

**FINAL SPECIES ACCOUNT
FOR WILLIAMSON'S SAPSUCKER SPECIES-HABITAT MODEL
IN THE OKANAGAN**

This account was based on the template developed first for the Okanagan-Shuswap Forest District in the 1990's for Ministry of Environment, Penticton, which has since been adapted for the Boundary TSA (Gyug 2009). This final account incorporates validation of the model and adjustments made since the preliminary account produced in November, 2009.

Common Name: Williamson's Sapsucker

Scientific Name: *Sphyrapicus thyroideus*

Species Code: B-WISA

Status: Provincial Listing: Red (B.C. Conservation Data Centre 2006).

Global G5; Provincial S3B for species, but Okanagan subspecies *thyroideus* is S2B; COSEWIC Assessment: Endangered (2005); SARA: Schedule 1

Identified Wildlife under FRPA in B.C. as of 2004.

Project Area:

Williamson's Sapsucker (WISA) Area of Occupancy (AO) on the east side of Okanagan Lake within the Okanagan-Shuswap Forest District. The WISA AO in the Okanagan as of 2008 was 291 km² in extent. Approximately 27% of this area was in forest licences and crown woodlots, 56% in Tree Farm Licence 35 (formerly TFL 15), and 17% in private and First Nations lands.

Ecoprovince: Southern Interior

Ecoregions: Thompson-Okanagan Plateau,
Okanagan Highland

Ecosections: Northern Okanagan Highland (NOH), North Okanagan Basin (NOB), Southern Okanagan Highland (SOH), Southern Okanagan Basin (SOB)

Biogeoclimatic Variants: PPxh1, IDFxh1, IDFdm1, MSdm1

Project Map Scale: 1:20,000

Map Products Used: Ecosystem Mapping covering most of the project area was available from several different sources including the Okanagan TSA Predictive Ecosystem Mapping (PEM BAPID 4031; 2001-2006) and Terrestrial Ecosystem Mapping for Tree Farm Licence 15 (TEM BAPID 4200; 1997), Naramata SEI (TEM BAPID 4483; undated), South Okanagan SEI (TEM BAPID 4197; 1995) and Osoyoos TEM SEI (TEM BAPID 4029; 2003). VRI (forest cover rollover-2007/2008), Forest Cover (1999) and DEM layers were also available, and were the primary source of the modeling in this project as modeling in the Boundary TSA showed that these layers were more accurate for prediction of WISA occurrence than ecosystem mapping. Digital orthophotos (1-m pixel) were available for 1990-1995 (Black and white) and 2004 (colour), and stereo pairs of aerial photos (1992 and 1996) were used for additional forest stand interpretation.

Distribution

Provincial Range

- breeds; uncommon summer resident (Cannings *et al.* 1987, COSEWIC 2005);
- primary area of abundance is east of Okanagan Valley to Greenwood (COSEWIC 2005, Gyug *et al.* 2007)
- uncommon migrant and summer visitant to the Thompson-Okanagan Plateau and Kootenay Trench (Campbell *et al.* 1990);
- breeds as far north as Scottie Creek (NE of Cache Creek), and west to Hat Creek (W of Cache Creek), Botanie Valley (W of Spence's Bridge) and Manning Park (Cooper 1995, Gyug *et al.* 2007); occasional breeding records near Kamloops as far north as Skull Mt (Barriere) (Gyug *et al.* 2007).
- Kelowna area (Chute Lake) is the northern limit of their range on the east side of Okanagan Lake with some reported west of Okanagan Lake from the border: Mount Kobau, Trout Creek, Terrace Mountain (Gyug *et al.* 2007), Salmon River (Gyug 2007)

Elevational Range:

- breeds between 800 and 1550 m with the majority between 975 and 1475 m (Gyug *et al.* 2007);
- in the Okanagan, 135 nests in 73 trees were found between 1996 and 2008 with all nests between 1000 and 1520 m, and the majority (91%) of nests found between 1100 and 1400 m (Tables 1 and 2, Gyug unpublished data). No Williamson's Sapsucker were observed below 1000 m.

Table 1. Elevations of Williamson's Sapsucker nests in the Okanagan, 1995-2008.

Elevation (m)	Nest Trees		Nests	
	n	%	n	%
1000-1099	4	5.5	4	3.0
1100-1199	14	19.2	24	17.8
1200-1299	28	38.4	57	42.2
1300-1399	22	30.1	42	31.1
1400-1499	4	5.5	6	4.4
1500-1520	1	1.4	2	1.5
Total	73	100	135	100

Table 2. Elevations of Williamson's Sapsucker breeding territories and other observations that could not be directly associated with breeding territories in the Okanagan, 1995-2008.

Elevation (m)	Territories with Nests or Breeding Pairs		Territories with Males present for >2 weeks or in >1 year		Other WISA observations	
	n	%	n	%	n	%
1000-1099	4	5.6	0	0.0	5	7.0
1100-1199	15	20.8	0	0.0	17	23.9
1200-1299	29	40.3	3	50.0	21	29.6
1300-1399	19	26.4	1	16.7	20	28.2
1400-1499	4	5.6	1	16.7	8	11.3
1500-1550	1	1.4	1	16.7	0	0.0
Total Territories	72		6		NA	
Total Observations	471		20		71	

Ecosections:

1. West of Okanagan Lake:
 - a. multiple breeding records in the Nicola Basin (22 nests), and Southern Thompson Upland (80 nests)
 - b. scarce breeding records from the Guichon Upland (3 nests) Hozameen Range (4 nests), Pavilion Ranges (4 nests), Thompson Basin (3 nests), and Tranquille Upland (nests at 1 site), Northern Okanagan Basin (1 nest), Okanagan Range (1 nest).
2. Okanagan-Boundary:
 - a. found mainly in the Southern Okanagan Basin (54 nests), Southern Okanagan Highlands (40 nests) and Northern Okanagan Highlands (193 nests),
 - b. two nest records from the Selkirk Foothills;
3. East Kootenays:
 - a. East Kootenay Trench (22 nests) and the McGillivray Range (23 nests)
 - b. Eastern Purcell Mountains (2 nests)

BEC Zones:

- highest relative breeding densities (9-10 detected per 100 call playback points, and 8-9 nest territories found per 100 call playback points) in B.C. were in the Okanagan-Boundary in the IDFdm1 and IDFxh1/xh4 (Gyug et al. 2007, updated to 2007 by Table 8 of Gyug 2007)
- moderate relative breeding densities (50% of highest observed) were in the IDFxh1 west of the Okanagan, and the MSdm1 in the Okanagan-Boundary (Gyug et al. 2007)
- relative breeding densities <25% of the maximum were in the MSdk, PPxh2, IDFdm2, IDFdk1, IDFxh2, ICHmk1 and IDFdk2
- considering only the Okanagan TSA, relative densities were highest in the IDFdm1, followed by the MSdm1 and by the IDFxh1. However, both the IDFxh1 and MSdm1 variants appeared to be used peripherally with the main abundance in the IDFdm1 (Table 3, Gyug, unpublished data)

Table 3. Williamson's Sapsucker relative density, and numbers of territories and nests found by BEC variant in the Okanagan TSA based on call playback surveys.

BEC Variant	CPB Survey Points	WISA detected	WISA detected /100 CPBs	Territories (Nests) found³	Random Pts within WISA AO (2008)	% Random Pts with WISA detected
IDFxh1-East	147	24	16.3	18 (28)	11	45.5
IDFdm1	360	49	13.6	56 (102)	38	31.6
MSdm1 ¹	139	18	12.9	4 (5)	6	16.7
IDFdk1 ²	243	4	1.6	2 (0)		
IDFdk2 ²	201	2	1.0	1 (2)		
IDFxh1-West	284	1	0.4			
IDFxh2	19	0	0.0			
IDFmw1	105	0	0.0			
ICHmk1	18	0	0.0			
MSdm2/xk1	16	0	0.0			
PPxh1	6	0	0.0			
BGxh1	3	0	0.0			
Totals	1541	98		81 (137)	55	32.7

¹15 of 18 WISA detections in the MSdm1 were within 350 m of the IDFdm1, and all were within 900 m.

²All WISA detections in the IDFdk1 and IDFdk2 were west of Okanagan Lake outside the mapped AO.

³Territories overlapping the edges of BEC variants were assigned to the BEC variant where the nest occurred.

Based on the locations of Williamson's Sapsucker from call playback surveys and follow-up nest searches, the Area of Occupancy (AO) was defined (COSEWIC 2005). The AO was considered to be the area where breeding was known to occur, or suspected to occur based on habitat similarities to known breeding locations and was recommended to be mapped at a coarse-scale (minimum cell size of 1-km blocks) (see COSEWIC 2005). In the Okanagan, 32% of the call playback points were within what was eventually mapped as the AO, and 68% were outside the AO. The remainder of this habitat modeling project only deals with the portion of the Okanagan Forest District contained within the WISA AO as it was revised in 2008. A minor revision was made to the AO during the final phase of this modeling to remove 195 ha that were in the PPxh1 or on steep rocky slopes immediately adjacent to the PPxh1.

Provincial Context

Williamson's Sapsuckers do not breed in Canada except in British Columbia, although they have been occasionally seen in Alberta and Saskatchewan (COSEWIC 2005). The remainder of the species breeding range is to the south in the United States.

Ecology and Key Habitat Requirements

Williamson's Sapsucker is the least numerous and most ecologically and genetically specialized species in its genus (Crockett and Hadow 1975, Johnson and Zink 1983). Williamson's Sapsucker require suitable trees or snags with internal decay for nesting, live trees for sap wells, ants upon which the adults forage extensively in the breeding period, and which are the primary nestling food, and standing live trees from which they glean the ants mainly from the trunks as the ants tend aphids in the trees.

Their general habitat descriptions prior to the research initiated by B.C. Environment in 1996 were:

- Found in montane forests in B.C. (Campbell *et al.* 1990);
- pure coniferous and mixed coniferous/deciduous forests, including western larch, interior Douglas-fir, ponderosa pine; most abundant in mature coniferous forests dominated by western larch (Cooper 1995);
- observed occasionally in orchards in the Okanagan valley but not breeding there (Bryan and Mulholland 1992)

Habitat use may be very traditional with 3 of 6 tagged nestlings returning to nest within 3 km of the nest within 2 years (Crockett 1975). However, the only other study that tagged nestlings found none of the 100 tagged nestlings in later years (unpublished data cited in Dobbs *et al.* 1997 from Arizona).

Habitat Use (Life Requisites and Seasons)

Temporal Pattern of Life Requisites:

- Breeding - eggs found from late April to mid-June; incubation begins in May and young fledge in second half of June and early July (Gyug *et al.* 2007); egg laying occurs between late April and late May (Dobbs *et al.* 1997); broods range from early May to mid-July (Campbell *et al.* 1990)
- Foraging – mid-March to late September
- Migration - arrive mid to late-March (Gyug, unpublished data) and most leave by mid-September and occasionally found up to mid-October (Campbell *et al.* 1990; Cannings *et al.* 1987, COSEWIC 2005);

Habitat Use and Ecosystem Attributes

BREEDING

Habitat Type

In B.C., and throughout most of their breeding range, there are two basic habitat types (Gyug et al. 2007, Gyug et al. 2009a):

1. Those dominated almost entirely by conifers where nesting trees are large conifers - mainly live Lw where it occurs, or other dead standing conifers where larch does not occur,
2. Those where trembling aspen occurs within a coniferous forest matrix, and where trembling aspen is the primary nest tree.

In the Okanagan, most occupied nest territories are in coniferous forest where western larch and Douglas-fir are present. Aspen stands are only occasionally used in the Okanagan (11% of nests).

Stands used for nesting can vary from densely forested stands to very open stands with only occasional scattered trees. Descriptions of WISA nesting habitat types in conifer forests (i.e. not in areas where they primarily nest in aspen) have included:

- Multi-storied grand fir and Douglas-fir forests in northeastern Oregon with mix of species including prominent Py and Lw (Nielsen-Pincus and Garton 2007, Bull et al. 1986),
- Mean tree densities of 57/ha (>22-cm dbh, Nielsen-Pincus and Garton 2007) to 220 trees/ha (>14-cm dbh, Bull et al. 1986),
- Fd forested stands in Montana with a major component of old growth, particularly Lw, and a mean basal area of 35 m²/ha (McClelland et al. 1979)
- Tree species composition (live trees >23 cm DBH) in Montana was Fd 52%, Bl, 22%, Se 12%, Lw 11%, others 3% (McClelland and McClelland 2000).

In Colorado, where WISA nest most often in aspen, they favoured nest sites adjacent to open Py forest (Crockett and Hadow 1975; Smith 1982). Nest stands were typically dominated by At, 0.34 ha in size (range 0.024-1.17 ha) with mean density of 772 trees/ha (range 182-1312 trees/ha; Crockett 1975) [note that size range of trees included in the density was not given]. Conway and Martin (1993) found much lower live aspen (>17-cm dbh) densities in nesting stands (mean 9.2/ha) probably because conifers made up the majority (87.5%) of the canopy cover in the nesting stands (which would imply a mean density of 74 trees/ha). Crockett and Hadow (1975) and Smith (1982) found WISAs nesting in aspens to be foraging in nearby Py stands, rather than in the aspen stands where they nested.

Nest Attributes

- They will often reuse the same tree, and may either reuse the same nest hole or excavate a new nest hole each year (Dobbs et al. 1997).
- WISA are relatively weak excavators (Schepps et al. 1999). They can penetrate very hard wood on the outside of the tree, up to one bill length, only if there are extant heart rots underneath the sound and shallow sapwood. Age of stand may be a good stand-in for presence of suitable nest trees including older Lw or At with heart rots, or standing dead Fd or Py.
- Up to 109 nest holes have been found in one Lw in Boundary (although not all those nest holes were WISA holes, and some may have been blind holes where excavations were started and not finished).

- The most commonly used nest trees in the Okanagan were (n = 135 nests; Gyug et al. 2009a):
 - very large live Lw (mean DBH 72 cm) 76%
 - large live At (mean DBH 43 cm) 9%
 - large dead Lw (mean DBH 61 cm) 6%
 - large dead At (mean DBH 38 cm) 2%
 - Ew (water birch) (mean DBH 34 cm) 2%
 - large dead Py (mean DBH 75 cm) 2%
 - large live Py (mean DBH 79 cm) 1%
 - 1 each of dead Fd (49 cm DBH), and dead Sx (hybrid white spruce) (43 cm DBH).

FORAGING

Diet (as summarized by Dobbs et al. 1997) consists of conifer sap and phloem during prenestling period, shifting to mainly ants gleaned from tree trunks after hatching of young. The ants were identified as either carpenter ants (*Camponotus* spp.) or wood ants (*Formica* spp.) (Crockett 1975). This predominance of ants in the nestling diet has been confirmed in B.C. based on collections of nestling fecal sacs from below active WISA nests from 2006-2008. These collections have yet to be quantitatively analyzed (a FIA project to analyze them is underway, and results should be complete by 2011).

Conifers used for sapwells are small to medium (10-50 cm dbh) Fd, Lw, Py or other conifers. Unhealthy medium-sized Douglas-fir appear to be the primary sap trees in the Okanagan-Boundary portion of the WISA range in B.C. (Gyug et al. 2009b). Pairs maintain 4-5 sap trees that they visit several times daily throughout the breeding season to keep sap wells open (Crockett 1975).

Foraging Habitat Type

Both young and mature trees with flowing sap are required for sapwells. Also required are woody structures for carpenter ants as well as other wood ants to nest in, which may include logs, stumps, trees with decay, and standing snags. These ants require standing live trees for aphids which they milk for honeydew (tree sap). These ants become accessible to foraging WISA as they crawl up and down the trunks from their nests to the aphid-tending sites. Age of stand may be a good stand-in for presence of large snags and standing trees with heart rots that are infected with carpenter ants.

TERRITORY SIZES AND DENSITIES

Territory sizes: Home ranges of WISA in Western Larch habitats in British Columbia estimated using radio telemetry (54 ha; Manning and Cooper 1996) appear to be larger than those estimated in Py/At habitats in Colorado and Arizona (4-11 ha) but using less direct methods (see COSEWIC 2005). Methodologies of determining territory size have been quite variable, and are difficult to compare. In Lw forests, average inter-nest spacing in benchmark habitat was about 450 m (Gyug et al. 2007).

Only considering census areas of 100 ha or greater, densities reported in Canada range from 0 to 3.1 breeding pairs per 100 ha (Gyug, unpublished data). Data is similar for the U.S. but with only one density higher than this at 4.8 nests/100 ha in San Juan National Forest (Py forest with nests in At patches). Intensive call playback surveys, nest searches and census areas have given us enough information to assign a density based on the 4-class scale (High, Moderate or Low) to all WISA observations made during the inventories conducted from 1996-2008.

Table 4. Habitat suitability using a 5-Class Rating Scheme based on the 6-class rating schemes of RISC (1998), and density equivalents for Williamson's Sapsucker based on census areas >100 ha in size (Gyug, unpublished data).

Percent of Provincial Benchmark	Rating	Numerical Code	Letter Code	Density (Nests or Breeding Pairs/km ²)
76-100%	High	1	H	2.3 - 3.1
51-75%	Moderately High	2	MH	0.8 - 2.3
26-50%	Moderate	3	M	0.2 - 0.8
6-25%	Low	4	L	0.03 - 0.2
1-5%	Very Low	5	VL	0 - 0.03
0-1%	Nil	6	N	

Ratings

This model employs the 6-Class rating scheme (Table 4) recommended in the RISC standards manual (RISC 1998). For the purposes of this Williamson's Sapsucker modeling, the Moderately High (2) and the Moderate (3) have been grouped. The WISA model profiles breeding (B) and foraging (F) habitats. WISA is a central-place forager, i.e., the nest site, so breeding and foraging habitats must occur within close proximity. These have been modeled together as the living (LI) life requisite. Breeding (nesting) occurs during the spring and foraging can extend from April to September, therefore living is modeled for the growing season.

The preliminary model was based on analyses of available data and then applied to Forest Cover/VRI attributes at the polygon level from the Forest Inventory Protocol (FIP) database (with adjustments for slope). The attributes used were those determined to be important based on ANOVA analyses of different known nest densities, and on random unoccupied points. During the Boundary TSA modeling (Gyug 2009), TEM/PEM mapping was found to be too generalized for forest structure characteristics to be useful for predicting Williamson's Sapsucker habitat suitability. Therefore TEM/PEM mapping was not applied to the Okanagan habitat modeling.

Provincial Benchmark Rationale

Provincial Benchmark density is at Schoonover Mt, east of Okanagan Falls, near the junction of 201, 200, Dutton and Browning FSRs on TFL 15 (Gyug et al. 2007). One other site with similar densities has been found at Lehman Springs property owned by The Land Conservancy. These are the only two sites known with nesting at these densities in Canada. One other stand (but smaller and less extensive) was found east of Naramata, but was too small to support similar nest densities. High densities have not been found in any other types of stands in Canada.

Provincial Benchmark

Density of 3.1 active nests/breeding pairs per km² east of Okanagan Falls (Gyug et al. 2007).

Ecosection: South Okanagan Basin/North Okanagan Highlands (SOB/NOH)

Biogeoclimatic Zone: IDFdm1 bordering on the IDFxh1 at Schoonover Mt. (Okanagan Falls),

IDFdm1 at Lehman Springs,

IDFdm1 bordering on MSdm1 at Naramata.

Habitat:

In 2003-2005, the Okanagan Falls site was predominantly forested (77%) interspersed with seedtree/partial cuts (23%). Additional timber harvesting at Okanagan Falls in 2006-2007 has lowered the forested portion to 57% of the area, and density fell to Moderate levels (0.85-2.15 nests/km²; Gyug, unpublished data) in 2008/2009 as several former nesting territories appear to have been permanently abandoned. Lehman Springs site was a forest remnant of about 34 ha isolated by hayfields. The site at Naramata was <20 ha in size, and within other types of forests.

The forest stands at all three sites contained 20-40 very large (≥ 60 cm dbh) western larch and Douglas-fir/ha within stands of 200-300 trees >17.5-cm dbh/ha, or 130-250 trees >22.5-cm dbh (Figure 1). The relatively high density of very large trees was the most characteristic property of these stands. Densities of smaller trees were more variable depending on local conditions and extent of Douglas-fir ingrowth since the most recent fire events. Total densities of trees >7.5-cm dbh varied from 390-645 with a mean of 503. Western larch made up 30-55% of the trees >22.5-cm dbh in these stands, and 35-80% of the trees >57.5-cm dbh. The benchmark stands at OK Falls and Lehman Springs had estimated Layer 1 ages of >200 years in the FC attribute database and of 192 years at Naramata, and estimated Layer 1 tree heights of 30-44 m. Site indices for Layer 1 were all >15.8. Slopes at each of these sites were gentle to moderate (<25%).

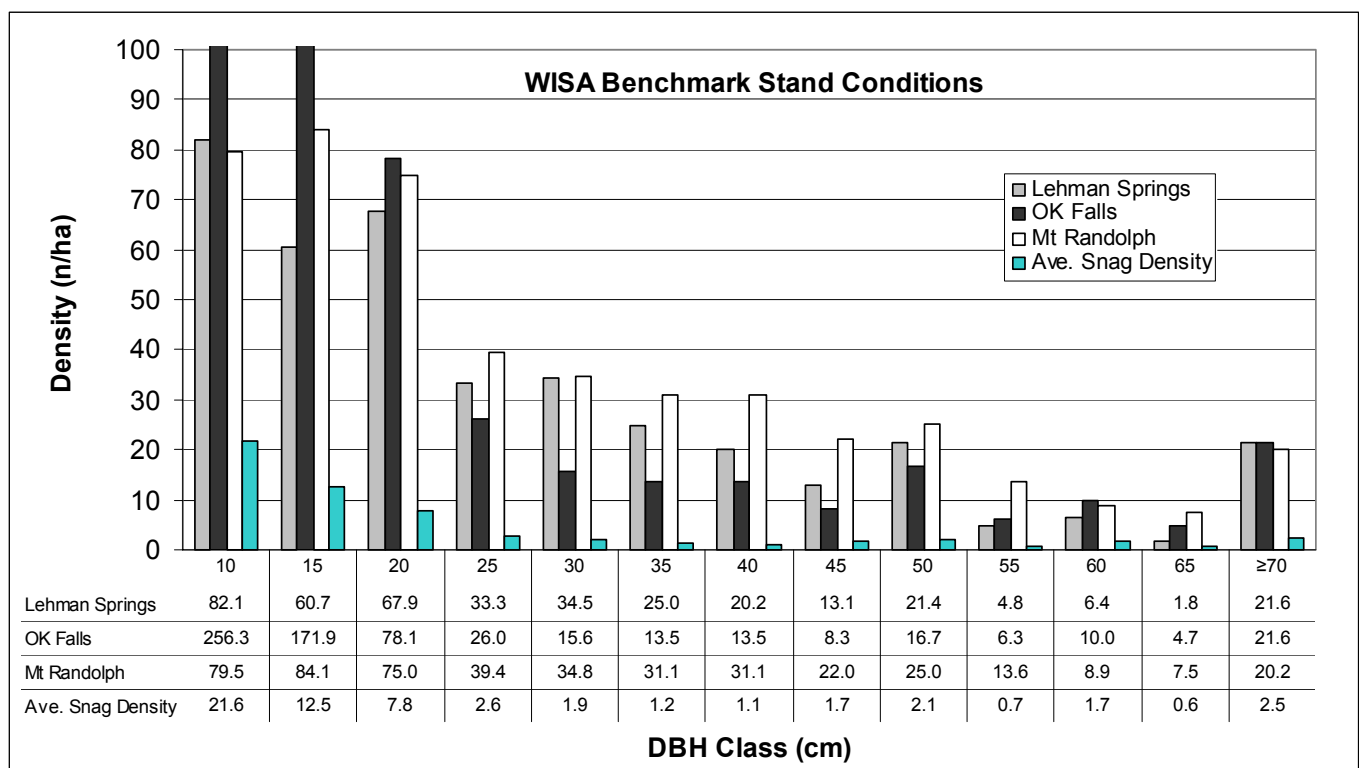


Figure 1. Live tree and snag densities by 5-cm dbh classes in Williamson's Sapsucker benchmark high density and high suitability habitat in B.C. Values for densities in the histogram are provided in the table below the histogram.

HABITAT MODELING using FC/VRI and Plot Data

Regional Habitat values

Ecosections in the project area will be rated against the Provincial Benchmark Ecosections as follows for Williamson's Sapsuckers using the 4-class rating scale:

NOH, SOB, SOH = H (Provincial Benchmarks)

SFH = L

Other Ecosections where Williamson's Sapsucker occurs in B.C. will be rated as:

EKT, MCR, STU, NIB = M

OKR, NOB, HOR, GUU, THB, SHB = L

Introduction and Methods

Based on very intensive research efforts conducted from 2006-2008, WISA habitat in B.C. can be much better described now. This data has yet to be fully analyzed or published.

Habitat plots measuring tree (>7.5-cm dbh) densities, species, size (dbh) and condition (wildlife tree class), and cavity presence and ant nest presence were conducted in the 16-ha area (225-m radius) around most of the nests occupied in 2006 and 2007 in B.C., and some in 2008. Stumps >22.5 cm dsh and logs >22.5-cm large end diameter were also measured. Random sites were sampled for Williamson's Sapsucker presence/absence in 2008 (Gyug 2008), and similar habitat plots were done.

Habitat data at unoccupied random sites within the AO in the Okanagan-Boundary were contrasted with the known nest sites occurring in different nest density classes from 2006-2008. The analyses presented in this paper were a subset of the analyses conducted for the Boundary habitat model (Gyug 2009) as the Okanagan and Boundary AO polygons are contiguous, and the habitat types are not different between the two. Habitat modeling was based on the plot results applied to available GIS variables derived from the GIS database layers. Variables available from the habitat plots included densities by size classes and species of live trees, snags, stumps and logs, volume of logs, densities of trees with nest cavities, and densities of ant nests (either tallied, or assumed based on sign). Variables available from the GIS layers included elevation, slope and aspect from the TRIM Digital Elevation Model, and Forest Cover (FC) attributes (now termed Vegetation Resource Inventory (VRI), even though most of the data consisted of rollovers from the older FC layers). Variables derived from FC attributes included stand age of Layer 1, maximum stand age of any layer, site index, crown closure for any layers >15-m ht., and species composition. DEM and FC attributes were attached to points by converting the layers to grids, and then attaching the cell grid mean or maximum to the point.

Analyses for Habitat Modeling

The first step in analyses were one-way ANOVA contrasts for each variable by nest density: High, Moderate, Low or Nil (unoccupied random sites). Some unoccupied random points that would have been selected for plots were not sampled because they had >70% composition of lodgepole pine in the FC attribute layer, or because there were no standing live trees at all on the site. No WISA nests had been found where lodgepole pine composed >70% of the stand, or where there were no trees at all, so these points would not have contributed any new information to the model, i.e. these points were going to be excluded from the final model at any rate. Therefore the basis of the habitat models already excluded areas where lodgepole pine dominated, and where there were no standing trees.

Table 5. Tree species composition of the 16-ha Williamson's Sapsucker nest territories in the Okanagan-Boundary (n = 66) within each class of woody structure.

Tree Species	Tree Species Composition within Category (%)						
		Small Live Trees	Large Live Trees	Very Large Live Trees	Large Snags	Logs	Cut Stumps
	Size Range (DBH)	8-22 cm	23-57 cm	≥58 cm	≥23 cm	≥23 cm	≥23 cm
	(n)	(3546)	(4135)	(624)	(802)	(1897)	(2454)
Western larch		20.3	25.2	57.0	18.7	29.6	24.4
Douglas-fir		48.9	56.3	36.9	53.5	38.2	52.5
Hybrid white spruce		9.1	11.7	2.7	7.1	7.8	10.2
Lodgepole pine		18.6	2.7	0.0	9.5	19.0	11.9
Trembling aspen		0.9	1.2	0.3	4.6	1.5	0.0
Ponderosa pine		0.3	1.1	2.3	1.0	0.6	0.3
Other species		1.9	1.8	0.8	5.7	3.0	0.6

Not every breeding territory is occupied every year, so that a certain percentage of breeding territories may have been misclassified based on presence/absence within 225-m of a random point in 2008. Occupancy rates of breeding territories have been shown to be 50% on the long term (Gyug et al. 2007) and about 70% on a year-to-year basis (Gyug, unpublished data based on 2006-2007). Therefore any habitat model is not likely to be more than 50-70% efficient at classifying random sites as truly unoccupied, or as possible nest sites. Depending on project area, 20-33% of the randomly selected sites were found to be occupied in 2008, so that model efficiency (nest vs. unoccupied) has probably been significantly improved by deleting these sites from the random sample alone, but still may only be 50-70% efficient at best.

Tree species composition around nests was also examined graphically for trends. Based on this examination in early 2008 of the nest plot data from 2006-2007 (Fig. 2), sites where lodgepole pine made up >60% of the crown closure were not considered to be WISA nesting habitat. No habitat plots were completed around random unoccupied sites where PI made up >60% of the forest cover layers. Table 5 gives a complete breakdown of tree species composition at WISA nest plots.

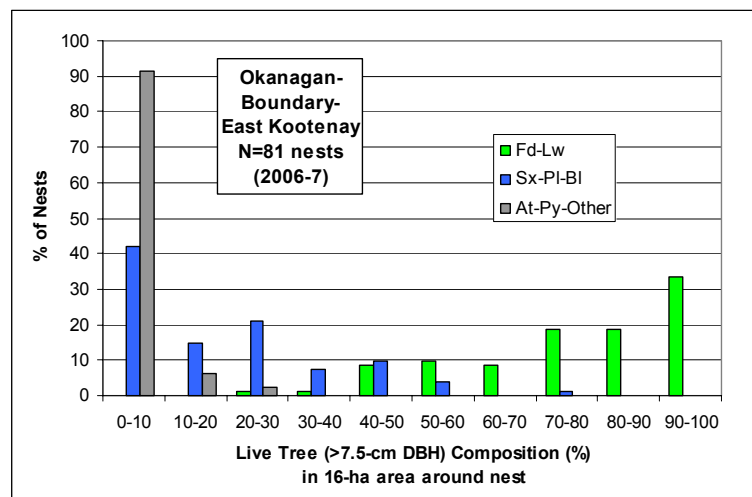


Figure 2. Tree species composition within 225 m of Williamson's Sapsucker nest trees, 2006-7.

HIGH Suitability Habitat

In or near provincial benchmark habitat (or similar stands) was the only type of site where High densities occurred. The preliminary habitat model used for High suitability habitat based on GIS layers is in Table 8. With the slope adjustment, there were 668 ha of Highly suitable habitat, or 2.3% of the gross area of 28857 ha (Fig. 3, Table 9). This estimate of High suitability habitat did not include some recent (2006) cuts in the benchmark habitat at OK Falls, and some blowdown in the same area in 2008, which will be adjusted during aerial photo interpretation.

Even though a polygon may be mapped as High suitability, it would still need to be field assessed for actual high suitability based on:

1. 125-250 live trees >22.5-cm dbh/ha,
2. <650 live trees >7.5-cm dbh/ha,
3. >20 very large live trees >57.5-cm dbh/ha, which include some western larch
4. >30% western larch composition of live trees >17.5-cm dbh
5. standing very large snags averaging 10% or more of the very large live tree density.

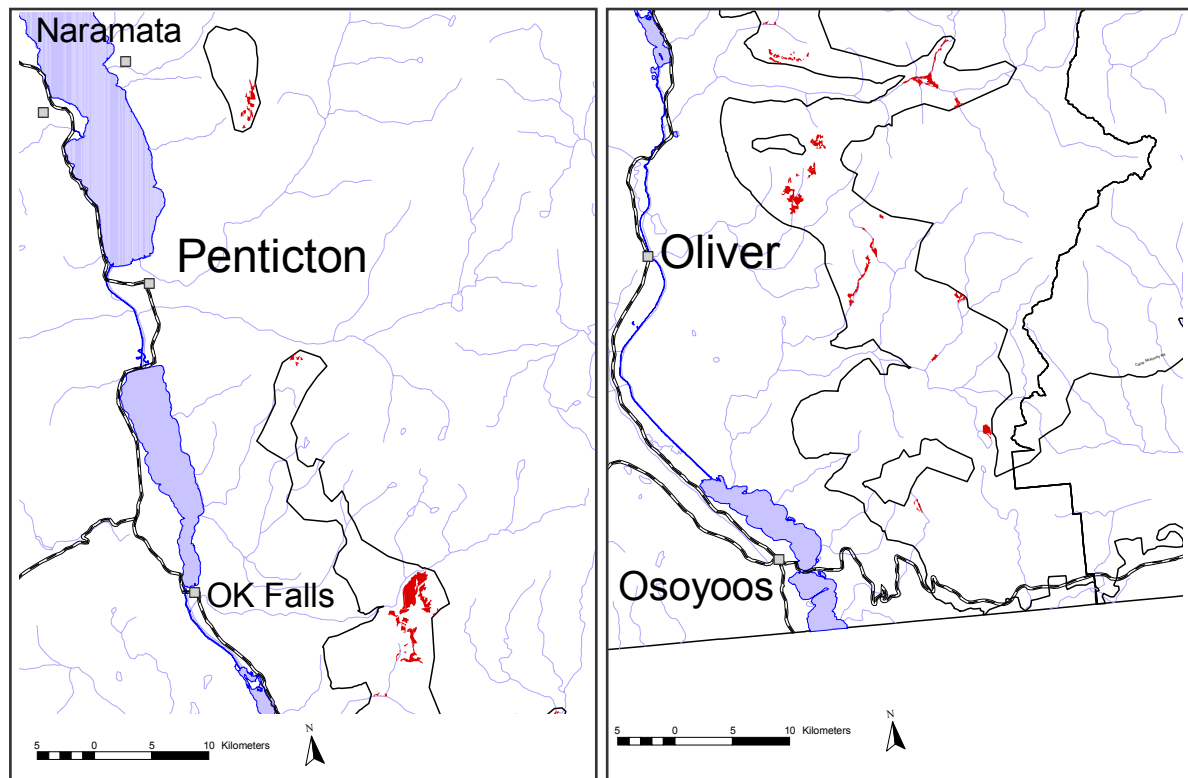


Figure 3. Williamson's Sapsucker Area of Occupancy (2008) within the Okanagan showing the High Suitability modeled (red) habitat based on Forest Cover attribute GIS layers, and excluding areas with slopes >30%. Area north of Vaseux Creek on the left, and south of Vaseux Creek on the right.

Characterization of Habitat Suitability

High density nest sites were characterized by moderate large tree densities (Table 6; D_LT_L) compared to low density sites where large trees were less dense, and unoccupied sites where trees were more dense. High density sites were characterized by higher densities of very large trees, very large snags and very large woody structures in general (D_VL). Stand tables (Fig. 4) show the “top-heavy” stand structure of High density and High suitability sites compared to Moderate, Low or Nil with higher densities of trees >57.5-cm dbh. There are also higher densities in the 40-50-cm dbh classes for High and Moderate sites than for the Low and Nil class. Other classes of sites had progressively greater densities of small trees (7.5-17.5-cm dbh) as the nest density and habitat suitability declined (Figure 6).

Nest sites had lower densities of lodgepole pine than random sites (Table 6), even though the random sites with the highest lodgepole pine densities had already been excluded from the study by design. However the differences in these densities were relatively low (10 trees/ha compared to 25 trees/ha) and would therefore not likely form good variable for use in GIS FC layer modeling where percentage composition of tree layers is rarely that precise. Nest sites had higher percentages of very large western larch than random sites, and while densities were low all around, the percentages were relatively large. Percent tree composition of spruce and balsam (mostly spruce) was higher at nest sites than at unoccupied sites, probably because nest sites tended to be better growing sites including creek bottoms where there were more spruce trees.

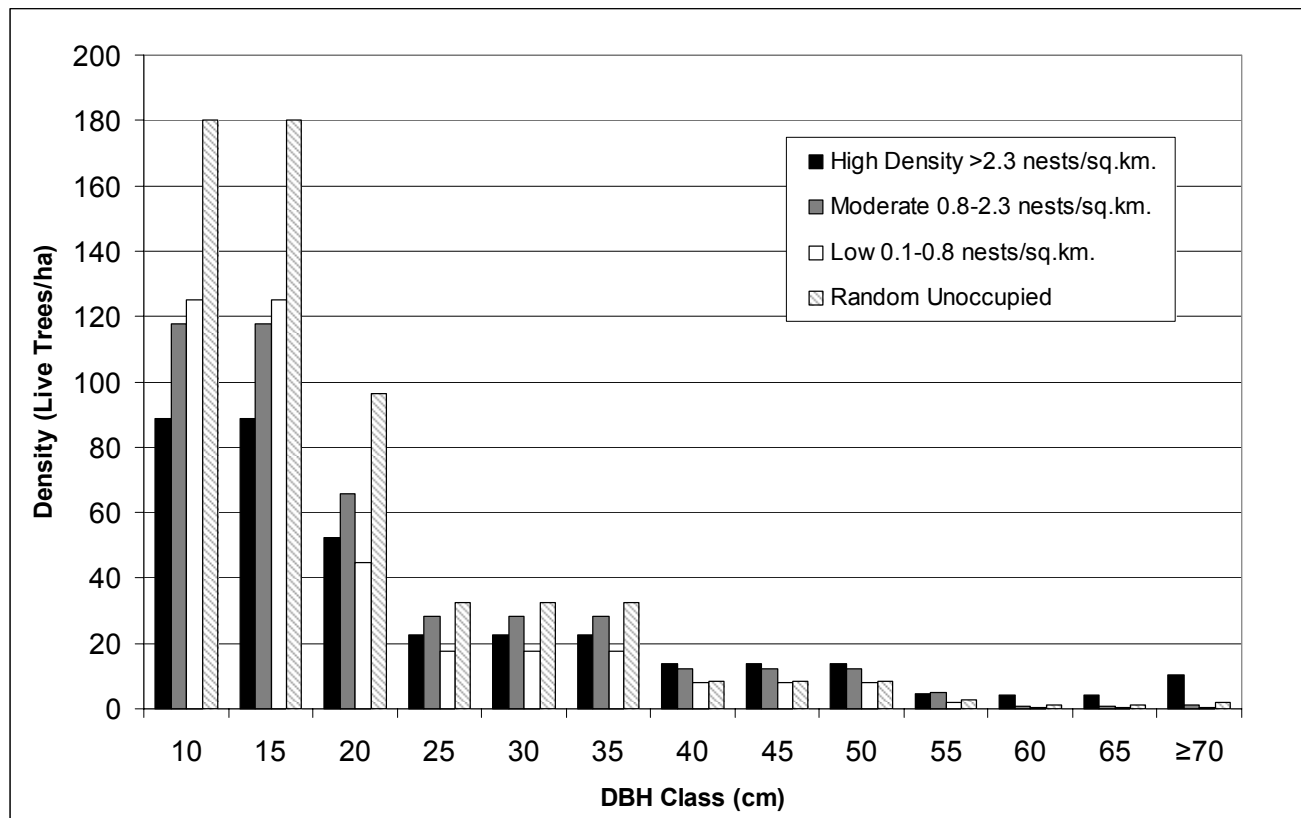


Figure 4. Mean stand structure of live standing trees within 225-m of Williamson's Sapsucker nest sites by nest density class and for random unoccupied sites within the Area of Occupancy in the Okanagan-Boundary.

Table 6. Means for plot and forest cover attribute variables for different densities of Williamson's Sapsucker nests in the Okanagan-Boundary where densities were significantly different at $p = 0.05$. Means followed by like letters were not significantly different at $p = 0.05$ using Scheffe's post-hoc test. If no letters present, then there were no significant post-hoc differences among means. Moderate or Low Density sites ($n = 5$) where there were High Suitability stands (based on high density of veteran western larch trees) present, but these were too fragmented or small to support high nest densities in a wide area have been included with the High for this contrast.

Variable Name	n	Nest Density				p
		<u>High</u>	<u>Moderate</u>	<u>Low</u>	<u>Unoccupied</u>	
		12	39	13	51	
Variables from habitat plots						
D_LT_S		175	235	250	360	0.028
D_LT_L		166 ab	192 ab	123 a	222 b	0.002
D_LT_VL		18.4 a	3.0 b	1.1 b	3.9 b	<0.001
D_LT		184 ab	194 ab	125 b	226 a	0.003
D_LT_GT8		361	430	374	591	0.006
D_SN_VL		2.5 a	1.2 b	0.6 b	1.0 b	0.001
D_VL_UP		30.7 a	15.5 b	11.8 b	15.6 b	<0.001
D_VL		32.5 a	19.0 b	13.2 b	19.9 b	0.002
P_LT_SB		20 a	12 ab	14 ab	6 b	0.005
D_LT_FD		82	117	64	113	0.048
D_LT_PL		9.9 a	8.1 ab	7.1 ab	23.6 b	0.041
D_LT_VL_FD		7.2 a	1.6 b	0.6 b	2.1 b	<0.001
D_LT_VL_LW		10.5 a	1.0 b	0.4 b	1.3 b	<0.001
P_LT_VL_LW		57.4 a	32.2 ab	43.4 ab	22.9 b	0.02
D_E_NEST		0.76 a	0.18 b	0.10 b	0.20 b	<0.001
D_E_ANT		34.2	27.1	23.9	33.7	0.042
V_LG_L_MN		28.6 ab	22.7 a	11.6 a	34.7 b	0.001
V_LG_VL_MN		9.6	6.3	3.2	11.9	0.018
V_LG_MN		39.5 ab	29.2 a	14.7 a	46.5 b	<0.001
Variables from DEM or FC/VRI						
DEMSLOPEP		13.5	16.7	14.2	21.9	0.026
CROWNGT15		52.1 a	41.0 b	19.2 c	33.5 abc	0.002
MAXAGE		220 a	125 b	106 b	109 b	<0.001
L1_AGE		219 a	114 b	78 b	98 b	<0.001

For variable names: D = Density, P = Percentage, LT = Live Trees, SN = Snags, ST = Stumps, S = Small (7.5-17.5-cm dbh), L = Large (17.5-57.5-cm dbh), VL = Very Large (>57.5-cm dbh), UP = trees, snags and stumps, D_VL includes trees, snags, stumps and logs >57.5-cm dbh.

D_E_Nest and D_E_Ant are estimated nest tree and ant nest densities based on densities and suitability of woody structures.

DEMSLOPEP indicates Percentage slope derived from Digital Elevation Model.

For variables derived from the Forest Cover attribute layer: L1 = Forest Cover Layer 1, MAX = Age of oldest stand layer, CROWNGT15 is crown closure sum for all layers ≥ 15 -m ht.

Log volumes were higher at unoccupied sites than at other sites (Table 6), partially because many unoccupied sites were on densely forested north aspects (with young stand ages). These younger and dense stands still had a high volume of CWD from the stand-initiating fire that may have been 60-100 years previous. In the older stands where WISA were generally found, the CWD from the stand-initiating fires had generally decayed to the point where they were not tallied.

Age of oldest stand layer (MAXAGE; Table 6) at the high density nest sites were significantly higher than at any other sites. Age of layer 1 was significantly higher at high density nest sites compared to moderate and low nest sites, and unoccupied sites. The proportion of very large larch in the stand was much higher at high nest density sites than at other sites, and very low at unoccupied sites. This was partly because there was no very large tree layer at all at many unoccupied sites, so these had been assigned a zero value for this variable.

Slopes were lower at nest sites than random sites (Table 6). However, to test if this was a spurious factor representing ease of finding nests on level ground than in broken or steep terrain, the 2008 random site data was analyzed alone where this bias would not have been evident since the results were based only on WISA detections, and not necessarily on finding an active nest. Two-factor ANOVA was used to contrast the slopes at random sites found to be occupied by WISA (where we had no habitat plot data) to the slopes at unoccupied sites. The result was found to be significant ($F_{1,135} = 3.85, p = 0.05$). However, the differences were more pronounced in the Boundary (22.4% slope vs 16.1%) and East Kootenay (19.4% vs 12.1%) than in the Okanagan (18.1% vs 17.3%).

Possible differences in aspect were examined using Chi-squared contingency tables for any sites with slopes >10% in the Okanagan. There were significant differences in aspect for nests and random sites (which included both occupied and unoccupied) (Chi-squared = 14.3, $p < 0.05$). Fewer nests (2 of 57) were on north aspects (315-045 degrees) than were random sites (12 of 36).

While sampling random points in the spring for WISA presence, and later for habitat plots, it appeared that many of the unoccupied sites lacked any suitable nesting trees or snags for WISA (see Gyug et al. 2009a). The lack of nest trees at some sites may make any analyses difficult to interpret because if that is a controlling factor, then sites may be suitable for all other stand characteristics, but will be unoccupied if there are no suitable nest trees.

Derivation of a Suitability Model based on FC/VRI and DEM attributes from the Plot Data

The most significant differences were between High density sites and all the other sites (Table 6), and this has already been incorporated into the characterization of High density sites using FC/VRI attributes.

It was more difficult to characterize the Moderate, Low and Unoccupied sites consistently on any single variable. The means between High, Moderate and Low progressively (and significantly) declined only for crown closure, but there was a significant decline in log volume, age, and very large snag density only from High to Moderate/Low. However, there was not another consistent drop to the unoccupied sites, and the means for the unoccupied sites were often in the mid of the other means. One conclusion might be that many of the unoccupied sites may be suitable as Low or Moderate habitat, but lack suitable nest trees.

Using the standard deviations as a guide to the limits of the criteria to separate densities/suitability (Table 7), a preliminary habitat suitability model (Table 8) based only on FC/VRI attributes was developed from the mean values for each variable. This model was applied spatially to the Okanagan FC/VRI attributes and shapefile (Fig. 5).

Table 7. Ranges of stand conditions used to define Williamson's Sapsucker habitat suitability based on observed means and standard deviations in the Okanagan-Boundary. In a normally distributed variable, 68% of observations will be within one SD above and below the mean. See Table 6 for explanations of variable names.

Variable Name	Comments	<u>High</u>		<u>Moderate</u>		<u>Low</u>		<u>Unoccupied</u>	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
D_LT_S	Moderate to Low densities are better.	175	135	235	134	250	316	360	294
D_LT_L	Moderate densities required. At low tree densities (<88), nest productivity will be reduced, and at high densities (>400), sites will not be occupied	166	41	192	61	123	71	222	110
D_LT_VL	Higher values better; VRI polygons with 20-40 VL trees/ha were benchmark habitat.	18.4	6.0	3.0	3.4	1.1	0.9	3.9	5.0
D_LT	Sum of D_LT_L + D_LT_VL Approximate range of densities occupied = 50-400.	184	44	194	62	125	71	226	111
D_SN_VL	10-15% of VL tree density is best. This indicates a healthy old stand, rather than one that is declining rapidly due to pest outbreaks, etc, or a previously harvested stand that has very few nesting opportunities	2.5	1.7	1.2	1.1	0.6	0.7	1.0	1.5
D_VL_UP	Higher better	30.7	9.6	15.5	9.6	11.8	7.6	15.6	12.8
D_LT_PL	Lower better	9.9	11.6	8.1	15.1	7.1	13.1	23.6	39.0
D_LT_VL_FD	Higher better	7.2	21	1.6	35	0.6	42	2.1	33
D_LT_VL_LW	Higher better	10.5	4.1	1.0	1.8	0.4	0.8	1.3	2.9
P_LT_VL_LW	Higher better	57.4	5.4	32.2	1.8	43.4	0.5	22.9	2.8
D_E_NEST	Higher better	0.91	0.36	0.18	0.15	0.10	0.06	0.20	0.22
D_E_ANT	Does not appear to be a controlling factor except in extreme circumstances since many unoccupied sites had high ant densities	34.2	16.5	27.1	13.5	23.9	13.1	33.7	14.2
V_LG_MN	Higher is better within occupied sites, but may be higher in unoccupied sites due to local stand history	39.5	25.0	29.2	18.8	14.7	9.4	46.5	30.7
DEMSLOPEP/ ASPECT10	South steep (>25%) slopes tend to be unforested, and north steep (>10%) slopes too densely forested	13.5	6.7	16.7	13.5	14.2	5.3	21.9	11.9
CROWNGT15	More is better, but there are limits as very high closures are associated with very high tree densities (and young ages, and north aspects)	52.1	15.4	41.0	24.0	19.2	25.5	33.5	25.9
MAXAGE	Older better- but this is generally not well mapped as veteran layer	220	64	125	75	106	109	109	70
L1_AGE	Older is better (more VL trees)	219	64	114	61	78	90	98	68

Table 8. Preliminary Habitat Suitability Model for the Okanagan for Williamson's Sapsucker based on Forest Cover/VRI attribute and DEM layers.

Input Data	High (H) (1)	Moderate (M) (2-3)	Low (L) (4)
Rank 1 Layer Projected Age	>190 years	>120	
Rank 1 Layer Projected Ht	>29.0 m		
Rank 1 Layer Site Index	>15.0		
Rank 1 Layer Crown Closure	>30%		
Crown Closure $\geq$ 15.0 m ht		>20%	
Age of oldest layer	>190 years	>125 years	>80 years
Tree Species	Fd or Lw leading, contains Lw	Fd or Lw present, but if in IDFxh1, then must contain both Fd and Lw	Fd or Lw present
Cw %.	<10%	<10%	<10%
Sum of PI and BI % composition of Layers >15 m height	<30%	<30%	<60%
Sum of Fd and Lw % composition of either L1 or L2			>40%
Upgrade from VL to L if:		Age of oldest Lw layer >125 yr (even if PI >60%) NP but age>125, on south or gentle slope, contains Lw, Crown Closure >10%	
		Contains Fd or Lw, PI <55%, At >4%, and age of At layer >55 yr	
Reduce one level if:	Slope >30%	Slope >30%	Slope >30%

Notes/Assumptions:

- Table only applies to potentially forested polygons:
 - Lake, Meadow, Alpine, Alpine Forest, Clearing, Cultivated field, Glacier, Ice, Gravel Bar, River, Claybank and Urban were assigned Nil (N) (6),
 - Open Range, Rock, Non-productive, or Swamp were assigned Very Low (VL) (5) because these may be partially forested.
- Any polygons not otherwise assigned to H, M, or L using the table were assigned VL (5).
- Steep (>30%) polygons were only applied to model if >1 ha in size.
- If forest cover polygons were split by slope and became <1 ha in size, they were dissolved back into the parent FC polygon.
- An assumption of this classification is that likely nesting trees (primarily veteran Lw >300 years old) are more common and abundant in older stands (>80 years old). The FC database tends to be rather conservative in estimating age of these trees, and rarely puts them at their correct age, even when they dominate a layer. In the Okanagan AO, most older stands will contain these trees as the stands are the product of a mixed fire regime and were therefore not even-aged. In areas where most stands are even-aged, this classification will not correctly classify habitat, because the assumption that veteran Lw >300 years old occur in most stands >80 years old will not be correct.
- In this model, Moderately High (2) and Moderate (3) of the 6-class rating scale have been grouped. However, if Moderately High were to be mapped, the criteria would be the same as for High, except Rank 1 height and site index criteria would be removed, and crown closure of Rank 1 would be >20%.

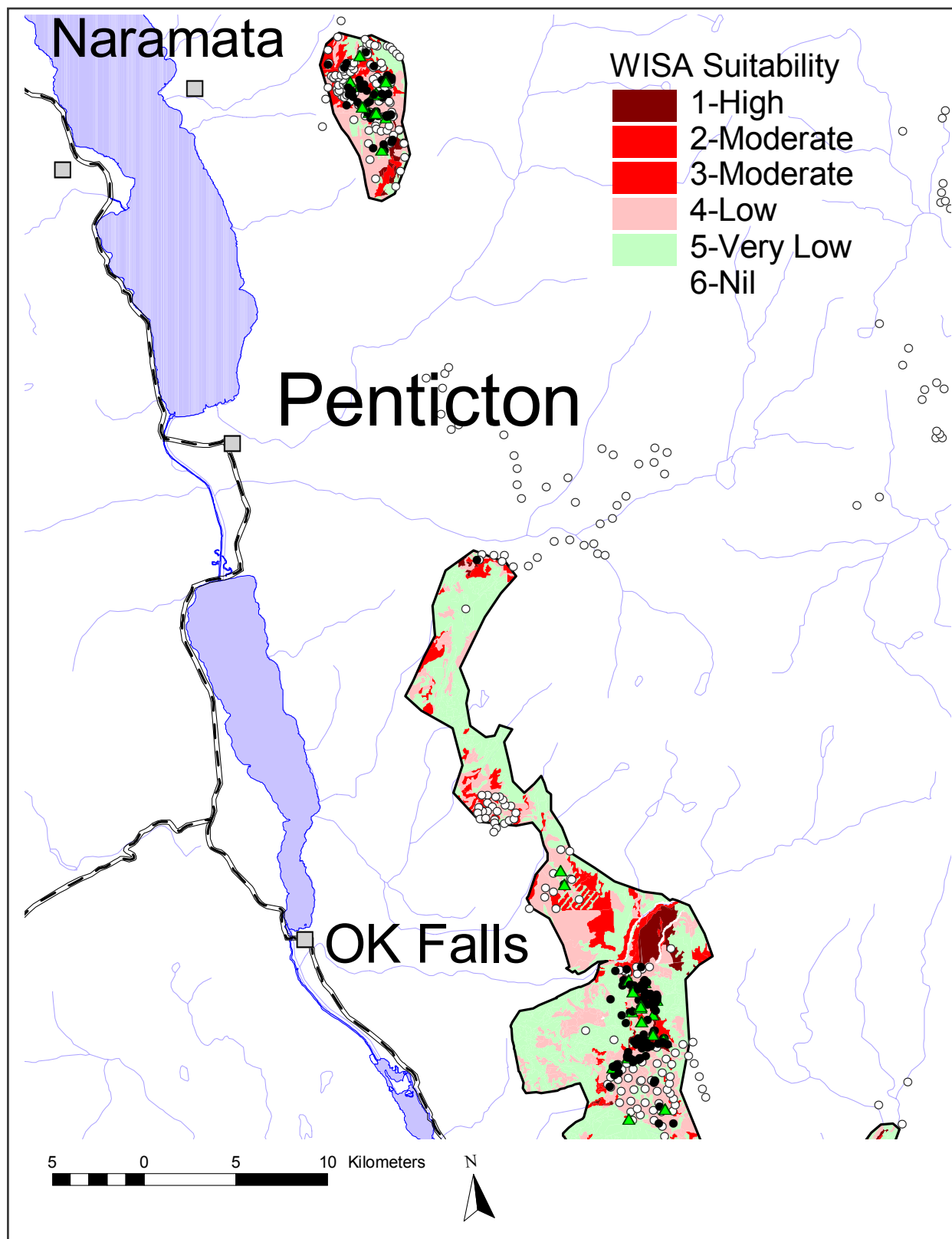


Figure 5A. Williamson's Sapsucker Area of Occupancy (2008) north of Vaseux Creek within the Okanagan-Shuswap Forest District showing the preliminary model of habitat suitability habitat based on Forest Cover attribute GIS layers only (Table 8). Shown are WISA nests (green triangles), other WISA observations (black dots), and unoccupied CPB and Random points (open circles).

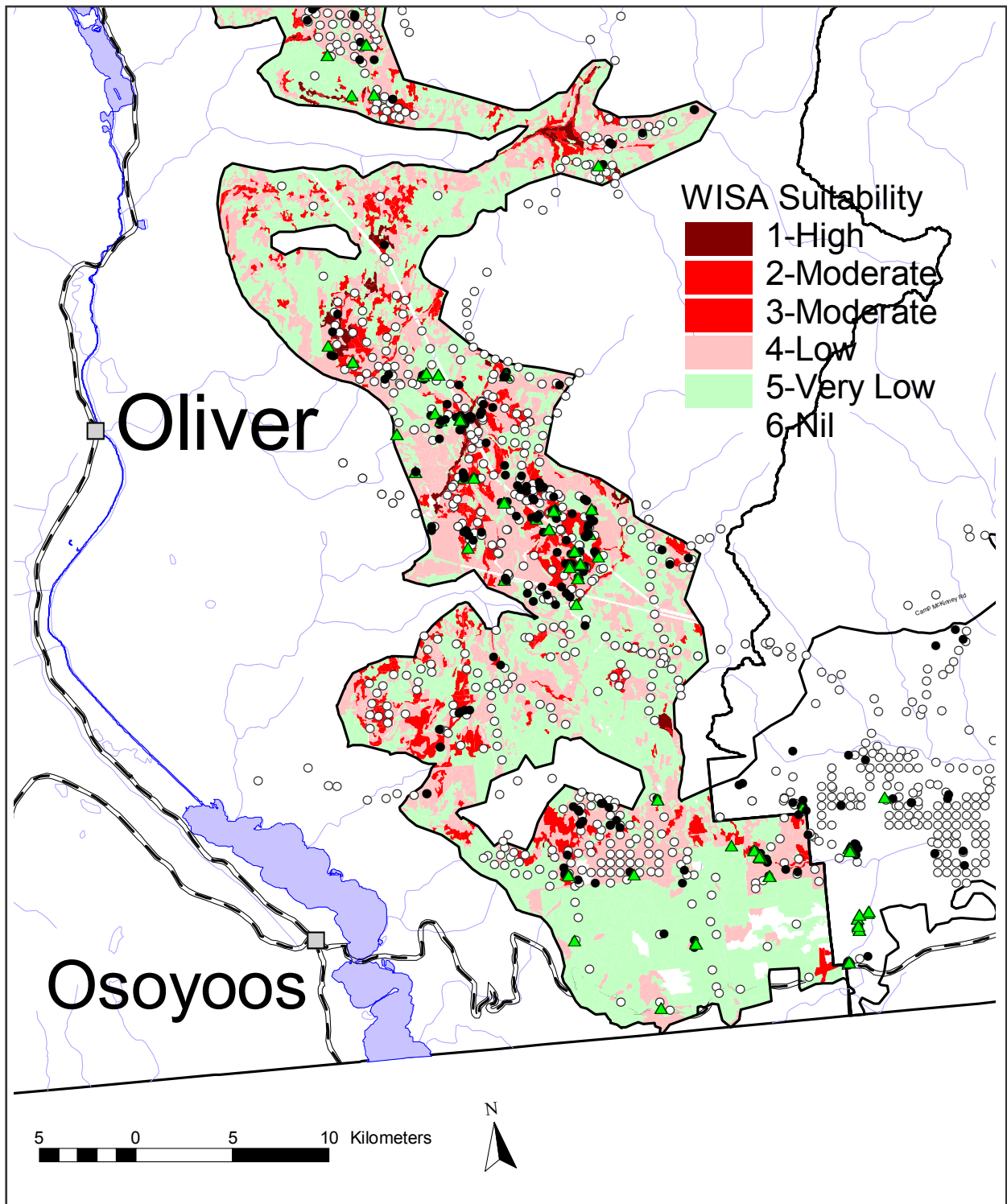


Figure 5B. Williamson's Sapsucker Area of Occupancy (2008) south of Vaseux Creek within the Okanagan-Shuswap Forest District showing the preliminary model of habitat suitability habitat based on Forest Cover attribute GIS layers only (Table 8). Shown are WISA nests (green triangles), other WISA observations (black dots), and unoccupied CPB and Random points (open circles).

Ratings Adjustments:

After the initial run of the Forest Cover/VRI (November 2009), each classification error of a nest in Very Low or Nil habitat, or of an unoccupied Random point in High, Moderate or Low habitat was examined to determine the source of the error, and how it might be corrected. Errors and possible corrections were identified (Tables 9 and 10).

Table 9. Classification errors of Williamson's Sapsucker observations in preliminary (November 2009) FC/VRI model for the Okanagan TSA and TFL 15 giving the Site ID for each error.

Nest Errors	WTY Errors	Obsn Errors	Type of Error	Correctable on complete AO basis using Aerial Photos?
Correctable from Base GIS Layer database				
WN010			Ew wet area (mapped as EP 54) with old High grading-nest was from 1996, but never used since adjacent Lw forest ST cut (where male was observed foraging).	Yes, add correction if L1 contains EP or EW to deciduous corrections if L1 Age >50.
Base Layer Mapping Error that can be corrected by revising linework				
WKN026			Mapping Error: Recent VRI has lumped vet Lw 201 yr stand with adjacent marsh.	Yes, revise recent VRI to old FC boundaries for any sites with mapped vet Lw >190 years.
WKN020			FC Mapping Interpretation Error: Mapped 40-m into OR polygon although should be part of Low stand 40-m away	Yes, remap boundaries of OR polygons to include sparsely treed sites adjacent to forested H/M/L polygons
[WN009 WN315 WN201]			1. Nest has not been used since site was burned (2003) Currently mapped correctly as VL in burn. Was correctly mapped in 1996 (old-growth Lw stand) when nest was used. 2. Clearcut since last mapping update 3. Cleared private land since last mapping update	These nests are to be left out of validation as habitat has been significantly altered since nest was last used. Therefore no correction required, but layers are to be brought up to date for burns and recent cuts using orthophotos, supplied Cutting Permit shapefiles, or Landsat.
		W0180	Mid-aged PI forest mapped incorrectly as clearcut	Double-check that clearcuts are mapped correctly—may have to alter linework in some places
Correctable using Aerial Photos—forests and partial cuts with vet Lw				
		W0076 W0079	Partial cut (High graded) 1965, Age 69, can see scarce (<2/ha) vets on photo	Yes, include old HG and partial cuts if vets visible on photos.
WKN009 WN041		W0294	Scarce unmapped Lw vets (<3/ha) and PI 50-60% composition WKN009, WN041 PI60Lw40 Age 107 W0294 PI75%, CC10%, logged 1985, slope >30% (no correction wanted—was probably in At patch to north)	Yes, upgrade from VL to L if Lw vets visible and Lw>29%, and slope <30%
WN043			Scarce unmapped Lw vets in old partial cut (1973) 15% Crown Closure, 53 years mapped age—Nest in remnant unlogged Lw vet stand on steep gully wall that was too small to map, and too small to be classified as slope>30%.	Yes, unlogged vet patch visible on photo on steep gully wall.
Correctable using Aerial Photos—ST Cuts and vet Lw				
WN042 WKN014 WN040 WN236 WN203		WK028 W0302 W0305 W0306 W0309 W0073 WK004 WK006	Scarce unmapped Lw vets (n=4 nests) and remnant old At patches (n=1 nest) in ST cut (8-16 ST/ha) and always within 100 m of dense forest stands—often has understory reserve as well.	Yes, add in all ST cuts if c. 2-25ST/ha but only including buffer of 140 m from dense forests for nests (although observations may be up to 250 m from dense forests).
WN226	WTY040	WK133	Scarce unmapped Lw vets in recent partial cut stands (25-60 ST/ha)	Yes, add in entire recent dense (contains both over and understorey Lw) ST cuts
		W0293	W0293 124 yr Lw vets in ST cut (3% Crown closure, GIS as 35 stems/ha)	1 year below 125 year Lw cut off date—Can't correct from GIS layer without major revisions of assumptions. Would be corrected if Lw are determined to be large/old vets during aerial photo interpretation.
	WTY055 WTYK016	W0097 W0169	Partial cut 1981, mapped as 77 years (released trees) when cutoff for Low was 80 years	Partially correctable since a few Lw vets can be seen on aerial photos.

Uncorrectable or no correction warranted				
WN306			Nest in Lw stub in partial cut, logged 1969-71, although mapped as 63 yr, 24 m ht	No. Would be correctable only by assuming all partial cuts (>100 remnant trees/ha) contain some possible nesting trees/stubs that are smaller than visible vets. However this would basically include any forested or partially forested area in the AO (the majority of the AO) except those that are clearly young single-aged stands.
		W0171	Slope > 30%, otherwise would be L-linework should be corrected since this corner of this polygon belongs in adjacent M (L) polygon.	No, this type of very minor (<1 ha) boundary correction is beyond the scope of this project.
		W0133 W0279 WK126	<20 m from a boundary	Not correctable for observations only since not nesting habitat and adjacent to actual habitat
		WK079 WK098 WK097	Slope >30%, otherwise would be L. Slope >30%, Age 192, CC20%, so VL	Not necessary to correct—location is vague. WISA just visiting, not necessary to correct
		WK094	Age 64, PI60%	Not necessary to correct—WISA just visiting.
		WK038	DLC cut 1970-VL—no Lw vets in this stand	Sap trees only (?) in partial cut—not correctable?
		W0065	In mapped younger forest (no mapping error)	Vague location, no correction necessary.

Table 10. Classification errors of unoccupied Random Points (2008) in preliminary (November 2009) FC/VRI model for the Okanagan TSA and TFL 15.

Point ID	Type of Error	Correctable on complete AO basis using Aerial Photos?
Correctable using Aerial Photos based on presence of vet Lw or surrounding stand type		
RanK011	Lw ST 199 yr 2% CC	Yes, can remove ST cuts if surrounded by young (<80 yr) PI stands
RanK055	L1Age 146 20% CC but has been partially cut and denuded of any potential nest trees	Yes, there are no vets visible in this partial cut, and this was confirmed by field plots. So can change suitability to VL on that basis.
RanK083	5-6 ha burn island + too heavy salvage in adjacent burn	Yes, Remove burn islands if they are also heavily burned, are isolated, and burn outside is too heavily salvaged. Double-check that 2003 burns are up to date-there are a few remnant un-updated polygons.
RanKP056 RanKP091 RanKP097 RanKP126 RanKP127	Recent heavy partial cutting-no vet Lw left, or for RanKP097, 126 & 127 no mature trees left at all	Yes, update mapping to reflect recent cutting on private land where either no vets or no trees are visible on orthophotos.
Uncorrectable or no correction warranted		
SprK129 RanK070 RanK065 SprK117	Habitat looked good (High to Moderate) but WISA absent	No, habitat looks suitable so no correction warranted. WISA may be expected to be absent from about 50% of suitable sites.
RanK103, RanK016 SprK122 SprK111	Habitat looked OK (Low) but WISA absent	No, habitat looks suitable so no correction warranted. WISA may be expected to be absent from about 50% of suitable sites.
RanK015 SprK115 SprK106	Lw 192 yr but lacking any suitable veteran nest trees (previous high grading)	No. Scarce (2-5/ha) Lw vets can be seen on aerial photo, and were detected in field plots. That none of them happen to be suitable for nesting is not possible to correct.
RanK101	Old high grading mapped as 122 yr FdPyLw-no suitable nesting vet Lw left	No, some vets were left, and were detected in field plots and can see in aerial photos, therefore cannot correct on the basis that none of them may be suitable for nesting.

Based on the errors classified in Tables 9 and 10, the following adjustments were made to the FC/VRI habitat suitability model based primarily on interpretation of colour stereo aerial photos, and of Landsat 5 with deciduous enhancement to assist in determining presence of deciduous tree patches. Total area upgraded from unsuitable to suitable was about 1700 ha, and downgraded to unsuitable from suitable was about 3100 ha. Additional typing was done using aerial photo interpretation for two blocks of private land within TFL 15 for which no typing was previously available.

Corrections made from existing FIP database or orthophotos/Landsat:

1. Upgrading from Unsuitable (VL) to Suitable (L) (107 ha)
 - a. Using FIP database, upgrade from VL to L if Ep/Ew and Lw occur in L1, not NP, slope <30%, Crown closure >25% and >10 m tall, and >50 years old (75 ha from VL to L)
 - b. Reinstated any lumping of polygons that occurred during the rollover from FC to VRI mapping where that lumping puts suitable stands into non-suitable types (3 ha) (Only an area of about 1000 ha was remapped during the rollover. For the most part large polygons were split, this particular lumping to create an error was unique.)
 - c. Remapped OR polygons on Anarchist Mt to ensure they were accurate—revise densely treed Py/Fd/Lw portions contiguous with adjacent forested polygons (30 ha from VL to L)
2. Downgrading from Suitable (H/M/L) to VL or Suitable (H/M) to Suitable (L) (2530 ha)
 - a. Brought mapping up-to-date (2009) for any recent timber harvesting (434 ha)
 - i. 327 ha downgraded from H/M to L
 - ii. 51 ha downgraded from H/M/L to VL
 - iii. Remainder was no change to suitability class
 - b. Revised mapping in the 2003 burns (Vaseux and Anarchist Mt) to reflect burn extent within remnant patches, and to reflect status of salvage mapping (244 ha from H/M/L to VL)
 - c. Revised and brought VRI mapping on private lands up to date (1852 ha from M/L to VL)

Corrections made using aerial photo interpretation of veteran trees/crown closure:

3. Upgraded from Unsuitable (VL) to Suitable (L) only for sites with slope <30% (1536 ha)
 - a. ST cuts (>2-50 ST/ha) upgraded from VL to L if Lw or At vets present in ST cut to a limit of 150 m from adjacent H/M/L heavily forested stand (>30% Crown Closure) (or 200 m if surrounded on all sides by forested stands (1023 ha)
 - b. Mature At patches upgraded from VL to L if > 1 ha and adjacent to Fd/Lw forest types (i.e., not Pl/Se) (100 ha)
 - c. Old high-graded (generally prior to mid-1960's), partially cut stands (generally from late 1960's to 1990's), or fire-origin (>70 years old) upgraded from VL to L if veteran trees present (>0.5/ha) (413 ha)
 - i. Revised polygon attributes if Lw vets scattered throughout at densities of >0.5/ha
 - ii. Split portions of the polygon if vets were clumped and if >1 ha
4. Upgraded from Unsuitable (VL) to Suitable (L) for sites with slope >30% if veteran Lw were more abundant than in VRI database (70 ha)
5. Downgraded from Suitable (H/M/L) to Unsuitable (VL) (605 ha)
 - a. ST cuts, even if ST Lw vets present, if surrounding sites are VL (young Pl stands) (15 ha)
 - b. <5% crown closure (>15 m ht) and not adjacent to intact forest stands—usually at lower edge of AO adjacent to open Py slopes (60 ha).
 - c. For ST cuts, partial cuts or high grading, but where no vets could be detected on aerial photos, revised downward to VL (530 ha)

Reliability/Verification of Models

The modeling is considered to be very reliable based on:

1. the extensive sampling covering 35% of the Okanagan AO by call playback points,
2. an additional 5% of the AO covered by other search methods
3. the number of nest sites, breeding territories and other observations, including negative data points where the species was not found, and
4. the aerial photo corrections made to the forest cover mapping to increase the accuracy of the mapping, particularly of rare habitat elements (large veteran Lw in particular).

There was very little High suitability habitat in the Okanagan, accounting for only 2.1% of the AO, and 5 of 72 known nest trees (Table 11). Overall High, Moderate and Low suitability habitat accounted for 46% of the AO (Table 12). The modeling after aerial photo corrections was fairly successful at classifying nesting and other territories (93-97%), but not quite as successful for other observations and random occupied points (72-77%; Table 12) that were not necessarily connected with breeding territories. This may have been expected since the birds may have wandered >500 m from nest sites to respond to the call playbacks at the random points.

The FC/VRI models were not very accurate at correctly classifying nests of a known density to the same habitat suitability level, and therefore should not be relied upon for precise ratings levels at the stand level. Of 70 nest trees with known densities (15 H, 36 M and 19 L), the FC/VRI model correctly classified 20% of the H nests, 36% of the M nests, and 84% of the L nests. Nest densities were calculated at levels larger than the stand (>100 ha) and were therefore usually the result of average habitat suitability of a number of polygons at that scale.

Table 11. Areas of suitable Williamson's Sapsucker habitat from preliminary Forest Cover/VRI habitat attribute model, and the numbers of nests and nest trees in each class.

Model		Habitat Suitability					Total
		High	Moderate	Low	Very Low	Nil	
Preliminary	Area (ha)	668	3798	10210	13477	702	28857
	% of AO	2.3	13.2	35.4	46.7	2.4	100.0
	Total Nests (n)	15	45	48	26	0	134
	Nest Trees (n)	8	25	26	13	0	72
Final	Area (ha)	603	2535	9731	14385	702	28876
	% of AO	2.1	8.8	33.7	49.8	2.4	100.0
	Total Nests (n)	5	43	80	4	0	132
	Nest Trees (n)	4	23	41	2	0	70

Table 12. Percentage of correctly classified locations based on presence/absence for preliminary FC/VRI habitat suitability model. Sample size for each column in ellipses.

Habitat Model	H/M/L		Presence ¹				Absence ¹	
			Nest Trees	Other Territories	Other Obsn	Random Occupied Point ²	Random Unoccu-pied Point	Unoccu-pied CPB point
	Area (ha)	% of AO	(72)	(14)	(71)	(18)	(36)	(343)
FC/VRI/DEM Preliminary	14676	48	82%	79%	62%	78%	44%	42%
FC/VRI/DEM Final	12869	46	97%	93%	77%	72%	58%	39%

¹Presence was considered correctly classified if observations were in High, Moderate or Low Suitability polygons, and Absence considered correctly classified if unoccupied random or other Call-Playback (CPB) points were in Very Low or Nil polygons.

²Random Occupied Points were the actual random point, and not the location of the bird, which would have been recorded in one of the three preceding columns (birds were known to travel up to 500 m from nests to be recorded within the 225-m random point radius).

Capability Ratings:

The modeling in this project used forest attributes for suitability that are not simply transferable to capability ratings. For ecosystem modeling, capability is normally calculated by removing the effects of the structural stage on the rating. However, structural stages were not used here because more complex algorithms of stand ages, height, and crown closure of multiple layers were used.

Most sites within the AO have some capability for Williamson's Sapsucker because most sites have some capability to grow large conifers, either Lw, or one or more of Fd, Py or Sx under the right conditions. The simplest measure of capability within the AO would therefore consider any productive sites with a Stand Index >10.0 as capable of growing conifers >60 cm DBH that would be suitable for nesting Williamson's Sapsucker, and of maintaining stands of crown closure >25%. These criteria apply to about 90% of the AO.

Field Ratings Adjustments:

This model has not been verified with additional field data. However, the model was based on a very large amount of data collected between 1996 and 2009 covering a very large proportion (approximately 40%) of the AO. Therefore, no adjustments would be warranted to the model based on very limited field sampling that might be possible in a very short term and limited project. However, adjustments may be made in the field for particular sites to ascertain or confirm site suitability. A draft field key was prepared for the Boundary TSA in March 2009, which was also meant to be applicable to all western larch regions occupied by Williamson's Sapsucker in B.C. It has been revised and provided separately (WISA Field Habitat Key Larch Regions DRAFT Jan2010.pdf).

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