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SCIENCE DIRECT
Forest Ecology and Management 187 (2004) 225–234
Forest Ecology and Management
www.elsevier.com/locate/foreco

Characteristics of pileated woodpecker (*Dryocopus pileatus*) cavity trees and their patches on southeastern Vancouver Island, British Columbia, Canada

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Received 14 May 2003; received in revised form 16 June 2003; accepted 7 July 2003

Abstract

Cavity trees and cavity patches (areas around cavity trees) used by pileated woodpeckers were located in Coastal Western Hemlock and Coastal Douglas-fir forest types on southeastern Vancouver Island during 1996 and 1997. Trees with active nests and with apparent pileated cavities ($n = 28$) were larger than trees without cavities ($n = 200$). Of the seven confirmed nest trees, three were grand fir (*Abies grandis*), two were Douglas-fir (*Pseudotsuga menziesii*) and two were red alder (*Alnus rubra*). These nest trees had a mean diameter at breast height (dbh) of 82 cm (±16 S.E.), a mean height of 22.0 m (±5.2 S.E.), and 91% (±9 S.E.) of their bark remaining. Compared to non-cavity patches ($n = 58$), patches with nests or apparent pileated cavities ($n = 18$) were significantly lower in elevation and greater proportions were in the oldest successional stages, in mature and old forest structural stages, and in moderately disturbed areas. The proportion in young forests, however, was not different than that in non-cavity patches ($n = 58$). Cavity patches had greater proportions of bigleaf maple (*Acer macrophyllum*) and grand fir, but less western hemlock (*Tsuga heterophylla*) than patches without cavity trees. The mean diameter of nest trees used by pileated woodpeckers in North America ranges from 40 to 100 cm and varies with location, tree species, and forest characteristics, such as the availability of large dead trees. Although this broad range of diameters indicates flexibility in nest tree selection, in all published studies, pileated woodpeckers select the larger trees of those available, thus revealing consistent preferences for large-diameter trees for nesting. Management of forests to supply nesting habitat for pileated woodpeckers on southeastern Vancouver Island, must include retention of large live and dead trees, particularly grand fir, Douglas-fir and red alder. In addition, stands should be reserved that have greater proportions of bigleaf maple and grand fir (but less western hemlock) and that are at least mature structural stages and mature climax successional stages.

Keywords: Cavity-nester; *Dryocopus pileatus*; Forest habitat; Nest trees; Pileated woodpecker

1. Introduction

Pileated woodpeckers require large-diameter trees for nesting that are typically defective, decaying, or dead. Hence, their nest trees are generally large, old

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0378-1127/$ – see front matter
doi:10.1016/S0378-1127(03)00334-7

trees in old-growth stands or are legacies remaining from old-growth stands (McClelland and McClelland, 1999). Breeding pairs usually excavate new nesting cavities annually, which in subsequent years are used for roosting or by secondary cavity-using birds and mammals as part of a resource web (Bonar, 2000). Nest trees are considered the limiting factor for most populations of pileated woodpeckers (Bull and Jackson, 1995), and so in managed forests, there is a need to ensure that these trees are not removed during timber harvesting and other forestry activities. These nest trees also occur in a particular forest context, the nest patch. These nest patches may reveal additional habitat characteristics that are associated with the nesting requirements of pileated woodpeckers. In this paper, our objectives were to compare characteristics of nest tree and nest patches with trees and patches without nests, and to consider their implications to forest management. We hypothesized that nest trees would be larger than trees without nest cavities and that nest patches would be in older structural stages and in older successional stages than patches without nest trees.

2. Study area

We chose a study area on southeastern Vancouver Island between Victoria and Duncan, because it has a population of pileated woodpeckers determined from pilot surveys and historical records (Campbell et al., 1990), a range of forest conditions, and because forests were harvested commercially. The study area is located within the Very Dry Maritime Coastal Western Hemlock Biogeoclimatic subzone (CWHxm) and the Moist Maritime Coastal Douglas-fir Biogeoclimatic subzone (CDFmm) (Ministry of Forests, 1993). Forests in the CWHxm subzone are coniferous, dominated by Douglas-fir, western hemlock, and minor amounts of western redcedar (*Thuja plicata*), but some deciduous species such as red alder and bigleaf maple occur (Green and Klinka, 1994). Forests in the CDFmm subzone are coniferous, dominated by Douglas-fir, as well as grand fir and western hemlock. Drier sites are characterized by the presence of Garry oak (*Quercus garryana*) and arbutus (*Arbutus menziesii*). Data were amalgamated for these adjacent subzones because they are broadly similar in tree species and other forest characteristics. The study area has warm, dry summers and moist, mild winters. Elevations range from 140 to 850 m.

Most of our search for nest trees was focused on the four study sites used by Hartwig (1999) for relative abundance surveys. These study sites were each about 1450 ha, thus encompassing an area that could be occupied by approximately two to three breeding pairs of pileated woodpeckers, based on results of Mellen et al. (1992) in similar coastal forests of western Oregon. All of the area of the early seral site was clear cut logged and 60–80% of the site's area was subsequently juvenile spaced (a silvicultural treatment to reduce the number of trees in young stands). Forty percent of the area of the mid-seral study site was clear cut logged and 39% of the area was spaced. Twenty percent of the area of the mature forest study site was clear cut logged and 4% of the area was spaced. Twenty-two percent of the area of the mature/old-growth study site was clear cut logged and 5% of the area was spaced. Thus these study sites included a wide range of stand conditions commonly found in managed forests on Vancouver Island. Stands varied from single-species, early and mid-seral forests; to mixed-species, early and mid-seral forests, and mature/old forests that were previously logged; to unlogged mature/old forests.

3. Methods

For our study, confirmed nest trees were defined as those that had pileated woodpecker adults incubating eggs or juveniles calling or fledging. Apparent pileated cavity trees were defined as those that had a cavity or several cavities of the size and shape created by pileated woodpeckers, but where active nesting was not observed. Thus, these could have been old nest trees, roost trees or cavity start trees. Non-nest trees were defined as dead (snags) or defective trees with no visible pileated woodpecker cavities. Snags were defined as dead trees $\geq$20 cm in dbh and defective trees were live trees $\geq$20 cm dbh with broken tops, scars, decay or damage.

Nest trees were located by systematic searches of areas with repeated observations of pileated woodpecker, as well as from incidental observations and opportunistic reports. Areas were searched during the reproductive season, by aligning four people at 10 m intervals and then walking slowly along the same compass bearing, while looking for nest holes or wood chips on all trees within 5 m of each observer. Incidental observations were recorded during fieldwork by Hartwig (1999). Opportunistic reports were obtained from sightings through the Rare Bird Alert (a telephone line for birders) and from biologists, park naturalists and members of the public.

3.1. Habitat characteristics

Using the same four study sites of Hartwig et al. (2002), habitat information was collected at 0.4 ha circular plots (35.7 m radius) established at each nest tree and also at a sample of systematically located plots without nest trees in the four study sites. At each habitat plot, three types of data were collected: information about the nest tree, information about non-nest trees (including snags or defective trees), and information about the site. Characteristics of plots with nest trees (nest tree patches) were compared to those without nest trees (non-nest tree patches).

Data collected for trees included: diameter (cm) at breast height (i.e., 120 cm above the point of germination), height (m) measured with a clinometer, estimated percentage of bark remaining on trunk, species, decay class (four classes modified from Bartels et al., 1985), number of limbs $\geq$1 m in length, top condition (broken, dead and unbroken, live and unbroken, unknown), canopy position (above canopy, within upper canopy or below upper canopy), and lean (degrees measured with a clinometer). Information about each habitat plot was recorded using the Ecosystem Field Form and procedures of the BC Ministry of Forests and Ministry of Environment (Luttmerding et al., 1990; Ministry of Forests and Ministry of Environment, 1996).

Variables used to describe the nest tree patch included basal area of snags and defective trees, mean dbh of snags or defective trees, stems per hectare, structural stage, successional stage, disturbance (none; fire, wind or edge; logging, thinning or spacing), and elevation (m). Basal area was calculated as $0.0001963 \times d^2$ (after Avery, 1975), where d is the diameter (cm) at breast height of each snag or defective tree. Stem density was estimated for each plot by counting all stems $\geq$3 m tall within a 5.64 m radius circle in the center of each plot, and then multiplying by 100. Structural stage categories were defined as: shrub; pole/sapling; young forest; mature forest; and old forest (Ministry of Forests and Ministry of Environment, 1996). Five successional status classes were defined as: pioneer seral or young seral; mature or overmature seral; young climatic climax; maturing climax or maturing; and climatic climax or disclimax (modified from Luttmerding et al., 1990).

3.2. Statistical analysis

Because all habitat data were not normally distributed, we used non-parametric Kruskal–Wallis tests to examine differences in the dispersion of ratio habitat data from groups of more than two samples (Zar, 1996; Norušis, 1998). A Mann–Whitney U-test was used for ratio data to determine the differences between the dispersion of two groups (Sokal and Rohlf, 1981; Zar, 1996). For nominal habitat data, a chi-square test was used to test for the hypothesis of independence of the rows and columns of a contingency table (Siegel and Castellan, 1988; Zar, 1996; Norušis, 1998). For a variable of particular interest (e.g., diameter at breast height or species of snags) with significant results, a chi-square test was used to test for significance within classes of the variable by comparing the proportions of an individual class to the proportions for all other classes (Zar, 1996). The level of significance used for table-wide comparisons was $\alpha = 0.05$. A Bonferroni correction was used for multiple comparison tests (Zar, 1996).

4. Results

4.1. Comparisons of confirmed nest trees and apparent pileated cavity trees

Twenty-one apparent pileated cavity trees were found during 1996 and 1997 along with seven confirmed as active nest trees. The 21 apparent pileated cavity trees had nest cavities, roost cavities, or cavity starts whose openings were in the shape and size typical of pileated woodpeckers.

We detected no significant difference in dbh, height, cavity height, bark remaining, decay class, or the number of limbs between confirmed nest trees and

Table 1
Comparison of characteristics of snags and defective trees (≥20 cm dbh) with a confirmed pileated woodpecker nest cavity and with those containing an apparent pileated cavity on southeastern Vancouver Island, 1996–1997[a]

Characteristics	Mean (±S.E.) or percentage		P
	Confirmed nest ($n = 7$)	Apparent pileated cavity ($n = 21$)	
Diameter at breast height (cm)	82 (±16)	77 (±7)	0.88[b]
Height (m)	22.0 (±5.2)	19.8 (±1.9)	0.80[b]
Height of lowest cavity (m)	17.4 (±3.5)	14.2 (±1.8)	0.33[b]
Bark remaining (%)	91 (±9)	69 (±8)	0.06[b]
Species (%)			No results[c]
Douglas-fir	29	76	**0.02**[d]
Grand fir	43	5	
Red alder	29	0	
Bigleaf maple	0	10	
Western redcedar	0	5	
Western hemlock	0	5	
Decay class (%)			0.07[c]
Live healthy/unhealthy	43	14	
Dead with or without needles and twigs	14	24	
Dead, most branches gone or absent	43	52	
Dead, extensive decay	0	10	
Limbs >1 m long (%)			0.79[c]
None	43	52	
1–10	0	10	
11–20	29	24	
>20	29	14	

[a] Bold indicates significance at $\alpha = 0.05$.
[b] Mann–Whitney U-test.
[c] Sample sizes too small for comparisons within class.
[d] Chi-square test.

apparent pileated cavity trees (Table 1). There is a possibility that we failed to detect a difference between the confirmed and apparent pileated cavity trees because of the low sample size and perhaps insufficient power to detect a difference if one were present. Differences between active nest trees, old nest trees, roost trees and (and cavity start trees) may exist (Bull and Jackson, 1995), however, for this study, we did not differentiate due to resource constraints. The proportion of Douglas-fir used as confirmed nest trees (2/7) was significantly less than the proportion in the apparent pileated cavity roost tree category (16/21). The proportion of grand fir (3/7) and red alder (2/7) appeared greater in the confirmed nest trees than in the apparent pileated cavity trees, but the sample sizes were too small to test for these and other species-related differences. Similarly, small sample sizes precluded tests for top condition and canopy position. Because few differences existed between confirmed and apparent pileated cavity trees, these two categories of trees were pooled, and hereafter referred to as "cavity trees", for comparisons with snags and defective trees not containing pileated woodpecker cavities.

4.2. Comparisons of cavity trees and non-cavity trees

Cavity trees differed significantly from non-cavity trees for some characteristics (Table 2). Cavity trees were significantly larger in diameter (78 ± 6 cm) than trees without cavities (47 ± 2 cm). As well, they were taller and comprised a larger proportion of the trees in the upper canopy and above canopy classes. There were no significant differences for proportions of bark remaining on the bole or for amount of lean.

Table 2
Characteristics of snags and defective trees (≥20 cm dbh) with a pileated woodpecker nest or apparent pileated cavity compared to those without a nest or roost cavity on southeastern Vancouver Island, 1996–1997[a]

Characteristics	Mean (±S.E.) or percentage		*P*
	Confirmed nest or apparent cavity ($n = 28$)	Non-cavity ($n = 200$)	
Diameter at breast height (cm)	78 (±6)	47 (±2)	**<0.01**[b]
Height (m)	20.3 (±1.9)	12.0 (±0.6)	**0.01**[b]
Bark remaining (%)	75 (±7)	70 (±3)	0.62[b]
Species (%)			No results[c]
Douglas-fir	64	40	**0.01**[d]
Grand fir	14	9	0.32[d]
Red alder	7	17	0.18[d]
Bigleaf maple	7	9	0.75[d]
Western redcedar	4	11	0.22[d]
Western hemlock	4	9	0.33[d]
Shore pine	0	1	
Western white pine	0	1	
Arbutus	0	1	
Unidentified	7	5	
Decay class (%)			0.39[e]
Live healthy/unhealthy	21	19	
Dead with or without needles and twigs	22	31	
Dead, most branches gone or absent	50	34	
Dead, extensive decay	7	18	
Limbs >1 m long (%)			0.40[e]
None	50	50	
1–10	7	20	
11–20	25	8	
>20	18	23	
Top condition (%)			No results[c]
Broken	93	84	
Dead and unbroken	0	12	
Live and unbroken	4	5	
Unknown	4	0	
Canopy position (%)			**<0.01**[e]
Above canopy	14	4	
Within upper canopy	46	20	
Below upper canopy	39	77	
Lean (°)	4 (±2)	2 (±1)	0.32[b]

[a] Bold indicates significance at $\alpha = 0.05$.
[b] Mann–Whitney *U*-test.
[c] Sample sizes too small for comparisons within class.
[d] Chi-square and Cramer's V comparison between particular class and all other classes.
[e] Chi-square test.

Douglas-fir comprised a greater proportion of the cavity trees than the non-cavity trees. No other species (grand fir, red alder, bigleaf maple, western redcedar, or western hemlock) showed similar significant differences. There were no significant differences in relative use for decay class or for number of limbs between the cavity and non-cavity trees. Small sample sizes precluded meaningful comparisons for top condition.

Table 3
Comparison of characteristics of habitat surrounding pileated cavity trees with habitat surrounding non-cavity trees on southeastern Vancouver Island, 1996–1997[a]

Habitat characteristics	Mean (±S.E.) or percentage (*n*, number of plots)		*P*
	Pileated cavity tree patch ($n = 18$)	Non-cavity tree patch ($n = 58$)	
Snag or defective tree basal area ($m^2\ ha^{-1}$)	7.6 (±1.0)	5.8 (±0.9)	**0.01**[b]
Dbh of snags or defective trees (cm)	78 (±6)	47 (±2)	**<0.01**[b]
Stems (ha^{-1})	1097 (±362)	784 (±163)	0.19[b]
Structural stage (%)			**0.01**[c]
Shrub	6	9	
Pole/sapling	11	19	
Young forest	6	31	
Mature forest	33	29	
Old forest	44	12	
Successional stage (%)			**0.01**[c]
Pioneer or young seral	17	33	
Mature or overmature seral[d]	11	15	
Young climatic climax[d]	0	16	
Maturing climax, maturing, climatic climax, and disclimax	72	36	
Disturbance (%)			**0.04**[c]
None	22	17	
Fire, wind, or edge	50	26	
Logging, thinning, or spacing	28	57	
Elevation (m)	180 (±39)	452 (±17)	**<0.01**[b]

[a] Bold indicates significance at $\alpha = 0.05$.
[b] Mann–Whitney *U*-test.
[c] Chi-square test.
[d] Classes pooled for statistical comparison.

4.3. Habitat characteristics of cavity tree patches

Habitat in the patches surrounding cavity trees differed significantly from habitat in patches around non-cavity trees, with respect to basal area of snags and defective trees, structural stage, successional stage, disturbance, and elevation (Table 3). Note that the number of plots is less than the number of cavity trees because there was >1 cavity tree in some plots. A greater proportion of cavity trees than non-cavity trees were in the ''old'' structural stage and the ''mature climax'' successional stages. Tree stem density did not differ between the cavity tree patches and the non-cavity tree patches.

The proportion of cavity patches without disturbance was not significantly different than that for non-cavity tree patches. The proportion of cavity patches with moderate disturbance, such as edge, was significantly greater for cavity trees than that for non-cavity tree patches.

The canopy coverage of some tree species differed between habitat patches around cavity trees compared with patches around non-cavity trees (Table 4). Western hemlock had less canopy cover in cavity patches, while bigleaf maple and grand fir had greater canopy coverage. No significant differences in cover were found for Douglas-fir, western redcedar and red alder.

5. Discussion

5.1. Nest trees

We accept our hypotheses that nest trees of pileated woodpeckers are larger in diameter, and that cavity trees are more likely to be in older structural stages,

Table 4
Comparison of canopy cover of tree species composition in habitat patches with pileated cavity trees and those without cavity trees on southeastern Vancouver Island, 1996–1997[a]

Species—canopy stratum	Mean % cover (±S.E.) or percentage		P
	Pileated cavity patch (18)	Non-cavity patch (58)	
Douglas-fir—all strata	40 (±6)	33 (±3)	0.27
Western hemlock—all strata	10 (±4)	16 (±2)	**0.04**
Western redcedar—all strata	26 (±7)	11 (±2)	0.17
Red alder—all strata	10 (±6)	3 (±1)	0.12
Bigleaf maple—all strata	6 (±2)	0 (±0)	**<0.01**
Grand fir—all strata	9 (±3)	0 (±0)	**<0.01**

[a] Bold indicates significance at $\alpha = 0.05$ (Mann–Whitney *U*-test).

and more likely to be in maturing climax successional stages than trees without pileated cavities. In North America, the diameter of nest trees used by pileated woodpeckers varies depending on the location, tree species, and forest characteristics, such as the availability of large dead trees (Table 5). Of the major studies of pileated woodpecker, the Cascade Mountains of northwestern Washington had the largest mean dbh of nest trees at 100 cm (Aubrey and Raley, 1995). This likely reflects the availability of large trees at their site which were, on average, larger than those in our study area. Harestad and Keisker (1989) reported the smallest mean dbh of any North American study at 40.5 cm in southcentral British Columbia. This small size of nest trees likely reflects the relatively small size of trees available in their study area.

Douglas-fir commonly used by pileated woodpecker in coastal forests of western North America (Mellen, 1987) is much larger in diameter than the trembling aspen (*Populus tremuloides*) preferred by pileated woodpeckers in the interior of British Columbia (Harestad and Keisker, 1989). The broad range in diameters of trees used by pileated woodpeckers for nesting indicates flexibility in nest tree selection. However, in all published studies, pileated woodpeckers select the larger trees of those available and thus reveal a consistent preference for large-diameter trees for nesting. Such preference probably relates to their need for suitably sized nest chambers in which to raise young.

Nest trees in western Washington were the tallest (40 m) and had the highest nests (35 m). . Virginia and southcentral British Columbia had nest trees with the lowest mean height, 20 and 19.2 m, respectively (Conner et al., 1975; Harestad and Keisker, 1989). These nests were also located lower on the boles at 14 and 9.2 m, respectively. Compared to nest trees with similar dbh from other areas, the mean height of nest trees from southeastern Vancouver Island was less and the nest height was lower. This observation may be due to greater numbers of short species such as red alder and bigleaf maple in our sample.

Grand fir, red alder, and Douglas-fir were used as nest trees on southeastern Vancouver Island. Douglas-fir was used extensively, particularly when we include

Table 5
Characteristics of nest trees used by pileated woodpecker for nesting trees in North America (in descending order of dbh)

Location	Preferred species	Mean values			n	Reference
		dbh (cm)	Height (m)	Nest height (m)		
Western Washington	Western hemlock Pacific silver fir	100	39.7	35.2	27	Aubrey and Raley (1995)
North-western Washington	Ponderosa pine Western larch	84	37	16	6	Madsen (1985)
North-eastern Oregon	Ponderosa pine	84	28	15	105	Bull (1987)
Vancouver Island	Douglas-fir	82	22.0	17.4	7	Hartwig (1999)
North-western Montana	Western larch	73	29	15.9	113	McClelland and McClelland (1999)
Western Oregon	Douglas-fir	69	27	20	18	Mellen (1987)
Virginia	Hickory, red oak	55	20	14	14	Conner et al. (1975)
Southcentral BC	Trembling aspen	46	30.7	–	6	Steeger et al. (1996)
Southcentral BC	Trembling aspen	40	19.2	9.2	20	Harestad and Keisker (1989)

apparent pileated cavity trees. Our findings are consistent, with other areas such as western Oregon, where roost trees included Douglas-fir, red alder, western redcedar, and bigleaf maple (Mellen, 1987). Apparent pileated cavity trees in our study showed a similar pattern. Species of nest or roost trees vary in different locations even when some species occur in both regions; a species of tree avoided in one region can be used extensively in another. In eastern Oregon and northwestern Montana, pileated woodpeckers preferred western larch (*Larix occidentalis*) over Douglas-fir (Bull, 1975; McClelland and McClelland, 1999). Although sapwood in western larch decays more quickly than the heartwood in Douglas-fir, west of the Cascade Mountains where Douglas-fir dominates, Douglas-fir is commonly used by pileated woodpeckers in western Oregon (Mellen, 1987). In northern Alberta, 98% of pileated woodpecker nest trees were in trembling aspen, although this species constitutes only 10% of the available trees (R. Bonar, pers. commun.). Similarly, affinities for deciduous trees occurred in south central BC (Harestad and Keisker, 1989).

5.2. Habitat patches

Although pileated woodpecker often forage in younger forests (Mellen et al., 1992), studies have generally found that nest trees of pileated woodpeckers are in dense, mature, or old stands of trees, in relict dead trees within young stands, or even in developed areas (McClelland, 1977). This observation was also true on Vancouver Island. Thus, habitat patches that are more likely to provide suitable nesting habitat for pileated woodpeckers have greater densities of large snags or defective trees, are in mature structural stages and mature climax successional stages; have less disturbance and are located at lower elevations.

Nest trees are less likely to occur in clear cut or patch-retention treatments (Guyg and Bennett, 1995). Nesting in fragmented habitats for some birds likely increases the vulnerability of nests to predators (Rosenberg and Raphael, 1991) and such risk of predation may extend to pileated woodpeckers. When suitable nesting trees are scarce in developed landscapes, trees may be reused annually or perhaps only by dispersing birds unable to occupy better habitat; also, repeated nesting by woodpeckers would likely reduce nesting opportunities for secondary cavity-nesters over time (Sedgwick, 1997). It would be prudent for managers to ensure some trees suitable for nesting are provided in stands of older forest.

Some studies have noted that pileated woodpecker nest near water in valleys or bottomlands (Hoyt, 1957; Conner et al., 1975; Conner and Adkisson, 1976). On Vancouver Island, areas with greater frequencies of large grand fir and deciduous species (species more likely to be used by pileated woodpeckers for nesting) more commonly occur in moist bottomlands—although large Douglas-fir (also commonly used for nesting) occur on dry sites. Renken and Wiggers (1993) explained that important habitat features, such as large trees and snags, are often associated with bottomland forests. In eastern Oregon, Bull (1987) discovered that most nest trees were located where large ponderosa pine (*Pinus ponderosa*) occurred, on ridges or on the upper half of dry slopes that averaged 19% gradient. Thus, the location of potential nest trees may be more important than features of the immediate habitat, although some site features, such as stand age and structural stage, would be associated with the availability of suitable nest trees.

6. Conclusions

In Canada, the pileated woodpecker is considered an ecological indicator and an umbrella species in Quebec, Ontario, Saskatchewan, Alberta, and New Brunswick (Savignac et al., 2000). The pileated woodpecker has been proposed as a keystone species in Canada and in the US Pacific Northwest because it is the only species able to excavate large cavities in hard snags and decadent live trees, that are subsequently used by a large number of other wildlife species (Aubrey and Raley, 2002). This is true particularly for large-bodied species such as Barrow's goldeneye (*Bucephala islandica*), common goldeneye (*B. clangula*), boreal owl (*Aegolius funereus*), and American marten (*Martes americana*) (Bonar, 2000).

On southeastern Vancouver Island, if habitat for pileated woodpeckers is to be part of future forests, then managers must retain larger live and dead trees, particularly grand fir, Douglas-fir and red alder. As well, some smaller, younger trees need to be set aside so that they can grow into trees with enough stature and, eventually, defects to be recruited to the supply of nest trees. In addition to retaining suitable large trees, it is important to reserve stands with a greater proportions of bigleaf maple and grand fir (and less western hemlock), in mature or older structural stages and mature climax successional stages.

Acknowledgements

Funding for this project was provided by the Habitat Conservation Trust Fund and the King-Platt Fellowship. Technical and logistical supports were provided by Capital Region Water District, British Columbia Wildlife Branch, BC Resource Stewardship Branch, TimberWest Forest Ltd., Pacific Forestry Centre, Department of National Defence, Capital Region District Parks, and BC Parks. We thank those who reviewed the manuscript.

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