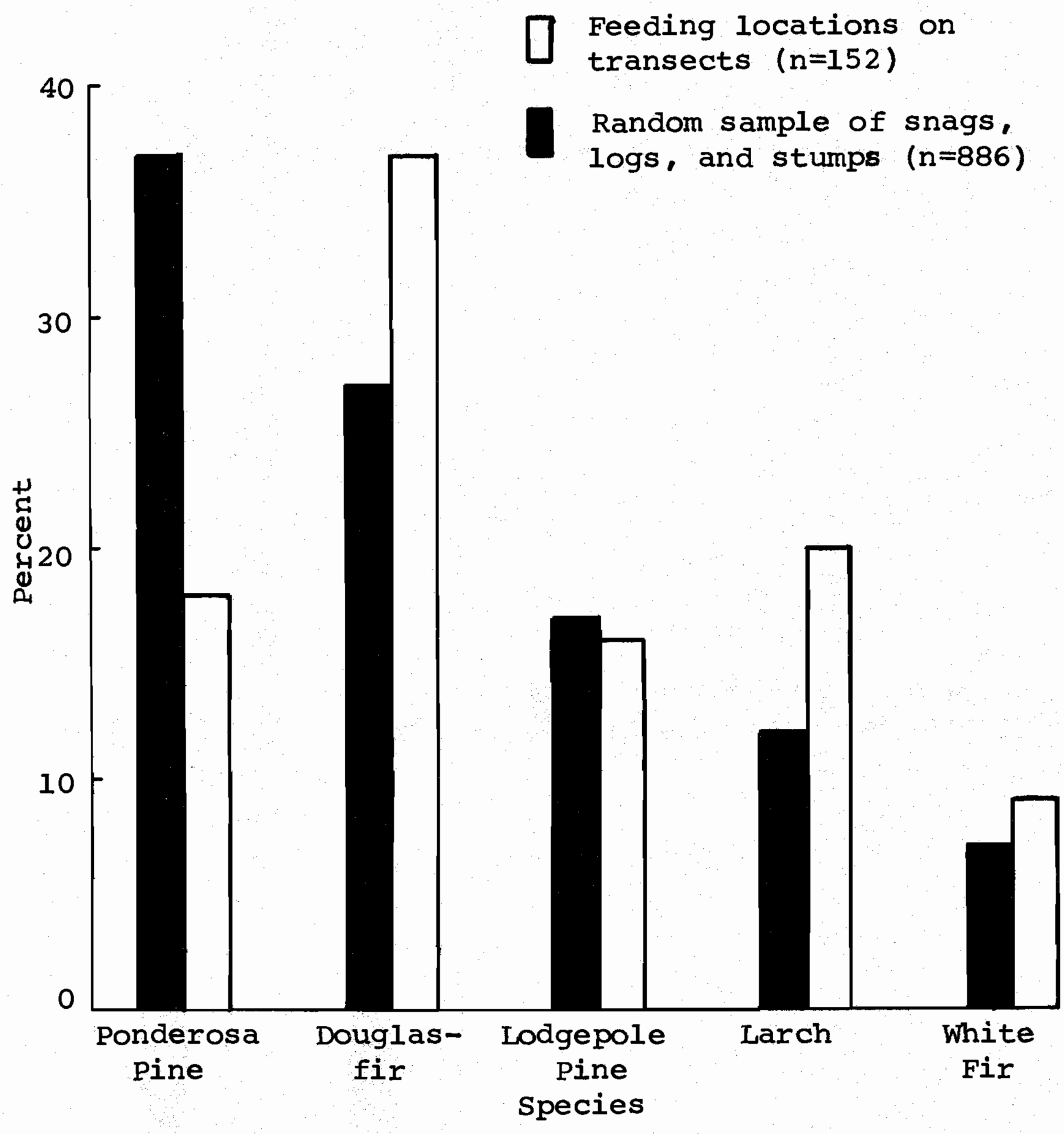

Fig. 5. Tree species utilized for feeding by pileated woodpeckers on transects.

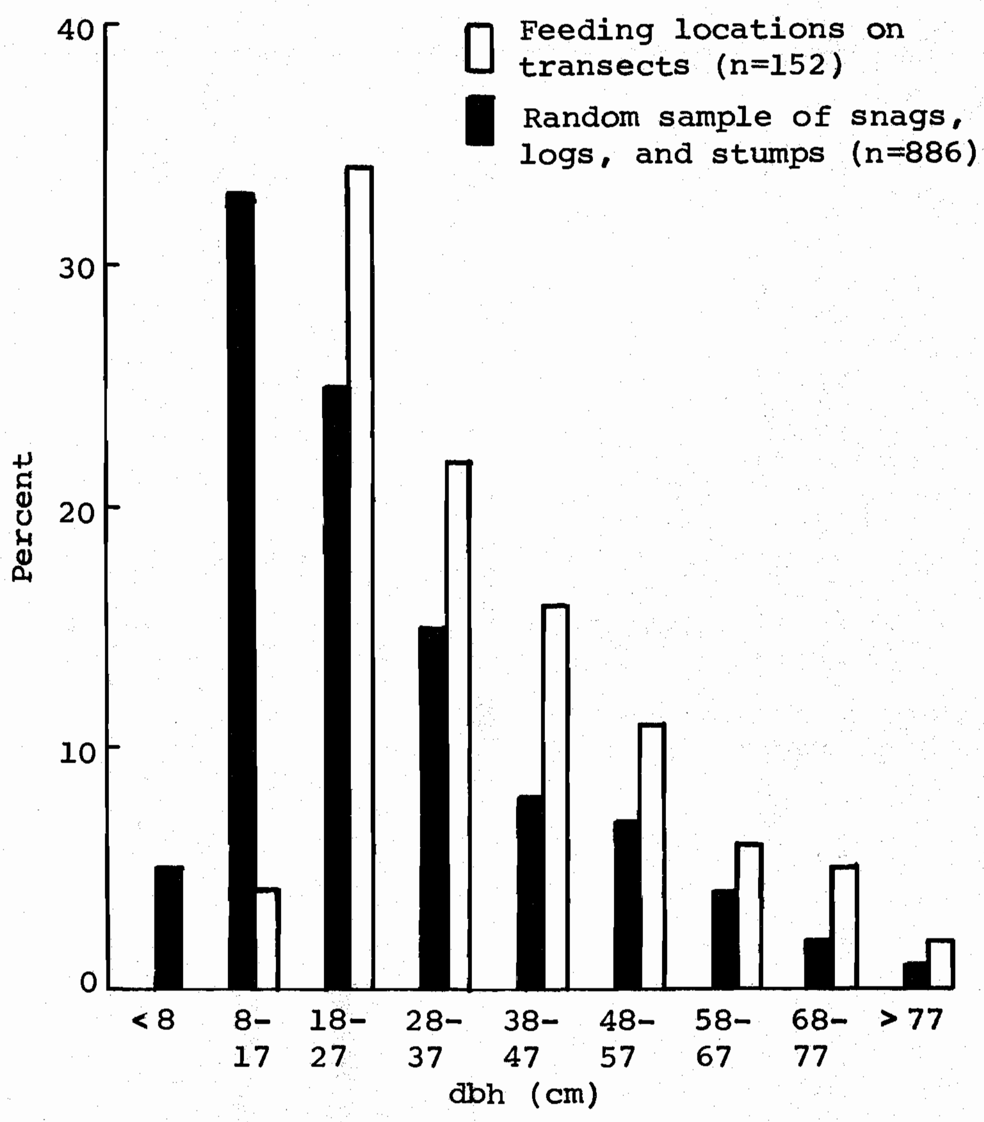

Fig. 6. Diameters of pileated woodpecker feeding locations on transects.

locations ranged from 0.17 to 0.45 with an average of 0.26.

Bark, limb, and top conditions were analyzed for 67 feeding locations in snags, 64 in logs, and 21 in stumps. No significant differences ($P > 0.05$) were found in the above conditions for snags. Logs without limbs and bark were preferred ($P < 0.05$) for feeding. Naturally created stumps (versus cut stumps) were selected ($P < 0.01$) for feeding.

Forest sites ($P < 0.01$), log and snag density ($P < 0.01$), ground cover height and type ($P < 0.05$), and canopy closure ($P < 0.01$) were found to be significantly different at feedings on transects than at transect sampling points. Open ponderosa pine forest sites (204) were lightly used for feeding, while the denser mixed species forest sites (214, 305, 315) were most heavily used (Fig. 7). Areas with high densities of logs and snags and dense canopies were selected; the taller ground cover classes were associated with pileated woodpecker feeding locations as was the group that made up these taller classes (shrubs).

Density

Thirteen active nests, belonging to 12 different

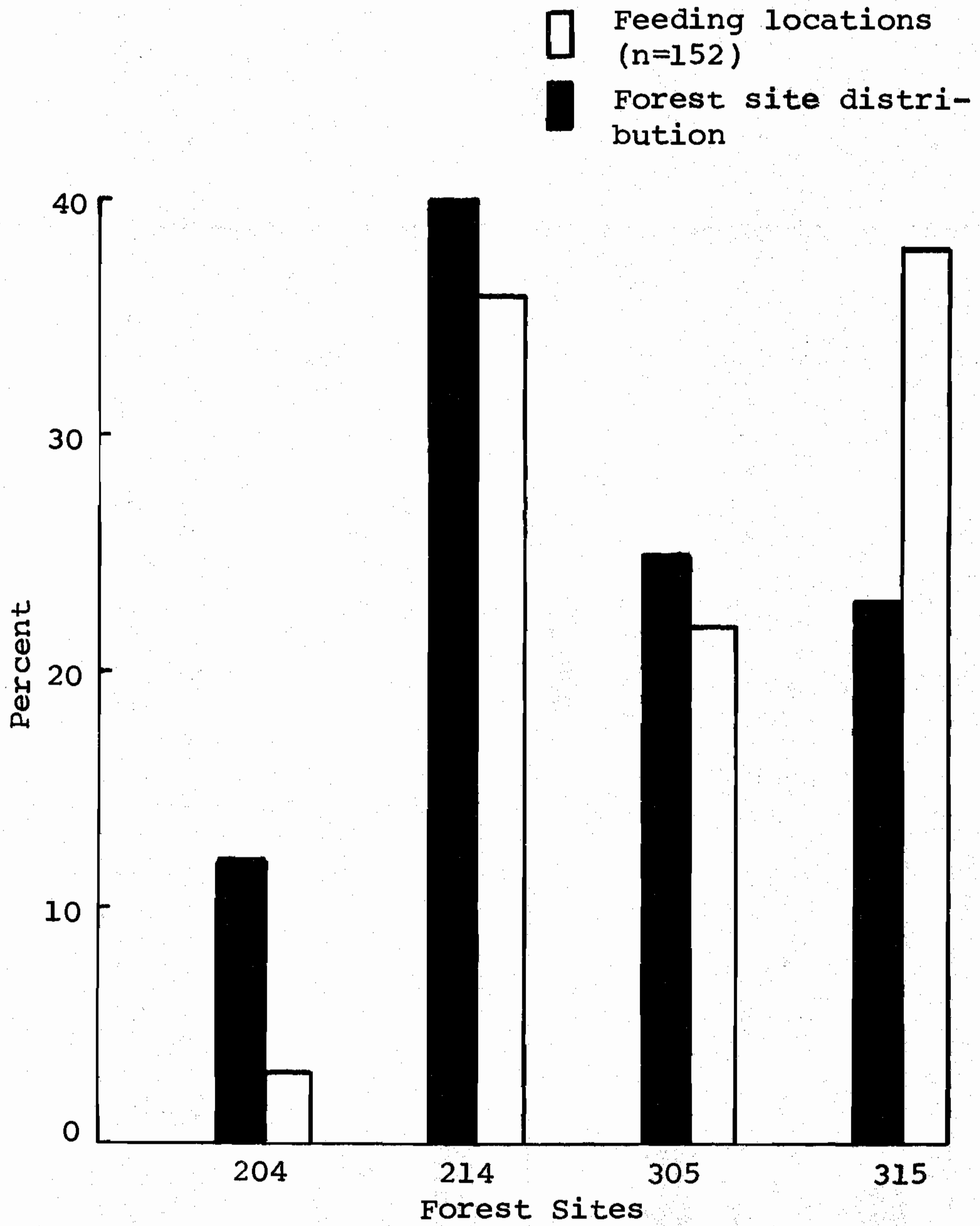

Fig. 7. Distribution of pileated woodpecker feeding locations by forest sites on Starkey Experimental Forest and Range, 1973-1974. Forest sites are a modification of Burr's (1960) classification.

pileated woodpecker pairs were located during the 1973 and 1974 field seasons (Fig. 8). Three of these nests were located off the study area; two were within 30 m of the boundary fence, and the third was approximately 0.5 km north of Starkey. These three nests were not considered when computing population density. At four locations, pileated woodpeckers were repeatedly observed but could not be identified with a nest. Counting these as four additional pairs, a minimum of 13 pileated woodpecker pairs were present on the Starkey in spring 1974.

Of 11,400 ha comprising Starkey, approximately 8,600 ha (75 percent) is forested. Assuming all pileated woodpecker pairs (13) were located, the minimum density was at least one pair per 880 ha of land area or one pair per 665 ha of forest.

Nest territory size was approximated from observations, vocalizations, and feeding locations. Estimates of the area utilized by the various pairs during reproduction ranged from 250 to 500 ha on Starkey.

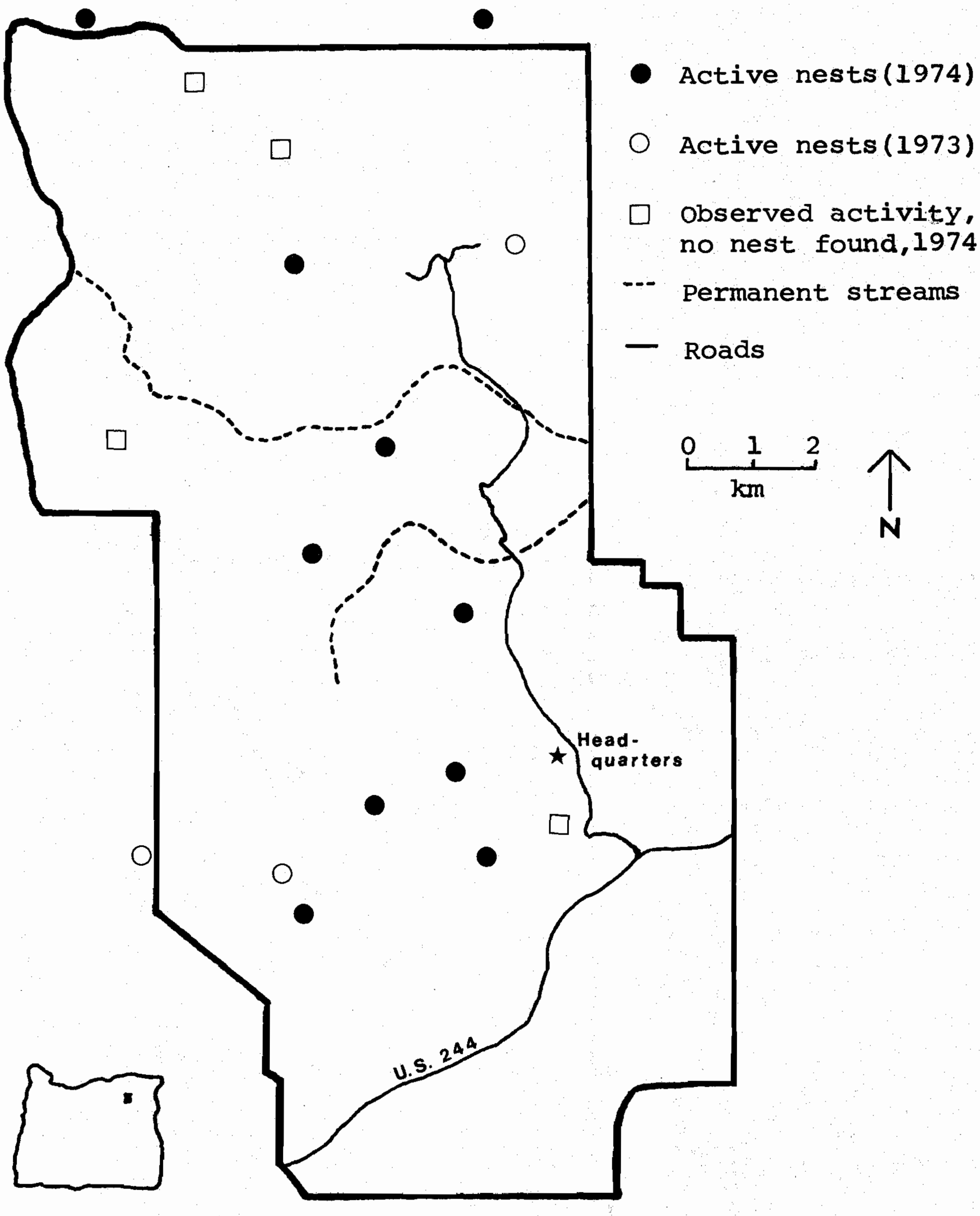

Fig. 8. Pileated woodpecker nest sites on Starkey Experimental Forest and Range, 1973-1974.

DISCUSSION

Habitat requirements of the pileated woodpecker must be understood if the bird is to receive consideration in forest management. Adaptability of the species determines how critical habitat management need be. An extensive range, presence in a wide variety of forest types, and a tolerance of human activity indicate the pileated woodpecker can adapt to at least limited habitat manipulation (Bent 1939; Hoyt 1957).

The data presented in this paper must be viewed within the context of the study area. Limited elevation range, absence of deciduous trees, and restricted logging activities are important restrictions which separate Starkey from other areas, even in the Blue Mountains. While I recognize restrictions, Starkey can be considered "typical" of large areas in northeastern Oregon currently managed for timber production.

Nesting Habitat

Of all components of the habitat used by pileated woodpeckers, the single most critical is the nest site. It is safe to assume that by meeting requirements for nests the

DISCUSSION

Habitat requirements of the pileated woodpecker must be understood if the bird is to receive consideration in forest management. Adaptability of the species determines how critical habitat management need be. An extensive range, presence in a wide variety of forest types, and a tolerance of human activity indicate the pileated woodpecker can adapt to at least limited habitat manipulation (Bent 1939; Hoyt 1957).

The data presented in this paper must be viewed within the context of the study area. Limited elevation range, absence of deciduous trees, and restricted logging activities are important restrictions which separate Starkey from other areas, even in the Blue Mountains. While I recognize restrictions, Starkey can be considered "typical" of large areas in northeastern Oregon currently managed for timber production.

Nesting Habitat

Of all components of the habitat used by pileated woodpeckers, the single most critical is the nest site. It is safe to assume that by meeting requirements for nests the requirements of roosts have also been fulfilled.

All active nests were in snags, ponderosa pine or larch, at least 38 cm dbh, usually with a broken top, at least 12 m tall, with a specific gravity of at least 0.23. Nest locations were most often in areas with stem densities averaging 494 trees per ha, snag densities of 50 per ha, and canopy heights of 25 m.

While large snags are not abundant on Starkey, they certainly are not uncommon. At least 3 of the 13 nest trees I observed probably had been used a previous year as a nest tree as suggested by the presence of at least two nest cavities. The proportion of pileated woodpeckers re-nesting in previously used snags may reflect the availability of large snags and could be used as an index to the availability of snags for nest use. In West Virginia where forests have a long history of manipulation, Conner (1974) found reoccupancy of nest snags was common. If large snags are scarce, there should be a higher incidence of reuse of nest trees than if large snags are abundant.

Positive spatial relationships existed between nest trees, drum trees, and feeding locations. Drumming most frequently occurred in the vicinity of the nest on nearby snags. These nearby snags were important constituents of the immediate nest vicinity and were used for drumming, perching, feeding, as well as serving for potential nest trees. During the nesting season proximity of the nest to food resources was obviously advantageous.

The high incidence of probe holes, test holes 5 to 9 cm deep (Rumsey 1968), in nest trees suggests that pileated woodpeckers select a specific site in the tree for the nest location. Condition of the wood is important, particularly the amount of decay present. A decayed inner core would not be suitable for a cavity due to lack of support and possible leakage of rain. Pileated woodpeckers seem to be capable of excavating in any hardness of wood; they preferred sound dry wood for nest sites. Coupled with this hardness selection was the location of the nest opening on the underside of the leaning nest tree.. Conner (1974) reported nests to occur on the underside of snags and attributed this phenomena to the protection it provided against weather and predators. My observations confirm that this nest location acts as an effective means of protection from the weather, but I found no evidence to support the protection from predators.

Several authors (McLaren 1962; Conner 1973) reported a high incidence of pileated woodpecker nests adjacent to clearings or water. Seven of eight ponderosa pine nest trees and one of five larch nest trees were within 15 m of a clearing of at least 0.5 ha. This more likely represents the distribution of ponderosa pine and larch snags than any selection for clearings by the woodpecker. There was a high incidence of ponderosa pine snags around clearings on forest edges, while large larch snags typically occurred in the midst of dense forest stands (forest sites 305, 315). The absence of an adjacent clearing, as was the case at four of five larch nest trees, does not preclude use of a snag for nesting.

Proximity to a water source was highly variable. All nest trees were within 0.5 km of water in May when incubation was in progress. However, by the same token, it was difficult to find any point on Starkey that was not within 0.5 km of water in spring.

I suggest that previous experience or imprinting may play a major role in nest site selection. A marked population of birds followed over time could establish the fact and effects of previous experience, imprinting, and nest site fidelity on the population.

Snags used as nest trees were the largest available and were comparable in size to the largest living ponderosa pines on the study area. Nest trees were in forest sites which contained the highest densities of snags and stems found on Starkey. The attributes of size and density are most commonly found in forests of mature, uncut timber.

Feeding Habitat

In the spring and summer pileated woodpeckers were observed to feed primarily on carpenter ants in logs. The large number of feedings found in snags along transects suggests during other times of the year, snags were used more heavily. During winter months when snows cover the majority of logs, the woodpeckers must depend heavily on snags for feeding.

Feeding locations in snags and logs were related to areas with high densities of snags and logs respectively. Feeding locations in stumps, however, were not related to areas with high densities of stumps. Areas with high densities of stumps, usually previously logged areas, were not preferred feeding locations, and the pileated actually selected against cut stumps. I suspect the basis for selection against cut stumps lies in their lower insect populations when compared to naturally created stumps.

Feeding locations were not specific in their location. Feeding occurred in all forest sites, in all sizes of material (> 10 cm diameter), and in all tree species present on the study area. Exploitable populations of carpenter ants, woodboring beetle larvae, and other insects undoubtedly determined feeding location.

Density

Pileated woodpecker density on Starkey in 1973 and 1974, may have been less than in recent past. I found sign (i.e. old nest cavities, old feeding locations) present in currently unoccupied habitat, and I observed no conflicts between pileated woodpeckers during the two field seasons. Whether this represents a reduction in density or a reallocation of space could not be determined here.

Evidence of past and present use was distributed uniformly on Starkey with the exception of the areas east of the Headquarters and south of the highway (Fig. 8). The area east of the Headquarters was predominantly open flat grasslands with scattered stands of young timber containing very few snags; such habitat was unsuitable for pileated woodpeckers.

Pileateds were seldom seen south of the highway, and there was very little evidence of past use. The terrain was steep with open rocky slopes; forest stands were usually limited to draw bottoms or ridgetops with a low density of snags. Although the species was present in the area, intensity of use was low.

Area utilized by a pair was directly related to the quality of that habitat. Tanner (1942) found 12 to 24 pileated pairs per 1000 ha of mature uncut timber but less than 4 pairs per 1000 ha of second growth timber. Mature timber in uncut stands can provide food for a much larger woodpecker population than can second growth or cut-over stands. On Starkey 2 to 4 pairs were found per 1000 ha of area. In areas of the Pacific Northwest with denser stands of larger timber and higher densities of logs, snags, and diseased trees I would expect higher bird densities brought about by each pair requiring less area for foraging.

FOREST MANAGEMENT IMPLICATIONS

The following discussion lists some possible alternatives in the management of the forest that would benefit pileated woodpeckers. These alternatives need not be applied on all forest lands to ensure presence by the species. Rather the alternatives are recommendations of how the forest could be managed to maintain specific habitat components known to be used by pileated woodpeckers. The applicability of each of these management alternatives depends on the forest types and intensity of timber management.

Management for large snags would provide many of the habitat components required by pileated woodpeckers. Existing snags must be left in addition to potential snags (live large trees) to eventually replace the existing snags; both need some vegetative cover around them (see appendix for a numerical rating system of large snags as to suitability for pileated woodpecker nest use). In addition to serving as nest and roost sites, snags become critical as foraging sites during the winter months when logs and stumps are covered by snow. The retention of decadent trees, snags, wood on the ground, and naturally created stumps provides foraging sites for pileated woodpeckers.

Another management alternative is the preservation of forested areas where timber is neither treated nor harvested. These areas would be stands of low productivity, buffer strips along streams, or sites too difficult to log because of slope or soil conditions. In theory these areas if of sufficient size and distribution, would provide habitat for those species of wildlife that can not adapt to a managed forest in addition to providing habitat for pileated woodpeckers.

A staggered rotation of timber stands could be used if at least one rotation period was long enough to allow development of mature trees (>58 cm dbh) and if thinning processes did not eliminate snags. This alternative ensures different age stands and a variety of habitat components occurring in a forest at any one time. There would be continual replacement of habitat components (snags, logs, large trees) as each mature stand was harvested.

LITERATURE CITED

Beal, F. E. L. 1911. Food of the woodpeckers of the United States. U. S. D. A. Bio. Surv. Bull. 37. 64 pp.

Bendire, C. 1892. Life histories of North American birds. U. S. Gov. Printing Office. Washington, D. C. 414 pp.

Bent, A. C. 1939. Life histories of North American woodpeckers. U. S. Natl. Mus. Bull. 174. 334 pp.

Bruce, D. 1955. A new way to look at trees. J. For. 53(3):163-167.

Burr, J. A. 1960. Soil survey, Starkey Experimental Forest and Range, Union and Umatilla Counties, Oregon. U. S. D. A. Soil Conserv. Serv. and Forest Serv. 32 pp. Typescript.

Conner, R. N. 1973. Woodpecker utilization of cut and uncut woodlands. M. S. Thesis. Virginia Polytechnical Inst. and State Univ. 82 pp.

_________________ 1974. The pileated woodpecker. Wildl. in North Calolina 36(6):24.

Conway, G. C. 1957. Pileated woodpecker king of the woods. Anim. Kingdom 60(2):52-58.

Driscoll, R. S. 1955. A guide to the Starkey Experimental Forest and Range. U. S. Dept. Agric., For. Serv., Portland, Or. 21 pp.

Gabrielson, I. N. and S. G. Jewett. 1940. Birds of Oregon. Oregon State College, Corvallis, Or. 650 pp.

Gale, R. M. 1973. Snags, chainsaws & wildlife: one aspect of habitat management. Fourth Ann. Joint Conf. Am. Fish. Soc. and Wild. Soc. Calif. Chapt. 20 pp. Typescript.

Hoyt, J. S. Y. 1941. Through the year with the pileated woodpecker. Audubon Mag. 43:525-538.

Hoyt, S. F. 1957. The ecology of the pileated woodpecker. Ecology 38(2):246-256.

Jackman, S. M. 1974. Woodpeckers of the Pacific Northwest: their characteristics and their role in the forests. M. S. Thesis. Oregon State Univ. 147 pp.

Lawrence, L. D. K. 1970. The apartment. Audubon 72(2): 4-7.

McGowan, R. W. 1967. A breeding census of the pileated woodpecker: a preliminary report. Migrant 39(3): 57-59.

McLaren, W. D. 1962. A preliminary study of nest-site competition in a group of hole-nesting birds. M. S. Thesis. Univ. of British Comumbia. 57 pp.

Rumsey, R. L. 1968. A pole's-eye view of woodpeckers. Forests and People.18(2):38-40.

Strickler, G. S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. Pac. Northwest Forest and Range Exp. Stn. Res. Note No. 180. 5 pp.

________________ 1965. Soil and vegetation on the Starkey Experimental Forest and Range. Proc. Soc. Am. For. 59:27-30.

Tanner, J. T. 1942. The ivory-billed woodpecker. Dover Publ., Inc., New York. 111 pp.

U. S. Department of Agriculture, Forest Service. 1955. Wood handbook. Agric. Handbook No. 72. 528 pp.

U. S. Department of Commerce. 1970. U. S. Environmental Data Service. Climatological data: Oregon. 76(13): 1-263.

Vickers, E. W. 1914. The roll of the log-cock or pileated woodpecker. Wilson Bull. 26(1):15-17.

Wetmore, A. 1964. Song and garden birds of North America. Natl. Georgr. Soc., Washington, D. C. 400 pp.

APPENDIX

APPENDIX

Introduction to Appendix

The data presented in the appendix are supplemental to the subject matter which has already been presented in the thesis. Presented here are a guide to snag evaluation as potential pileated woodpecker nest trees, a compilation of measurements obtained during the study, and tests of significance for these data. In each instance the tables are self explanatory.

Potential Pileated Woodpecker Nest Trees

The following guide (Table 1) applies to these forest types: ponderosa pine and Douglas-fir, mixed white fir, larch, and lodgepole pine. The habitat surrounding the snag must provide cover around (minimum of 150 stems per acre) and canopy above (at least 40 feet tall) the snag. An area with a snag density of at least six per acre is preferrable.

The point system was developed by assigning negative values to those characteristics of a snag that made it unsuitable as a pileated woodpecker nest tree. Those characteristics which were considered the minimum requirement were given low positive values while the preferred or optimal characteristics were rated with high positive values.

Table 1. A guide to snag evaluation as potential pileated woodpecker nest trees. For potential pileated nest tree use a minimum value of 30 points is required.

Characteristic		Points
DBH	less than 15 inches	-10
	15-20 inches	5
	greater than 20 inches	10
HEIGHT	less than 20 feet	-10
	20-30 feet	5
	greater than 30 feet	10
SPECIFIC GRAVITY	less than 0.23	-10
	0.23-0.33	6
	greater than 0.33	8
SPECIES	ponderosa pine	8
	western larch	8
	white fir	2
	Douglas-fir	1
BARK CONDITION	none	3
	1-50 % intact	4
	50-100% intact	5
BRANCH CONDITION	none	4
	some	5
	lots	3

Table 2. Data collected on tree characteristics of snags at transect points and at sites of pileated woodpecker activity.

Characteristic	Points on Transect	Active Nest	Old Nest	Feeding on Transect	Snags >38cm	Snags >28cm	Drum Tree
n=	282	13	36	67	17	39	21
Species							
ponderosa pine	89	8	31	7	14	26	6
Douglas-fir	61	0	0	27	0	0	0
white fir	14	0	0	1	0	0	0
larch	43	5	5	12	3	13	15
lodgepole pine	74	0	0	20	0	0	0
dbh(inches)							
3- 6	119	0	0	1	0	0	0
7-10	93	0	0	26	0	0	0
11-14	38	0	0	8	0	22	2
15-18	15	0	1	13	8	8	7
19-22	9	0	3	8	5	5	4
23-26	4	3	13	4	3	3	4
27-30	2	5	10	4	0	0	3
> 30	2	5	9	3	1	1	1
Height(feet)							
11-20	59	0	0	11	3	7	1
21-30	61	0	0	5	0	4	1
31-40	51	1	2	8	1	3	0
41-50	42	2	6	8	1	2	2
51-60	25	3	8	9	1	2	2

Table 2. (Continued)

Characteristic	Points on Transect	Active Nest	Old Nest	Feeding on Transect	Snags >38cm	Snags > 28cm	Drum Tree
Height(ft)							
61-70	10	2	6	6	1	2	3
71-80	16	2	5	13	2	5	3
> 80	18	3	9	7	8	13	9
Bark							
50% intact	242	3	9	59	9	21	5
50% intact	40	10	27	8	8	18	16
Limbs							
with	208	10	32	44	10	22	6
without	74	3	4	23	7	17	15
Top							
broken off	98	12	29	26	7	18	11
intact	184	1	7	41	10	21	10

Table 3. Data collected on tree characteristics of logs and stumps at transect points and at sites of pileated woodpecker activity.

Characteristic	Random Sample of Logs	Log Feedings on Transects	Random Sample of Stumps	Stump Feeding on Transects
n=	308	64	295	21
Species				
ponderosa pine	107	16	128	4
Douglas-fir	95	22	84	8
white fir	28	9	19	3
larch	27	13	35	5
lodgepole pine	51	4	29	1
dbh(inches)				
< 3	34	0	9	0
3- 6	117	6	54	0
7-10	89	23	40	2
11-14	33	18	63	7
15-18	15	8	46	4
19-22	8	4	45	5
23-26	6	4	26	1
27-30	4	1	10	2
> 30	2	0	3	0
Height(feet)				
1-10	98	6	295	21
11-20	73	11		
21-30	64	17		
31-40	42	7		
41-50	16	10		

Table 3. (Continued)

Characteristic	Random Sample of Logs	Log Feedings on Transects	Random Sample of Stumps	Stump Feeding on Transects
Height (ft)				
51-60	12	5		
61-70	1	2		
71-80	0	3		
> 80	2	3		
Bark				
50% intact	109	13	149	15
50% intact	199	51	146	6
Limbs				
With	105	11	13	2
Without	203	53	282	19
Top				
broken off	207	42	118	16
intact	90	20	-	-
cut	11	2	177	5

Table 4. Data collected on forest characteristics at points on transects and at sites of pileated woodpecker activity.

Characteristic	Points on Transect	Active Nest	Old Nest	Drum Tree	Feeding on Transect	Snags >38cm	Snags >28cm
n=	375	13	36	21	172	17	39
Forest Sites							
204	43	0	5	1	5	2	5
214	146	4	17	4	52	12	24
305	87	5	9	10	34	2	4
315	99	4	5	6	59	1	6
Landform							
slope	335	12	32	21	153	16	36
ridge	22	1	4	0	10	0	3
draw	18	0	0	0	9	1	
Slope gradient							
0-15%	178	5	24	13	96	6	16
16-30%	86	4	9	5	42	2	8
31-45%	60	4	3	2	25	6	11
>45%	29	0	0	1	4	3	4
Slope aspect							
north	134	4	6	8	76	5	10
east	102	4	5	9	34	4	10
south	53	2	14	0	29	3	7
west	61	3	8	4	23	5	12
Log density(%)							
0-10	215	8	21	7	68	13	30
11-20	101	2	9	9	61	3	7
21-29	17	0	1	3	8	0	1
>30	44	3	5	2	33	1	1

Table 4. (Continued)

Characteristic	Points on Transect	Active Nest	Old Nest	Drum Tree	Feeding on Transect	Snags > 38cm	Snags > 28cm
Log size (in)							
< 7	172	6	15	9	66	10	18
7-14	140	3	7	11	68	4	14
> 14	61	4	14	1	37	3	7
Snag index							
< 2	166	0	9	1	51	10	21
3- 6	113	6	10	12	55	6	13
7-12	60	6	16	7	46	1	4
13-20	28	1	1	1	12	0	1
> 20	8	0	0	0	8	0	0
Stump density							
< 5	177	8	18	8	84	6	14
5-15	162	4	13	11	78	9	19
16-25	27	1	4	2	6	1	6
> 25	11	0	1	0	2	1	
Ground cover (%)							
0-25	160	1	7	7	90	7	21
26-50	135	6	16	10	50	7	13
51-75	66	5	6	3	25	2	4
76-100	15	1	7	1	7	1	1
Ground cover height (in)							
< 3	46	1	7	5	31	1	2
4-6	198	3	15	10	67	12	26
7-12	116	8	14	5	66	3	10
> 12	14	1	0	1	6	1	1

Table 4. (Continued)

Characteristic	Points on Transect	Active Nest	Old Nest	Drum Tree	Feeding on Transect	Snags >38 cm	Snags >28cm
Ground species							
grass	287	9	29	15	114	16	35
forb	74	3	7	4	43	1	4
shrub	14	1	0	2	14	0	0
Canopy height (ft)							
<25	8	0	0	0	1	0	2
25-45	28	0	3	2	13	1	
46-65	74	2	10	6	41	3	8
66-85	149	6	15	4	62	6	14
>85	115	5	8	9	53	7	15
Canopy closure (%)							
0-25	56	2	5	0	14	3	8
25-50	69	2	9	2	31	5	10
50-75	107	2	9	4	37	3	6
75-100	145	7	13	15	90	6	15
Stem density per acre							
0-100	51	0	15	3	23	1	3
101=200	187	5	16	10	92	9	22
201-300	110	7	5	7	45	5	11
301-400	22	1	0	0	10	1	
> 400	6	0	0	0	2	1	3

Table 5. Chi square analysis of tree characteristics of pileated woodpecker active nests, old nests, drum trees, and feeding locations.

Characteristic df=1	Active Nests	Old Nests	Drum Tree	Feeding Location in: Snags	Logs	Stumps
Species						
pond.pine,larch > 38cm dbh	9.13**	21.6**	14.5**			
other species > 38cm						
dbh						
pond.pine,larch > 38cm	54.7**	99.4**	38.1**			
pond.pine, larch < 38cm						
Height						
pond.pine,larch>38cm,> 9m	2.55	6.76**	5.62*			
pond.pine,larch >38cm,<9m						
Bark						
pond.pine,larch>38cm,>50%	2.74		5.02*			
pond.pine,larch>38cm,<50%						
wood with versus without				1.77	6.73**	1.17
Limbs						
pond.pine,larch>38cm with	1.08		4.25*			
pond.pine,larch<38cm without						
wood with versus without				0.23	5.16*	3.50
Top condition						
pond.pine,larch>38cm,intact	8.31**		0.21			
pond.pine,larch>38cm,broken						
wood with versus without versus cut				0.39	0.11	10.5**
Species						
pond.pine > 38cm	1.62	.13	7.96**			
larch > 38cm						

Table 6. Chi square analysis of forest characteristics of pileated woodpecker nests, drum trees, and feed- locations.

Characteristic X^2(df)	Active Nests	Drum Trees	Feeding Locations
Forest sites	8.72*(3)	15.5**(3)	14.0**(3)
204			
214			
305			
315			
Landform	0.04(1)	1.70(1)	0.05(2)
slope			
other			
Slope gradient	3.69(3)	3.99(3)	7.44(3)
0-15			
16-30			
31-45			
> 45			
Slope aspect	0.28(3)	6.46(3)	6.01(3)
north			
east			
south			
west			
Log density(%)	1.90(2)	11.5**(3)	14.8**(3)
0-10			
11-20			
21-29			
> 30			
Log size (in)	0.77(2)	2.70(2)	3.48(2)
< 6			
7-14			
> 14			
Snag index	14.3**(3)	15.0**(3)	16.1**(4)
0- 2			
3- 6			
7-12			
> 12			
Stump density	2.04(2)	0.41(2)	4.44(3)
< 5			
5-15			
16-25			
> 25			

Table 6. (Continued)

Characteristic X^2(df)	Active Nests	Drum Trees	Feeding Locations
Ground Cover(GC) %			
0-25	5.43(3)	2.35(3)	4.75(3)
26-50			
51-75			
76-100			
GC height(in)	7.26(3)	5.12(3)	9.44*(3)
< 3			
4-6			
7-12			
> 12			
GC species	3.51(2)	5.05(2)	7.71*(2)
grass			
forbs			
shrubs			
Canopy height(ft)	1.01(3)	5.12(3)	3.08(4)
< 45			
46-65			
66-85			
> 85			
Canopy closure(%)	1.25(3)	9.16*(3)	11.6(3)
0-25			
25-50			
50-75			
75-100			
Stem density per acre	2.97(4)	9.93*(3)	4.97(4)
0-100			
101-200			
201-300			
301-400			
> 400			