

WILLIAMSON'S SAPSUCKER
FINAL SPECIES ACCOUNT FOR SPECIES-HABITAT MODEL
FOR THE EAST KOOTENAY

Common Name: Williamson's Sapsucker

Scientific Name: *Sphyrapicus thyroideus nataliae*

Species Code: B-WISA

Status: Provincial Listing: Red (B.C. Conservation Data Centre 2006) for both the species as a whole in BC, and for the East Kootenay subspecies *nataliae*.

Global G5; Provincial S3B for species as a whole, but East Kootenay subspecies *nataliae* is S1S2B;

COSEWIC Assessment for species as a whole (i.e. not by subspecies): 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) in the East Kootenay. The provisional WISA AO in the East Kootenay as of Dec 2009 was 853 km² in extent based on minor revisions made to the April 2009 provisional AO to include several newly discovered nests. The mapping algorithm was applied to a larger area of interest that included all WISA observations in the East Kootenay from 2004-2009 so that should the AO change in the future, suitability mapping would be available outside the current boundaries. However, the final phase of this project including aerial photo interpretation was only applied to the AO.

Ecoprovince: Southern Interior Mountains

Ecoregions: Northern Columbia Mountains, Southern Rocky Mountains

Ecosections: East Kootenay Trench (EKT), Eastern Purcell Mountains (EPM), MacGillivray Range (MCR), Southern Purcell Mountains (SPM), Flathead Valley (FLV)

Biogeoclimatic Variants: PPdh2, ICHmk4, IDFdm2, MSdk1

Project Map Scale: 1:20,000

Map Products Used: Predictive Ecosystem Mapping (PEM BAPID 4485, 2009) was examined for use in this modeling, but was found to have a non-recoverable error in the coverage and could not be used. The primary sources were Vegetation Resources Inventory (VRI) (2009), which was a forest cover (FC1) rollover with some updating to 2008, additional FC opening layers to identify reserves within harvested blocks and newly harvested blocks not yet included in the VRI, and Digital Elevation Models at the 1:20,000 (20-m grid) and 1:250,000 (90-m grid) levels. Digital colour orthophotos (1-m pixel) were available for 2004-2005. Several Landat 5 images (30-m pixel) were used including a recent image from Sept 2009 for updating recent timber harvesting blocks.

Distribution

Throughout this account, all references are to Williamson's Sapsucker in general, rather than to subspecies. The two subspecies are very weakly defined, not identifiable to subspecies in the field, individual specimens cannot be reliably identified to subspecies, and there are no known ecological differences between the two subspecies (COSEWIC 2005). Therefore the differences between the two subspecies have not been emphasized in this account. Where references throughout this report are only to the East Kootenay, these refer to the *nataliae* subspecies, which only occurs in BC in the East Kootenay.

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), west to Hat Creek (W of Cache Creek), Botanie Valley (N of Lytton) 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 at Mount Kobau, Trout Creek (Gyug 2007), Terrace Mountain (Gyug *et al.* 2007), Salmon River (Gyug 2007)
- In the Rocky Mountain Trench, has not recently been found north of Wycliffe although there is an older (non-breeding) record from Brisco (Cooper 1995), and a possible breeding records from the Whiteswan Lake area (Gyug *et al.* 2007).
- There are probable breeding records from the Flathead Valley (Cooper 1995) that could not be confirmed as an occupied area during sampling from 2006-2008 (Ohanjanian, unpublished data).

Elevation Range:

- breeds between 800 and 1550 m with the majority between 975 and 1475 m (Gyug *et al.* 2007);
- additional data since Gyug *et al.* (2007) found one nest below 800 m at 704 m elevation near Merritt in the western region (Gyug 2007)
- in the East Kootenay, 48 nests in 46 trees were found between 2005 and 2009 with all nests between 840 and 1360 m (Figure 1, Tables 1 and 2, Ohanjanian, unpublished data).

Table 1. Relative density by elevation as detected on Call Playback (CPB) points in the East Kootenay, 2005-2009.

	CPB Points	WISA detected	WISA detected/100 CPB points
Elevation (m)	n	n	
700-799	27	0	0
800-899	223	8	3.6
900-999	307	7	2.3
1000-1099	458	11	2.4
1100-1199	437	11	2.5
1200-1299	346	13	3.8
1300-1399	261	4	1.5
1400-1499	88	0	0
1500-1599	22	0	0
1600-1699	<u>5</u>	<u>0</u>	0
Total	2174	54	

Table 2. Elevations of Williamson's Sapsucker known nest trees, breeding territories and other observations that could not be directly associated with breeding territories in the East Kootenay, 1995-2009.

	Nest Trees		Territories with Nests or Pairs		Territories with Males present for >2 weeks or in >1 year		Other WISA observations	
Elevation (m)	n	%	n	%	n	%	n	%
800-899	5	11.1	7	12.5	0		4	8.7
900-999	11	24.4	13	23.2	3	100	7	15.2
1000-1099	11	24.4	14	25.0	0		11	23.9
1100-1199	5	11.1	6	10.7	0		16	34.8
1200-1299	7	15.6	11	19.6	0		8	17.4
1300-1399	<u>6</u>	<u>13.3</u>	<u>5</u>	<u>8.9</u>	<u>0</u>		<u>0</u>	<u>0.0</u>
Total	45	100	56	100	3	100		
Total Observations			268		9		46	100

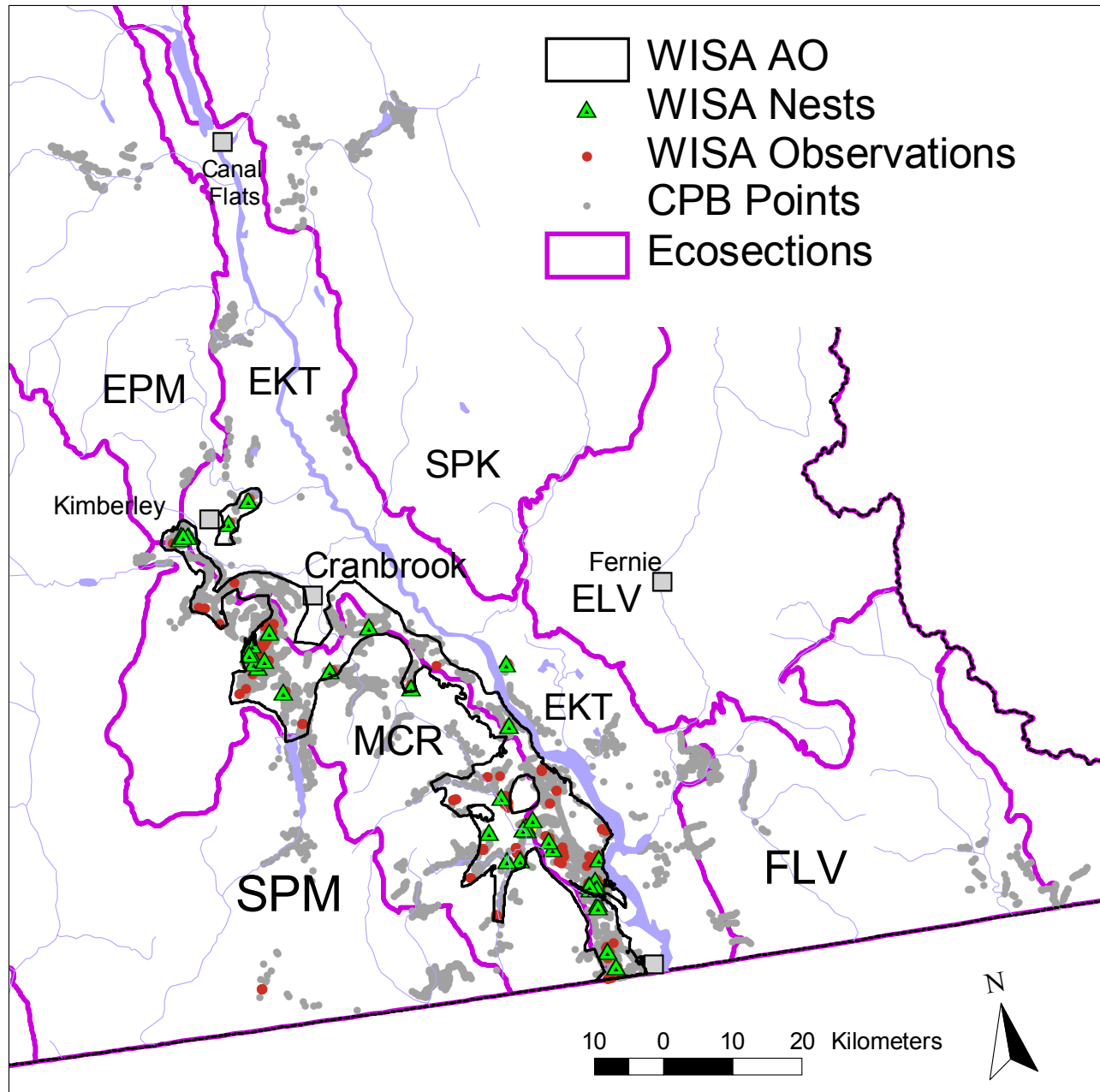


Figure 1. Call playback stations and Williamson's Sapsucker observations and nests in the East Kootenay, 1996-2009. The provisional Area of Occupancy as of December 2009 is shown in heavy black outline clipped to the 800 and 1400 m contours. For Ecosection 3-letter codes see Table 3 (except ELV = Elk Valley).

Ecosections:

WISA were found primarily in the Southern Interior Ecoprovince (268 detected at 6749 call playback stations; 4.0 detected/100 CPB) and in the Southern Interior Mountains Ecoprovince (56 detected at 2342 CPB stations; 2.4 detected/100 CPB). Only CPB points that were not part of intensive area searches, were at least 300 m from other points, >800 m from points with previous detections, and were not repeats of previous year's points were included in the relative density analyses.

At the Ecoregion level, WISA were found primarily in the:

1. Thompson-Okanagan Plateau (4.2 detected/100 CPB; n = 5324 CPB),
2. Okanogan Highland (13.5 detected/100 CPB; n = 312 CPB),
3. Northern Columbia Mountains (3.3 detected/100 CPB; n = 1121 CPB), and the
4. Southern Rocky Mountain Trench (2.1 detected/100 CPB; n = 808 CPB).

Other ecoregions where they were detected uncommonly were the

5. Selkirk-Bitterroot Foothills (1.1 detected/100 CPB; n = 167 CPB), and the
6. Northern Cascade Ranges (0.2 detected/100 CPB; n = 440 CPB).

At the Ecosection level (Table 3), most of the known breeding populations occurred in 7 ecosections:

- 24% in the Nicola Basin and Southern Thompson Upland west of Okanagan Lake,
- 57% in the Southern Okanogan Highland, Southern Okanogan Basin and Northern Okanogan Highland in the Okanagan-Boundary, and
- 16% in the MacGillivray Range and East Kootenay Trench in the East Kootenay.

Note that the Northern Okanogan Highland was not occupied throughout its area, as WISA were concentrated in a narrow band of <10 km from the Southern Okanogan Basin and Southern Okanogan Highland. This was the primary location where very large veteran western larches historically occurred at high densities because of a high-frequency low-intensity fire regime. This fire regime was not found throughout the remainder of the range of western larch in B.C except perhaps in the southern Rocky Mountain Trench of the East Kootenay (Gyug et al. 2007, 2009a). This fire behaviour pattern at the landscape level is a possible causal influence on WISA distribution within BC. Of 193 nests in the NOH, 88% occurred within 10 km of the SOB or SOH boundary, with the exception accounting for 11% of the nests above Naramata in the northern most location where high densities of very large veteran larch were found.

Table 3. Relative density of Williamson's Sapsucker based on call playback (CPB) responses and known nests and nest territories by ecosections in B.C., 1995-2009.

Ecosection		CPB Points	WISA detected	WISA detected/ 100 CPB	Nests	Known Nest Territories	
		n	n		n	n	%
West of Okanagan Lake							
NIB	Nicola Basin	215	25	11.6	22	13	5.5
STU	Southern Thompson Upland	1490	74	5.0	80	44	18.7
NOB	Northern Okanagan Basin-West	377	3	0.8	0	0	0.0
THB	Thompson Basin	397	2	0.5	1	1	0.4
GUU	Guichon Upland	418	2	0.5	3	2	0.9
HOR	Hozameen Range	262	1	0.4	1	1	0.4
CAB	Cariboo Basin	4	0	0.0	0	0	0.0
NTU	Northern Thompson Upland	181	0	0.0	0	0	0.0
OKR	Okanagan Range	178	0	0.0	0	0	0.0
PAR	Pavilion Ranges	648	0	0.0	0	0	0.0
SCR	Southern Chilcotin Ranges	25	0	0.0	0	0	0.0
SHB	Shuswap Basin	173	0	0.0	0	0	0.0
SOB	Southern Okanagan Basin-West	1	0	0.0	0	0	0.0
TRU	Tranquille Upland	411	0	0.0	0	0	0.0
Okanagan-Boundary							
SOB	Southern Okanagan Basin-East	192	35	18.2	54	26	11.1
NOH	Northern Okanagan Highland	1644	119	7.2	193	91	38.7
SOH	Southern Okanagan Highland	119	7	5.9	40	16	6.8
SFH	Selkirk Foothills	167	2	1.2	2	1	0.4
NOB	Northern Okanagan Basin-East	18	0	0.0	0	0	0.0
East Kootenay							
MCR	MacGillivray Range	849	36	4.2	23	20	8.5
EKT	East Kootenay Trench	808	17	2.1	22	18	7.7
SPM	Southern Purcell Mountains	185	1	0.5	0	0	0.0
COC	Crown of the Continent	18	0	0.0	0	0	0.0
EPM	Eastern Purcell Mountains	87	0	0.0	2	2	0.9
FLV	Flathead Valley	121	0	0.0	0	0	0.0
SPK	Southern Park Ranges	107	0	0.0	0	0	0.0
Total		9095	324		443	235	100

Table 4. Williamson's Sapsucker relative density inside and outside the Area of Occupancy (as revised in December 2009), numbers of territories and nests found by BEC variant in the East Kootenay.

BEC Variant	Outside AO		Inside AO		Entire East Kootenay	Territories (Nests) found	Inside AO (2008)	
	CPB Points	WISA detected /100 CPB	CPB Points	WISA detected/ 100 CPB	WISA detected/ 100 CPB		Random Pts (2008)	% Random Pts with WISA detected
MSdk1	410	0	225	9.8	3.5	20 (17)	7	0.0
IDFdm2	354	0.6	725	3.6	2.6	35 (25)	14	21.4
PPdh2	35	0	37	5.4	2.8	3 (2)		
ICHmk4	120	0.8	12	8.3	1.5	1 (0)		
ESSFdk1	10	0			0.0			
ICHdm	104	0			0.0			
ICHdw1	22	0			0.0			
MSdk2	120	0			0.0			
Totals	1175	0.3	999	5.1		59 (44)	21	14.3

BEC Zones:

Provincially:

- 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, 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, IDFdck1, IDFxh2, ICHmk1 and IDFdck2

East Kootenay (Table 4):

- relative densities were highest in the MSdk1, followed by the IDFdm2, but well below those observed in the Okanagan-Boundary
- the MSdk1 appeared to be used only partially, i.e. not including the highest elevations,
- the PPdh2 appeared to be only used peripherally where adjacent to the IDFdm2, and at elevations >800 m.

Based on known locations of Williamson's Sapsucker from inventory and research conducted up to 2008, a provisional Area of Occupancy (AO) was defined in April 2009 (Gyug, unpublished results). 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). This AO was modified in December 2009 to include 4 nests and 2 other locations found in 2009 on the west side of the Kootenay River. The intent in mapping the AO was to include all CPB points such that the relative density of CPB responses was <1 response per 100 CPB points outside the AO.

In the East Kootenay, 46.0% of the 2175 call playback points were within the AO as mapped in December 2009 (Figure 1). Within the AO, WISA were detected at 44 (4.4%) of the CPB points. The remainder of this habitat modeling project only dealt with the portion of the Rocky Mountain Forest District contained within the WISA AO. However, should the breeding range expand or contract, the AO would be expected to change over time. Therefore the same VRI algorithms used for this modeling were applied to a wider area so that possibly suitable habitat outside the 2009 AO could be identified. This wider area of interest included at least a 5-km buffer around the AO and any WISA observations outside the AO.

Provincial Context

Within Canada, Williamson's Sapsuckers breed only in British Columbia, although they have been occasionally seen in Alberta and Saskatchewan (COSEWIC 2005). The remainder of the species breeding range lies to the south in the United States. As previously referred to (see Distribution) only the *nataliae* subspecies occurs in the East Kootenay but there are no known ecological, behavioural or physiological differences between the *nataliae* and *thyroideus* subspecies.

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 which are the primary nestling food, and upon which the adults forage extensively in the breeding period, and
- standing live trees from which they glean the ants mainly from the trunks as the ants tend aphids in the trees.

Prior to the research initiated by B.C. Environment in 1996, there were only general habitat descriptions available as follows:

- 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);

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). No data is available on return of tagged adults or nestlings in BC.

Habitat Use (Life Requisites and Seasons)

Temporal Pattern of Life Requisites:

- 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);
- Foraging – mid-March to late September
- 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)
- Timing of breeding is very similar between the regions in B.C. (Gyug and Ohanjanian, unpublished data), and there are no known differences in timing of breeding between the regions in B.C.

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:

1. Coniferous stands 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, and
2. Trembling aspen stands where trembling aspen occurs within a coniferous forest matrix, and where At is the primary nest tree.

In the East Kootenay, most occupied nest territories were in coniferous forest where western larch and Douglas-fir are present. Aspen stands were only occasionally used in the East Kootenay (18% of nests) and 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) elsewhere in their breeding range 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.

Resource selection analysis of data from 2006-2008 (Drevers et al. manuscript) showed that the probability of nest occurrence was strongly tied to densities of potential nest trees, which were older-aged trembling aspen (*Populus tremuloides*) and ponderosa pine (*Pinus ponderosa*) west of Okanagan Lake, and open forests with large (diameter-at-breast-height >57.5 cm) western larch in the Okanagan and East Kootenay regions.

Tree species composition around nests based on the plots from 2006-2008 was broken down by type of woody structure (Table 5). Lw and Fd were present at every WISA nest. In no case did lodgepole pine make up >60% of the tree species composition (Figure 2).

¹ Tree species referred to in the remainder of the account using Min. of Forests two-letter codes as follows: At, trembling aspen; Bl, Subalpine fir; Fd, Douglas-fir; Lw, western larch; Py, ponderosa pine; Pl, lodgepole pine; Se Engelmann spruce

Table 5. Tree species composition of the 16-ha Williamson's Sapsucker nest territories in the East Kootenay 2006-2008 (n = 28) within each class of woody structure. Number of trees, logs or stumps counted in each category is in ellipsis in bold (**nnn**), and percentages in each portion of the table beneath each tally in ellipsis total 100%. The most frequent species in each category is shaded in grey.

Tree Species Composition within Category (%)							
		Small Live Trees	Large Live Trees	Very Large Live Trees	Large Snags	Logs	Cut Stumps
Size Range (DBH)		8-17 cm	18-57 cm	≥58 cm	≥23 cm	≥23 cm	≥23 cm
Tree Species	(n)	(953)	(1659)	(221)	(418)	(776)	(2398)
Western larch		19.9	33.0	41.6	27.3	31.3	24.1
Douglas-fir		50.6	50.8	48.0	38.5	27.8	39.4
Hybrid white spruce		2.52	3.3	1.4	3.1	7.2	1.0
Lodgepole pine		23.7	6.8	0.0	19.6	11.6	25.9
Trembling aspen		0.1	0.4	0.0	0.2	0.4	0.0
Ponderosa pine		1.26	3.8	9.0	4.1	5.8	6.5
Subalpine fir		0.94	1.3	0.0	5.3	1.3	0.0
Western redcedar		0.84	0.4	0.0	0.0	0.1	0.0
Black cottonwood		0	0.2	0.0	0.0	0.1	0.0
Paper birch		0.1	0.0	0.0	0.0	0.0	0.0
Western hemlock		0	0.0	0.0	0.0	0.1	0.0
Western white pine		0	0.1	0.0	0.0	0.0	0.0
Unknown		0	0.0	0.0	1.9	14.2	2.9

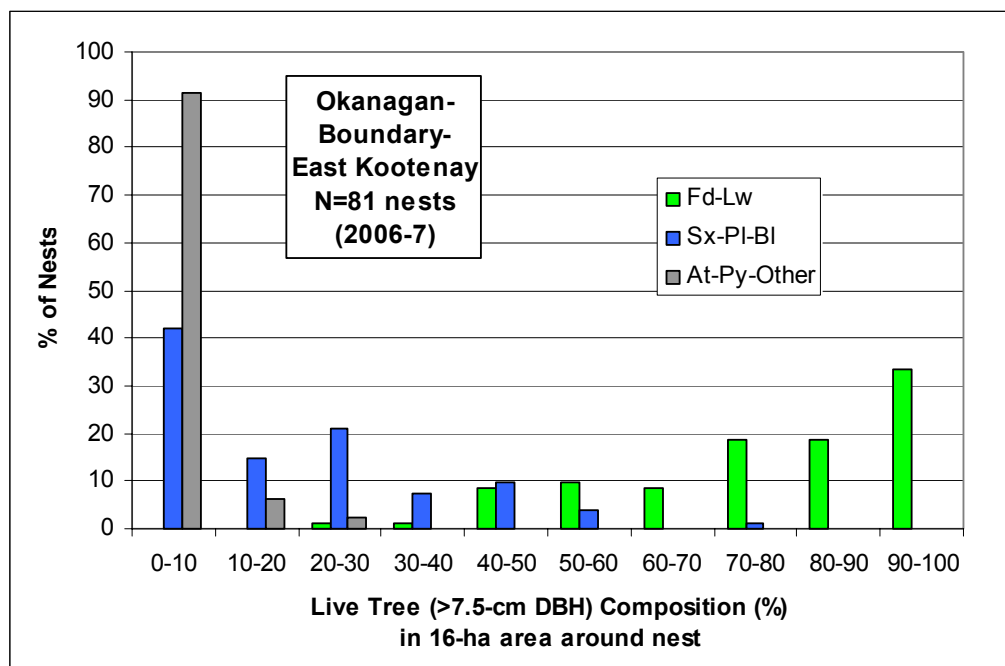


Figure 2. Tree species composition within 225 m of Williamson's Sapsucker nest trees, 2006-7.

Table 6. Characteristics of Known Nest Trees in the East Kootenay, 2004-2009.

Tree Species	Condition	Size (DBH-cm)		Nest trees	
		Mean	Range	N	%
Lw	Codominant live	45	35-56	14	31
Lw	Very large, live	82	60-104	13	29
At	live	36	28-51	7	16
Lw	dead	52	27-92	5	11
Fd	live	39	37-43	3	7
Fd, Py	dead	49	45-52	2	4
At	dead	20		1	2

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, Gyug et al. 2009a).
- 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 but only if there are extant heart rots underneath the sound and shallow sapwood. Age of stand may provide a reasonable surrogate for suitable nest trees that would include 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 observed nest tree in the East Kootenay (Table 6) was Lw (71% of nest trees) based on 32 nest trees (Gyug et al. 2009a) and 13 additional nest trees found in 2009 (P. Ohanjanian, T. Antifeau, unpublished data).

Mean Lw nest tree size was smaller in the East Kootenay (64 cm DBH) than in the Okanagan-Boundary (79-cm DBH) (Gyug et al 2009a). This was because very large (>60-cm DBH) nest trees made up 75% of all Lw nest trees in the Okanagan-Boundary, but in the East Kootenay smaller (<60-cm DBH) nest trees made up the higher percentage (56%) of Lw nest trees. Logging histories appeared to be quite different in the two regions (Gyug 2009b). Fewer very large nest trees appeared to be left after the extensive and intensive logging undertaken in the first half of the 20th century (1900-1940) in the East Kootenay whereas, in the Okanagan-Boundary, many stands were not logged during that period, or were logged much less intensively (Gyug 2009b). These smaller (or codominant) nest Lw trees in the East Kootenay were generally >100 years old, and appeared to have been cull trees from the logging of the early 20th century because they were already fire-scarred. Some of these trees that were examined (Gyug 2009b) appeared to be already so damaged in the early 20th century, that they released little if at all compared to healthy Lw or Fd in the same stands.

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 sapwell 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 sapwell. 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.

Densities of trees could be used for a foraging habitat model, rather than the nest tree location model developed here. Tree densities were different at nest sites and unoccupied sites with a higher than even likelihood of WISA occupation where there were moderate tree densities of 50-250 trees/ha (Drevers et al. manuscript). Nest territories (225-m radius) were characterized by significantly ($p < 0.05$) lower densities of trees from 7.5-37.5-cm dbh than Random Unoccupied stands (Fig. 3). Unoccupied stands had mean small (<25-cm dbh) tree densities more than double those of nest sites, and moderately sized (25-35 cm dbh) tree densities 60% higher than at nest sites. “Moderate” suitability sites based on the Okanagan-Boundary algorithm (>125 years old, Lw and Fd present, Crown closure >20%) had intermediate and not significantly different very small tree densities, but significantly higher moderately-sized (25-55 cm dbh) tree densities than either nest sites or random sites.

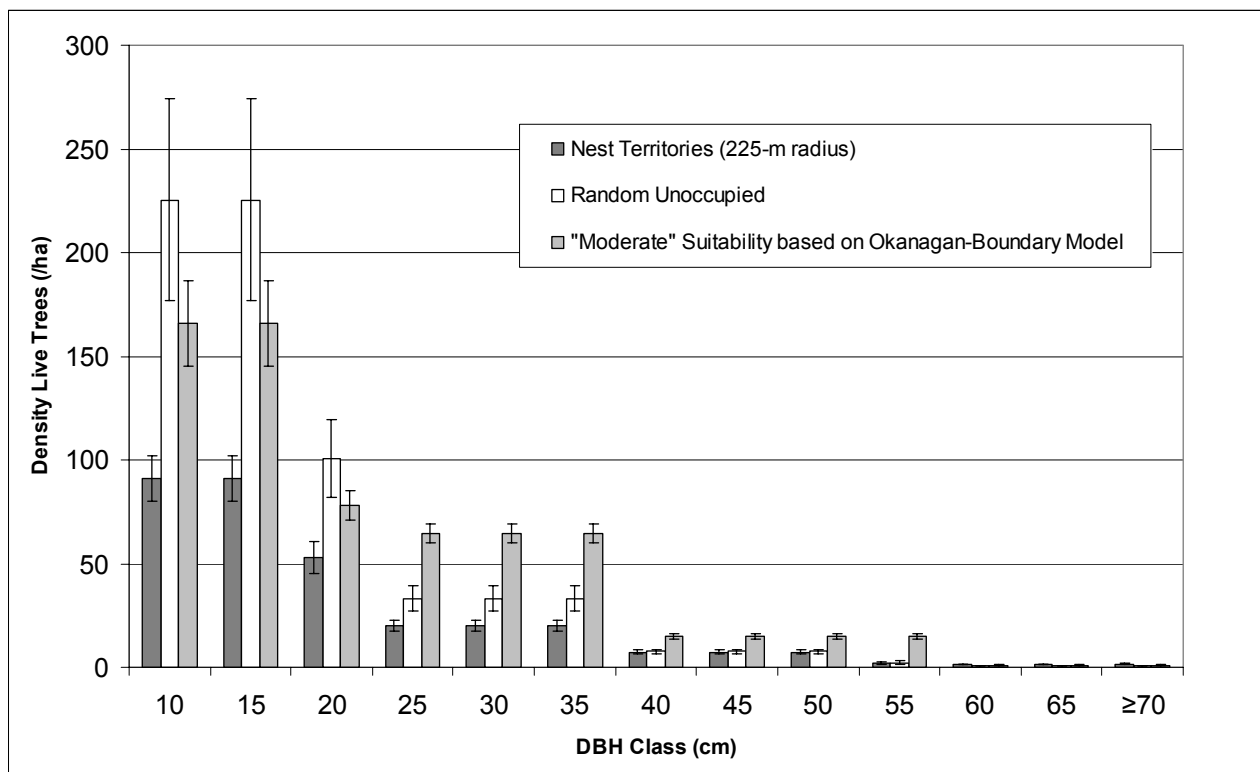


Figure 3. Stand structure in the East Kootenay showing mean and standard error (error bars) of live standing trees within 225-m of Williamson's Sapsucker nest sites, at random unoccupied sites (2008) and at sites considered of Moderate suitability according to the Okanagan-Boundary model algorithm (Gyug 2009b).

Table 7. Minimum breeding densities based on nest search areas fairly thoroughly covered by call playback and follow-up nest searches in the East Kootenay, 2006-2009.

Search Area	Year	Known Nests	Other Territories	Area (km ²)	Minimum Density (/km ²)	
					Nests	Nests + Other Terr.
Kiahko Creek	2006	3	0	4.33	0.69	0.69
	2007	2	2	10.11	0.20	0.40
	2008	3	4	10.15	0.30	0.69
Strauss/Linklater	2007	3	0	3.86	0.78	0.78
	2008	3	3	3.86	0.78	1.55
Caven Junction	2008	3	0	1.37	2.19	2.19
	2009	1	3	2.03	0.49	1.97

TERRITORY SIZES AND DENSITIES

Territory sizes: Home ranges of WISA in Western Larch habitats in British Columbia appear (54 ha) appear to be larger than in Py/At habitats in Colorado and Arizona (4-11 ha) (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 ranged from 0 to 3.1 breeding pairs per 100 ha (Gyug et al. 2007, Gyug, unpublished data). Densities were similar for the U.S. based on minimum nest densities available in the Birds and Burns Network reports (see COSEWIC 2005) but with one density higher than this at 4.8 nests/100 ha in San Juan National Forest (Py forest with nests in At patches).

No census areas had been conducted in the East Kootenay, but several areas had been covered very intensively during call playbacks and follow-up nest searches allowing an estimate of breeding densities to be made. These must be used with the caution because these were not attempts at complete censuses of these areas but are thought to be relatively accurate. Minimum breeding densities at Strauss and Caven Junction were in the range considered to be Moderate (25-75% of benchmark). These sites were characterized by openings with numerous reserved trees and patches within the openings created during partial cutting from 1986-1991 at Caven Junction, and 1990-1999 at Strauss/Linklater. Examination of 10 randomly-selected forested sites where moderate densities may have been expected using the Okanagan-Boundary model algorithm (>125 years old, Lw and Fd present, Crown closure >20%) were found to contain very few WISA (only at 3 of the 10 sites, Gyug 2009b). There was only one confirmed breeding territory based on observations of recently fledged young (T. Antifeau, pers. comm.), so that clearly this algorithm did not work in the East Kootenay to predict breeding densities given the logging histories and current stand conditions (Gyug 2009b).

Table 8. Habitat capability and 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 in the Okanagan-Boundary and western regions (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 to 0.2
1-5%	Very Low	5	VL	0
0%	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 preliminary model was based on analyses of nest locations and is therefore more directly applicable to nest stand suitability modeling than foraging suitability. However, WISA is a central-place forager, when they are feeding young in the nest, 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.

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. Two other similar (but smaller and less extensive) stands were found east of Naramata, but were too small and fragmented 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).

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

Biogeoclimatic Zone: IDFdm1 bordering on the IDFxh1 at Schoonover Mt.,
IDFdm1 at Lehman Springs,
IDFdm1 bordering on MSdm1 at Naramata.

Benchmark Habitat Description:

In 2003-2005, the Okanagan Falls site was predominantly (77%) forested interspersed with seedtree/partial cuts (23%). Additional timber harvesting at Okanagan Falls in 2006-2007 has lowered the forested portion to only 57% of the area, and density appeared to have fallen to Moderate levels by 2008 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%).

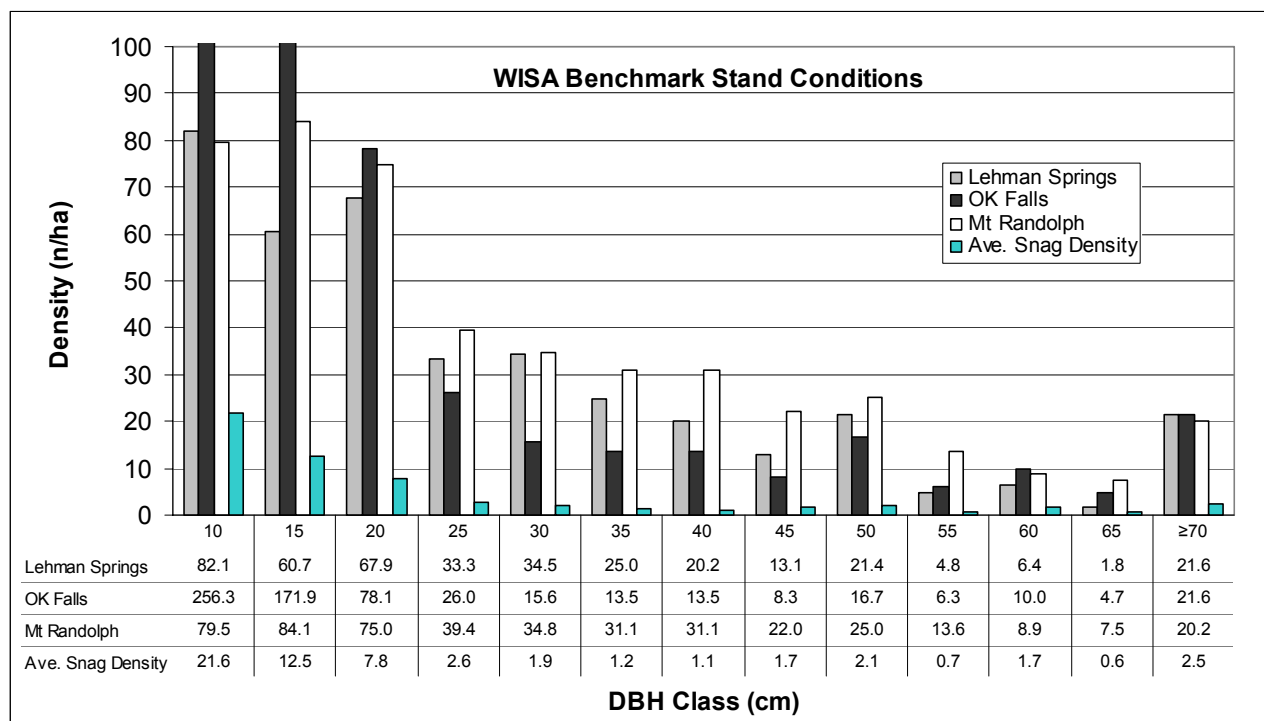


Figure 4. Live tree and snag densities by 5-cm dbh classes in Williamson's Sapsucker benchmark high density and high suitability habitat in B.C. Values for densities in the histogram are provided in the table below the histogram.

Regional Habitat Values

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

East of Okanagan Lake: NOH, SOB, SOH = H (Provincial Benchmarks)

EKT, MCR, STU, NIB = M

EPM, SPM, FLV, OKR, NOB, NOH (West), SOB (West), HOR, GUU, THB, SHB, SFH = L

Density estimates from census areas have not been made for any sites in the East Kootenay but, based on presence of known nests and of other nearby pairs where nests were not found, no high density breeding locations were found in the East Kootenays. Maximum breeding densities were most likely between 0.8 and 1.4 pairs per km² indicating these would be of Moderate density class (25-50% of the benchmark). The maximum suitability possible in any of the ecosections in the East Kootenay was Moderate.

Regional habitat values were only applied when an area larger than the AO was being mapped. The AO boundary was based on a relative density boundary (>1% detections on CPB inside, <1% outside) so that where suitability mapping was only considered within the AO, regional habitat values were not applied and any Ecosections and BEC Variants found within the AO would be considered of equal potential suitability.

HABITAT MODELING using FC/VRI

PEM mapping, with its rather broad Structural Stage description of stand structure tended to be too broad to reliably predict WISA habitat suitability in both the Boundary and the western regions. The modeling in the East Kootenay was based on analysis of nest locations, and development of a model using the environmental envelope method to encompass known data (Guisan and Zimmermann 2000). The coverage and database used for this assessment was the Vegetation Resource Inventory (VRI) coverage and associated attributes for layers 1 and 2 downloaded January 2010. This coverage is updated every 2 years, so the projected age and height information were for January 2009. However, the coverage was not up-to-date for some recent timber harvesting or fires, and had to be checked against Landsat images to ensure it was up-to-date. Most of the VRI was a rollover of polygons from the previous Forest Cover FC1 layer, with attributes from the Forest Inventory Planning (FIP) database. Additional FC "opening" data was used to refine the VRI layer for small reserves (e.g. Wildlife Tree Patches) within cutblocks that were not usually mapped in the VRI.

For preliminary model development, half the nest data (n = 22 nest trees randomly selected) was used for model development, and the other half reserved for model testing. For refinement of the final model, all nest trees were used (n = 44). The model is based on nest locations, and is therefore a nest habitat model. It will not be expected to accurately predict all non-nesting observations since WISA will forage in a much wider variety of stands than it will use for nesting, i.e., they can, and will, forage in almost any stand that has both trees and ants within a certain proximity of a nest. The relative value/suitability of foraging stands would require unbiased location data and foraging observations from radio-telemetry, but such studies have yet to be done.

Table 9. Ranges of VRI stand attributes at the nest location for 44 nest trees in the East Kootenay, 2005-2009, and used for final model development. Nest trees were only counted once, even if used in multiple years. Stand ages projected to 2009.

N nests	Stand Age	Height	Crn Clos.	Site Index	Tree Species	Nest Tree	Comments	Rating		Correct by:
								Pre	Fin	
Coniferous nest trees										
No layers (n = 19)										
13	NSR	0	0	15.0-20.0	None listed	Lw vet 5, Lw cod 6, Fd cod 2	Attribute Table empty, even though ST or partial cuts.	5	5	Upgrade ST/Partial Cuts from photos VRI updating cuts
2	(91)*	(24.7)	(70)	19.4	(PI90Lw10)	Lw cod	ST Cut (pre 2004) not mapped.	5		
1	(101)	(18.0)	(30)	12.8	(PI80Lw20)	Vet Lw	ST/Partial Cut (pre 2004) on private land not yet mapped.	5		"
1	(181)	(25.8)	(50)	14.0	(Lw60PI20Fd20)	Py cod	"	5		"
1	(181, 81)	(25.8, 21.2)	(5, 70)	(14.0-17.2)	(Lw100, PI70Lw30)	Lw cod	"	5		"
1	(224)	(24.8)	(50)	12.8	(Lw90PI10)	Lw cod	ST Cut (pre 2004) not yet mapped.	5	5	"
1 VRI layer (n = 8)										
1	29	8.0	3	15.0	PI70Fd30	Lw cod	Partial Cut 1986, remnant Lw and other trees not mapped	5		Map ST/Partial Cuts
1	28	6.7	3	15.0	Fd60PI40	Lw cod	"	5		"
1	71	17.5	70	15.3	Fd90Lw10	Vet Lw	Vet Lw in adjacent polygon but boundaries poorly mapped.	5		Correct stand boundaries
1	95	15.3	30	11.0	PI70Lw20Fd10	Vet Lw	Vet Lw not mapped	4		Lw vets on photos
2	131	28.1	60	17.0	Lw60PI30Fd10	Vet Lw, Lw cod	Unmapped Lw vets, Intact Forest	3		Individual vets not always visible in "ragged" canopy (see text)
1	140	27.9	60	16.2	Fd70Lw20Py10	Lw cod	Mapped OK, nest in codom	3		"
1	226	25.2	50	12.1	Fd59Lw41	Vet Lw	Mapped OK with vets	6		Steep slope correction (see text)
2 VRI layers (n = 9)										
1	102, 16	24.4, 3.7	4, 1	18.0	Lw80Fd20, Fd48PI27Lw25	Lw cod	Partial Cut 1991	4		OK
1	107, 23	23.8, 6.4	8, 3	15.9, 18.0	Fd60Lw40, Fd56PI34Py4Sx4Lw2	Lw cod	Partial Cut 1991, vets unmapped	4		OK
2	110, 52	19.2, 5.4	15, 5	12.6, 7.1	Fd88Py9Lw3, Fd97Py3	Fd cod	Partial Cut 1990	4		OK
1	130, 50	23.7, 7.3	10, 20	14.3, 9.2	Lw60Fd30PI10, Fd90PI10	Vet Lw	Partial Cut 1983	4		OK
1	130, 90	26.2, 13.7	10, 20	15.8, 10.3	Fd80Lw10PI10	Vet Lw	Partial Cut 1983, Lw vet not mapped	4		OK
1	131, 46	23.8, 10.2	3, 10	14.3, 15.0	Lw60Fd40, BI50Fd30Sx20	Vet Lw	Partial Cut 1984	3		OK
2	181, 76	30.9, 21.8	10, 60	17.0, 17.8	Lw70Fd30, Lw40PI30Fd30	Vet Lw, Lw cod	Intact Forest	3		OK
At nest trees (n = 8)										
2	NSR	0	0	15.0-19.0	None listed		Attribute Table empty, even though ST Cut	5		Map ST/Part Cut
1	21	5.3	2	15.0	PI60 Fd30 At10		Partial Cut 1990, At nest tree cohort at stream edge not mapped	5		Map ST/Part Cut
1	14	5.1	4	21.0	PI44 Fd30 BI13 Lw13		In riparian reserve in cutblock. Mapping boundaries inaccurate.	5		Map ST/Part Cut correctly
1	97	27.7	70	21.5	PI70 Lw30		At in riparian area not mapped	5		Map riparian At
1	91	20.5	50	15.0	Fd60 At20 Py10 Lw10		Mapped Correctly	4		OK
1	91	20.7	60	15.1	At60.Sx20 Fd20		Mapped Correctly	4		OK
1	107, 25	22.4, 7.5	4, 3	14.8, 16.0	Lw66Fd17PI17, PI53Lw31Fd6At5Sx5		Partial Cut 1989	4		OK

* Data in ellipsis indicate attributes prior to cutting because maps had yet to be updated.

* cod = codominant layer nest tree, <60-cm DBH; vet = veteran tree >60-cm DBH.

Information available for model testing included:

- Other WISA observations including,
 - possible or probable breeding territories where nests were not found (n = 18), and
 - any other observations that could not be associated with breeding territories (n = 49),
- Call playbacks at unoccupied sites (no WISA detected within 600 m) (n = 767), and
- Random plot locations from 2008 (n = 21, Ohanjanian 2008).

Variables available for modeling at this stage included Ecosection and BEC variant from provincial-level GIS layers, elevation, slope and aspect from the TRIM Digital Elevation Model, and VRI attributes including non-forest stand descriptor, projected stand age, projected stand height, site index, crown closure, and species composition for each layer. Only up to two layers (not including “silvicultural” layers recently planted) were found in any given polygon.

Final Model Development

For 47% of nests, there were no attributes in the VRI table from which to develop a model. These sites had been timber harvested (either seedtree cuts or partial cuts listed as “openings” in the attribute table) but the attribute table was either emptied, or never updated (even to 2004), in other words, the timber harvest had been treated as if it were a clearcut.

Full corrections to the attribute tables would require interpretation of tree species, densities, and height within the reserves in cuts that was beyond the scope of this project. Polygon linework for cuts was updated using FC Openings layers, with corrections to some areas done based on orthophotos for sites not correct in either layer. In particular, wildlife tree patches and other reserves within the blocks where the VRI has treated them as if they were part of the cut were added from the FC openings layer.

Possible selection for slope or aspect was examined using ANOVA for slope, and Chi-squared contingency tables for slope and aspect. Since there were 44 nests, a set of 44 random points within the AO were generated. Slopes were not significantly different between nests and random points ($F_{1,86} = 0.69$, $p = 0.41$). There were just as many nest sites (11 of 44) on slopes >20% as random sites (14 of 44) ($\chi^2 = 0.50$, $p > 0.05$), and just as many nests (5 of 44) on slopes >30% as random points (8 of 44) ($\chi^2 = 0.81$, $p > 0.05$). The maximum nest slope was 36%. However, there were no nests on north aspects (285-060°) for nests with slopes >20% (n = 11) in the East Kootenay but there were significantly more random points (8 of 14) ($\chi^2 = 9.24$, $p < 0.05$). However, examination of the preliminary model found one misclassification because there were a few nests at 061°, so this restriction was changed to the northern quadrant (315-045°), and changed to detailed 1:20,000 (20-m grid) DEM from the preliminary mapping that used 1:250,000 (90-m grid) DEM.

Variables from the habitat plots were examined for differences between Moderate nest density, Low nest density, and random unoccupied (2008) sites (Table 10). Variables examined included live tree densities by size class and by species; snag, stump and log densities; and log volumes. Very few variables were significantly different between the sites, and none that were consistent enough to allow for reliable differentiation. Moderate density sites were characterized by higher average density of stumps, and WISA nest sites were characterized by higher average densities of very large live trees. However, even these characteristics could not be used to consistently and reliably distinguish different breeding densities of WISA. Lw was present in the live tree >17-cm DBH layer at all nest sites, Fd at all but one, and no other tree species was consistently found. With the exception of Lw and Fd presence, none of the other variables could be easily applied to the VRI layer using surrogates to assist in nest model development.

Table 10. Means and standard deviations for plot and forest cover attribute variables contrasted by local density of Williamson's Sapsucker nests in the East Kootenay. Only variables significantly different at $p = 0.05$ are shown. Means followed by like letters were not significantly different at $p = 0.05$ using Scheffé's post-hoc test. If no letters present, then there were no significant post-hoc differences among means.

Variable Name*	Nest Density								p	
	Moderate			Low			Random-Unoccupied			
	n =12			n =15			n = 17			
	Mean	SD		Mean	SD		Mean	SD		
D_LT_S	159	122	a	200	111	a	451	403	b	0.002
D_LT_L	124	65		147	100		224	140		0.043
D_LT_VL	3.4	2.8		4.7	3.6		2.2	2.2		0.070
D_LT_VL	4.1 ± 3.3						2.2 ± 2.2			0.041
D_LT	127	67		152	101		227	141		0.049
D_ST_L	201	97	a	94	54	b	90	61	b	0.002
D_ST_VL	17.3	10.2	a	7.0	6.0	b	6.2	6.7	b	0.007
D_VL	21.4	12.2	a	12.4	7.6	b	9.0	6.5	b	0.002
D_LT_VL_LW	0.7	0.6	a	2.3	2.3	b	0.4	0.7	a	0.002
D_CAVW_TOT	0.13	0.19	ab	0.49	0.64	a	0.07	0.21	b	0.016
D_LG_VL	4.7	4.3	a	3.1	3.7	ab	0.6	1.7	b	0.006
D_LG_VL	3.8 ± 4.0						0.6 ± 1.7			0.003

*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),

As outlined under the Density section, assessment was made (Gyug 2009b) of how well the Boundary habitat model fit the East Kootenay. WISA were found in 3 of the 10 these randomly selected "Moderate" stands in the East Kootenay, indicating these stands are not truly of moderate suitability. Almost all mature forests in the East Kootenay appeared to have been logged in the first part of the 1900's. Understory trees too small to be taken as saw logs have since released, and while these forests are now mapped as 125-195 years old, these forests are relatively even-aged and dense, and appear more similar in structure to 70-100 year old stands than the mapped age. CWD levels appeared generally very low in these stands, and potentially suitable nest trees (using the same standard as in previous WISA habitat plots) were very scarce (0.06/ha). Aerial photo examination of sites where veteran Lw were known to be present within these relatively dense forests showed these could not always be reliably seen when the overall canopy was mapped as >140 years old (similar to the Boundary, Gyug 2009a). Mapping of WISA suitability in these stands from GIS layers or from aerial photos will be problematic with no simple solution.

In the final model, stands <140 years were reduced in suitability from L to VL if the canopy was very even in height. This indicated that the stand likely generated from a single stand-replacing event with virtually no veteran trees surviving. However stands >140 years with "ragged" canopies were retained as suitable, even though the lack of potentially suitable nest trees and very low levels of CWD may mean they are not truly suitable in their present condition..

In moderately aged (125-195 year) forested stands, densities of very large old stumps >7/ha (mostly Lw) was the most reliable characteristic to distinguish presence from absence (Gyug 2009b). These stumps

had been cut in the 1900-1940 period. However, it was not possible to map forests that may have been once dominated by veteran Lw trees. Only where there were also quite a few veteran Lw cull trees would this be mappable, and this was not often the case. Within the sites where WISA occurred, the precise site occupied was best distinguished from other sites in the same stand by the presence of very large veteran trees (mean 10/ha, range 4-24) even though 37% of other absence plots also contained some very large Lw (range 4-20). However, as discussed in the previous paragraph, these vets could often not be identified in 125-195 year old stands.

Ratings Assumptions – Final VRI Stand Attribute Model

1. This model was derived from nest locations, and will therefore be a nest stand model. It will not be expected to accurately predict all non-nesting observations since WISA will forage in a much wider variety of stands than it will use for nesting. However, it can be tested for predictive reliability using other observations since WISA is a central-place forager when feeding young at the nest, and are most likely to be observed near a nest. Management decisions based on this model must acknowledge that this model only predicts nest stands, and adjacent foraging stands will need to be included when stand management prescriptions near nest stands are developed.
2. No adjustments or ratings were made for ecosection as the AO mapping applied to only a fairly small area. If mapping at a much wider scale, the maximum ratings would apply only to the MCR and EKT ecosections with all others downrated by two levels but remain above Nil (Table 3).
3. Only the PP, IDF, MS and ICH BEC Zones will be considered to have any suitability for WISA in the East Kootenay (Table 4). Within the AO, all BEC variants will be considered to have equal capability for WISA, as these are the only BEC zones within the AO. Outside the AO, maximum rating in any BEC variant would be downrated according to Table 8 (maximum Low in ICHmk4, maximum Moderate in MSdk1, IDFdm2, PPdh2, maximum Nil in all other BEC variants).
4. Adjustments made for elevation with maximum ratings only between 800 and 1400 m and Nil ratings at any other elevations (Tables 1 and 2). For preliminary mapping over a very wide area all adjustments for elevation, slope, aspect, BEC or Ecosection were all based on location of VRI polygon centres. For final mapping in the AO, polygons were split by the 800 and 1400 m elevation contours, and polygons <800 m and > 1400 m discarded from the AO shapefile set.
5. Table 11 provides the VRI characteristics used to define stand nesting suitability.
 - a. VRI polygons incapable of being forested (e.g. Urban, Rivers, Rock, etc) or non-productive (NP) were rated Nil.
 - b. In contrast to other districts, OR polygons often contained VRI attributes, and were treated as if they were potentially forested polygons with a maximum rating of Low if polygon size was <25 ha.
 - c. Any polygons not otherwise assigned H, M, L or Nil according to Table 11 were rated Very Low.
6. A potential High suitability rating was retained for the East Kootenay based on the Okanagan-Boundary habitat model even though no such high WISA breeding densities have been found in the EK.
7. Moderately High (2) and Moderate (3) of the 6-class rating scale have been grouped. The 6-class scale was used so that sites with some potential could be mapped as Very Low, and non-forested sites with no potential could be rated Nil.

Table 11. Final Habitat Suitability Model for the East Kootenay for Williamson's Sapsucker based on VRI attributes only.

Input Data	High (H) (1)	Moderate (M) (2-3)	Low (L) (4)
Layer 1 Projected Age	>195 years	>195	
Layer 1 Projected Ht	≥29.0 m		
Layer 1 Site Index	≥15.0		
Layer 1 Crown Closure	≥30%		
Crown Closure ≥15.0 m ht of Layer 1	≥30%	>20%	>0%
Age of oldest layer	>195 years	>195 years	>100 years
Fd and Lw	Present and leading	Present	Present
Cw and Hw.	Absent	Absent	Absent
PI % composition of both L1 and L2 if height >10 m (i.e. not counting silvicultural layers).	≤30%	≤30%	≤70%
Upgrade from VL to L if:		Fd or Lw present, PI ≤70%, At present, and age of At layer >55 yr	

8. A Moderate suitability rating was used for forested stands, adapted from the Okanagan-Boundary model, even though in the East Kootenay moderate densities were found only in areas fragmented by seedtree or partial cuts, but fragmentation indices were not included in this modeling. Low density nest sites also occurred in sites with similar fragmentation, so fragmentation alone was not a reliable characteristic to distinguish between the Moderate, Low or Very Low suitability.

Adjustments made:

9. Adjustments were made for slope and aspect based on a coarse-scale (90-m grid) DEM from the 1:250,000 NTS series for the wide area model extending beyond the AO and applied based on the value at the center location of each polygon. For the AO, fine-scale (20-m grid) 1:20,000 TRIM DEM was used for the final model as follows:
 - a. North/cold (315-045°) steep (>20%) slopes were rated Very Low (if potentially forested) as none of the 44 nests known from 2004-2009 were on steep north slopes,
 - b. Slopes >40% rated Very Low (if potentially forested) as there were no nests found on very steep slopes,
 - c. Any polygons in the slope and aspect shapefile <2.5 ha were dissolved into the adjacent polygon. This slope and aspect shapefile was unioned with the VRI shapefile. After that union, any polygons <1 ha in size were dissolved back into their parent VRI polygons.
10. Many forested sites that were mapped as Low suitability in the preliminary mapping based only on stand age (>90 years) but many of these were not suitable because they were relatively even-aged and evenly-structured stands regenerating from stand-replacement fires, or recovering from logging in the 1900-1940 period. These were generally not suitable for WISA unless veteran trees were present (Gyug 2009b). In the Okanagan-Boundary, it was a fairly safe assumption that most sites mapped as >125 years old with Lw present did contain some suitable nesting trees, but this assumption did not hold in the East Kootenay (Gyug 2009b). For the final mapping:

- a. the lower limit on stand age was 100 years for Low suitability, but
 - b. stands 100-140 years old and lacking any detectable veteran trees from stereo-pair aerial photo interpretation were reduced to Very Low.
- 11. All of the nests in At nest trees occurred in sites with Low breeding density, but these were not always mapped. Using Landsat images enhanced for deciduous vegetation, stereo-pair aerial photo interpretation, any unmapped aspen patches were added to the attribute table. Where At patches were mapped as <55 years old, they were assessed on the aerial photos to determine if any possible nest trees were present, and if so, these were added as suitable to the attribute table.
- 12. No model derived from the current VRI alone could accurately map suitability for WISA because approximately 50% of nests were in recent seedtree or partial cuts with no VRI attributes associated with the polygons. These were corrected by:
 - a. Adjusting linework for missing harvested areas by unioning polygons from the Forest Cover Results shapefiles for openings, reserves and silviculture where the 2009 VRI was missing linework for harvested areas.
 - b. Adjusting attributes on a on a polygon-by-polygon basis for presence of mature seed trees at densities >1/ha using:
 - i. Stereo-pair aerial photo interpretation for pre-2001 sites (2000 Aerial photos)
 - ii. 2004 1-m pixel digital orthophotos for sites harvested between 2000 and 2004
 - iii. Landsat images or personal knowledge of the area for sites harvested after 2004. The accuracy of these will only be moderate, and will require confirmation. These have been flagged in the database.

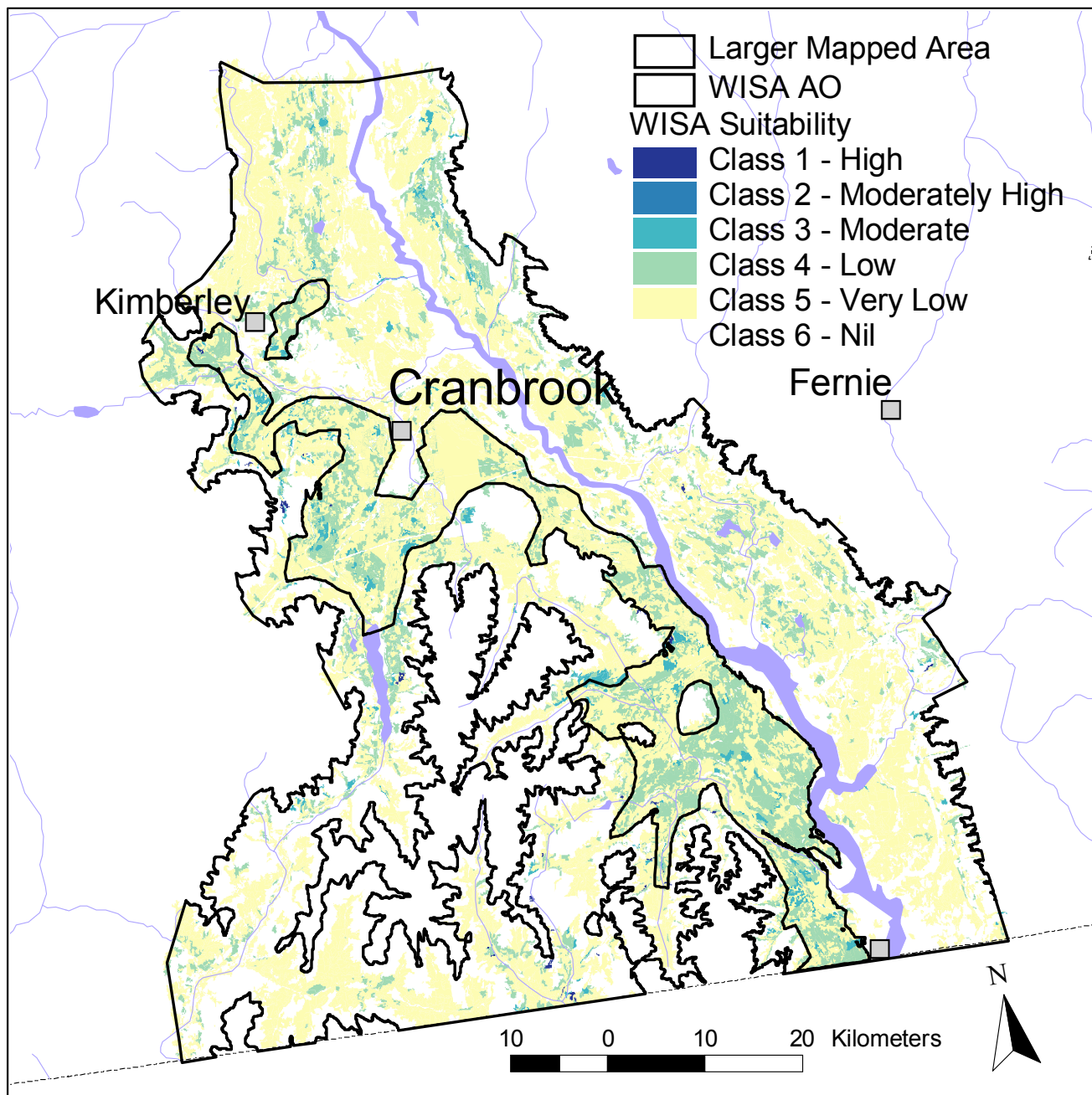


Figure 5. Final WISA habitat suitability modeling for the East Kootenay AO using the VRI algorithms from Table 11, and including slope and aspect adjustments, and additional GIS and aerial photo adjustments and corrections as outlined in the Assumptions section. Only VRI algorithms and coarse-scale slope and aspect adjustments were made to the larger mapped area outside the AO.

Table 12. 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. One nest tree used in model development was in VL habitat outside the AO on the east side of Kootenay River.

Model		Habitat Suitability					Total
		High	Moderate	Low	Very Low	Nil	
Preliminary (Feb 2010)	Area (ha)	107	17324	18622	31557	17414	85024
	% of AO	0.1	20.4	21.9	37.1	20.5	100.0
	Model Nest Trees (n)	0	4	4	12	1	21
	Reserved Nest Trees (n)	0	2	7	11	2	22
Final (Mar 2010)	Area (ha)	90	3138	25656	48120	4872	81876
	% of AO	0.1	3.8	31.3	58.8	6.0	100.0
	All Nest Trees (n)	0	0	42	0	1*	43

*Tree was mapped as in Marsh but was actually in adjacent forest.

Table 13. Percentage of correctly classified locations based on presence/absence for preliminary VRI habitat suitability model. Sample size for each column in ellipses.

Habitat Model	H/M/L Suitability		Presence ¹				Absence ¹	
	Area (ha)	% of AO	Nest Trees	Other Territories	Other Obsn	Random Occupied Point ²	Random Unoccupied Point	Unoccupied CPB point
Preliminary Nest VRI Attribute Model (Feb 2010)	36053	42	(21)					
Model Data			38%					
			(22)	(18)	(48)	(3)	(18)	(766)
Tested			41%	61%	35%	33% (67%)	61% (22%)	56%
Final Nest VRI Attribute Model (Feb 2010)	28884	35	(43)	(18)	(48)	(3)	(16)	(746)
All Data			98%	83%	67%	33% (33%)	56% (44%)	56%

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 Points have two percentages given: the first is for the precise random point; and the second in ellipses is for the highest suitability in the 225-m radius that was searched around each random point. Unoccupied random points were only considered correctly classified if there was no Moderate or Low suitability habitat within the 225-m radius. Any WISA detections on random points were also recorded in one of the preceding three columns of observations as well.

Model Calibration and Reliability

The preliminary Nest VRI habitat suitability model (February 4, 2010, Fig. 5) was compared to see how well it fit the randomly selected nest data from which it was developed, and fit the data reserved for testing (Tables 12 and 13). The model fit both the original nests and those nests reserved for testing relatively poorly, although it performed similarly in each case. This was primarily because of the half or more nests for which there were no VRI attributes. Corrections were made for these in the second (final) phase of the project using stereo-pair aerial photo interpretation and modifications to the VRI attributes used in the model. The final attributes used and corrections made have been outlined in the Assumptions section.

WISA Nests and Observations

The final AO model would be considered very reliable based on the corrections made to fit to the data from which it was derived (98% of nests, Tables 12 and 13). Application of the GIS and aerial photo corrections reduced the amount of H/M/L suitability habitat from 42% of the AO to 35% (Tables 12 and 13). Most (83%) of other breeding territories contained at least some of the observations associated with the territory in H/M/L suitability habitat (Table 13). Other observations not associated with known breeding territories were most often (67%) in H/M/L suitability habitat (Table 13).

CPB locations

The majority of CPB points (56%) where WISA were not detected were in Very Low or Nil suitability habitat (Table 13). However, caveats apply to the use of CPB points to judge model performance (Psyllakis and Gillingham 2007) because of movements of birds toward the CPB point before detection, possible errors in estimation of bird location, or locations of birds traveling between suitable habitats within their breeding territories. Only one of the 225-m radius areas around occupied random points contained some H/M/L suitability habitat, but then none of the points had resident WISA on them, and any birds detected appeared to have come from other habitats into the sampled area. About half of the sampled area at unoccupied random points contained no H/M/L suitability habitat at all.

Model Limitations

This model was based on 1:20,000 VRI stand data at nest locations, and therefore has the implicit assumption that nest location can be predicted by VRI stand characteristics, and that this factor outweighs other factors that may control breeding locations. Since Drever et al. (manuscript) showed that WISA occupancy probability was correlated best with the densities of trees that have the highest suitability as nest trees, this assumption may hold. Since WISA is a central place forager, nest locations (to a certain extent) also describe the foraging territory, and since the nest model is also based on tree densities (since nest trees cannot be present if trees are not present), this is partially included in the model already. The exception will be for treed stands (usually even-aged or <100 year old stands) that may have Very Low suitability for nesting, but may be suitable for foraging. Foraging requires trees and ants and is therefore a function of tree density (Drever et al. ms, Gyug et al. BBN manuscript) and ant availability, but this has yet to be extrapolated successfully to VRI surrogate factors for wider area modeling.

There is very little confidence in this model in distinguishing Moderate from Low suitability habitats, and it would be better to consider any High, Moderate or Low suitability habitats as "Suitable". The breeding densities that supply the benchmark, and the other densities rated against the benchmark, were estimated over large areas (>100 ha) that would normally encompass a variety of stands that may differ markedly. This nest stand model will not be successful at reconciling individual stand suitability with large-area densities because of the different scales. Grid methods that average foraging suitability and nesting potential would probably be required to reliably estimate suitability over the range of habitats typically found in most breeding territories, and in larger census areas.

Field Ratings Adjustments:

Adjustments may be made in the field to ascertain actual site suitability. A draft field key for the regions where larch is the primary WISA stand type has been prepared separately. This field key was based on summaries of the differences between High, Moderate and Low density sites, and unoccupied random plots partially as outlined in Drevers et al. (manuscript), and as detailed in the Boundary and Okanagan WISA species accounts, and for the East Kootenay in this account. In the East Kootenay, the most important stand attributes to key out WISA suitability will be the presence of suitable nest trees, and the presence of multiple stand layers, rather than sites dominated by relatively even layers 70-195 years old, or approximately 15-25 m in height.

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