

**Williamson's Sapsucker
Baseline Monitoring 2011:
Field Report
and Preliminary Analyses**

20 July 2011

Prepared by
Les Gyug, R.P.Bio.

Okanagan Wildlife Consulting
3130 Ensign Way,
West Kelowna, BC V4T 1T9

and

Keystone Wildlife Research
112 – 9547 152nd Street
Surrey, BC V3R 5Y5

In fulfillment of contracts:

K2F51-11-4015 to Okanagan Wildlife Consulting (West Region),
and
K2F51-11-4016 to Keystone Wildlife Research (Okanagan-Boundary Region)

Prepared for:
Environment Canada – Canadian Wildlife Service
5421 Robertson Road, Delta, B.C

EXECUTIVE SUMMARY

Williamson's Sapsucker (WISA) baseline monitoring began in 2010, and was continued into 2011, which is reported here. Call-playback points in the Okanagan-Boundary (AO) (52 points) and in the West (51 points) Areas of Occupancy (AO) were sampled 5 times each in May and June, 2011, by two habitat strata--1. Moderate which included any High and Moderately High, and 2. Low-- and by accessibility strata--1. road or 2. non-road (>400 m from a road). Occupancy (ψ) and detectability (p) were calculated from presence/non-detection at CPB points using the software program PRESENCE.

Occupancy was significantly higher in the Moderate than Low habitat suitability strata in both 2011 (0.64 vs 0.45) and in 2010 (0.83 vs 0.17) although the magnitude of the difference was not as large in 2011 as in 2010. Occupancy was not significantly different in the Okanagan-Boundary and West regions, and did not differ by road or non-road access strata. Detectability did not differ between Moderate and Low habitat strata or regions. Detectability was lower in the non-road stratum, primarily because of lower detectability in the Moderate non-road sites, although no behavioral cause was apparent.

There was a positive effect of habitat on occupancy (increased habitat suitability ratings showed higher occupancy), and a negative effect of day-of-year and cloud cover. Detectability was high in early May (0.59), declined after mid-May (0.50), and was lower in late-May and early June (0.44-0.47). Detectability was lower in 2010 (0.38) but not significantly different from the same time period in 2011. The 2011 and 2010 data should be examined to determine if zero-inflated binomial models are required for analyses as was applied in 2010 when the detection data seemed very sparse.

Detectability was lowest in complete overcast conditions in 2011, but this effect was not significant in 2010, nor in previous relative density analyses from call playback results analyzed in preparation of Gyug et al. (2007) (Gyug, unpublished data). No other sampling covariates had any effect on detectability including hour-of-day (sunrise to late afternoon), wind (winds of Beaufort 0-3, no sampling was done if winds were >Beaufort 3), air temperature, and precipitation (none, drizzle or light rain—no sampling was done during heavy rain).

To maximize detectability, and minimize the number of repeat visits to sites to determine occupancy reliably, WISA sampling for monitoring should be mid-May or earlier when detectability is 0.60 or greater, and only two or three visits to any site are required. Detectability during the territory establishment phase (mid-March to early or mid-April) is not yet known, but may be even higher than 0.60. However, most roads in the WISA AO are snow covered, or in the process of melting out of snow cover in that period, which creates logistical difficulties. Sampling in that period would have to be limited to snow-free roads, or access could be by snow machine and 4WD vehicle depending on road and snow conditions.

TABLE OF CONTENTS

INTRODUCTION.....	4
METHODS.....	4
<i>Study Design</i>	4
<i>Field Methods</i>	6
<i>Data Submission</i>	7
<i>Occupancy and Detection Analyses</i>	7
RESULTS.....	8
DISCUSSION.....	11
<i>Occupancy and Detectability</i>	11
<i>Presence/Absence vs Count Data</i>	12
<i>Sampling Site Choice</i>	12
<i>Occupancy Assumptions</i>	12
LITERATURE CITED	13
Appendix 1. 2011 WISA baseline monitoring detection histories formatted for occupancy and detection rate estimation in Program PRESENCE.....	15
Appendix 2. Detection history of WISA CPB points sampled with 3 repeats in 2010.	16
Appendix 3. Detection histories of WISA CPB points repeated in 2010 and 2011.....	17

List of Tables

Table 1. Optimal allocation of effort for Williamson's Sapsucker call-playback (CPB) points in 2011 based on formula of Thompson (2002, p. 123) given 10 available field days to sample each point once, and all points to be sampled 5 times.....	5
Table 2. WISA probability of occupancy (ψ) of categorical strata estimated in a naïve manner and using PRESENCE software including the estimate of standard error (SE). Only originally allocated random CPB points were used in the analysis.	9
Table 3. WISA probability of detection (p) of categorical strata estimated in a naïve manner and using PRESENCE software including the estimate of standard error (SE). All CPB points were used in the analysis.	9
Table 4. WISA probability of detection (p) by date estimated in a naïve manner, and using PRESENCE software on each date period.	9
Table 5. Site and sampling covariates affecting WISA site occupancy (ψ) and detectability (p) of WISA in 2011 using 103 originally allocated sites sampled 5 times each.	10

Acknowledgments

This assessment was funded by the Canadian Wildlife Service of Environment Canada, Delta, B.C. through contracts K2F51-11-4015 to Okanagan Wildlife Consulting (West), and K2F51-11-4016 to Keystone Wildlife Research (Okanagan-Boundary). Ian Parnell of CWS was the contract monitor and set up these contracts. The study was designed with the assistance of Darcy Pickard of ESSA Technologies. Thanks go to Dustin Oaten and Philip Gyug for assistance in collecting field data in 2011.

INTRODUCTION

Williamson's Sapsucker (WISA) is a medium-sized woodpecker specialized for feeding on sap. It has been designated as Endangered in Canada (COSEWIC 2005), and is listed under Schedule 1 of the Species at Risk Act. This project was the continuation of the baseline population monitoring in support of the WISA Adaptive Monitoring Framework (AMF) (Marmorek and Pickard 2010) that was begun in 2010 using call playback (CPB) methods. CPB results were analyzed using the methods of MacKenzie et al. (2002) for rare and imperfectly detectable species using occupancy rates, and in a manner that allowed detection rates to be estimated.

Habitat suitability modeling for WISA had been completed in 2009-2010 (Gyug 2009, 2010a, 2010b, 2010c) for the Areas of Occupancy in each of three regions (West, Okanagan-Boundary and East Kootenay). In 2010 WISA detections on CPB showed the models to perform as expected in the West and Okanagan-Boundary regions with an occupancy rate of 0.737 in Moderately suitable habitat (which included High and Moderately High habitats grouped together), 0.224 in Low, and 0.008 in Very Low (Pickard and Ainsworth 2011). For 2011, only Moderate and Low habitats were sampled since there were no detections in Very Low habitats in the West and Okanagan-Boundary regions in 2010, and each sampling point was sampled five times to determine detection rates more precisely.

The baseline monitoring was funded by Environment Canada, Canadian Wildlife Service. In 2011, CPB were conducted in the Okanagan-Boundary under contract K2F51-11-4016 from CWS to Keystone Wildlife Research, and in the West region under contract K2F51-11-4015 from CWS to Okanagan Wildlife Consulting. This report was intended to satisfy the reporting requirements of both those contracts since the project was designed for the data to be analyzed together as one dataset. Separate WISA monitoring was planned for the East Kootenay in 2011 that was not part of this project. Different methods were to be used there to derive a population estimate for that region.

The purpose of this report was to describe the study design and the methods used for sampling in 2011, present the 2011 results, and provide a preliminary analysis of those results as to how WISA CPB detection rates may vary with sampling covariates (e.g. weather, time-of-day, time-of-year), and how probability of occupancy may vary by habitat suitability, by region and by accessibility, i.e., roaded or non-roaded sites.

METHODS

Study Design

A stratified random sampling design was used. As in 2010, sampling was apportioned evenly by region (West and Okanagan-Boundary), and apportioned by habitat suitability within regions. Habitat strata included Moderate (which included any High or Moderately High) and Low suitability only. The Very Low stratum was not sampled in 2011 because no WISA were detected in 45 Very Low suitability CPB sample points in each of the West and Okanagan-Boundary regions in 2010. Further sampling within the Very Low was not considered to be an efficient use of limited sampling resources.

Table 1. Optimal allocation of effort for Williamson's Sapsucker call-playback (CPB) points in 2011 based on formula of Thompson (2002, p. 123) given 10 available field days to sample each point once, and all points to be sampled 5 times.

Access Strata	Habitat Strata	Variance ¹	Area (km ²)	N ²	Sites/day	Cost per site (days)	n points	n days	Ok-Bdy	West
NonRd	L	0.088	213	424	5	0.2	19	3.8	9	10
Road	L	0.102	263	523	20	0.05	51	2.6	26	25
NonRd	M	0.213	98	194	5	0.2	14	2.8	7	7
Road	M	0.232	64	127	20	0.05	<u>19</u>	<u>1.0</u>	<u>10</u>	<u>9</u>
Sum							103	10.1	52	51

¹Variance of probability of occupancy (psi) from 2010 estimates (Pickard and Ainsworth 2011, and Pickard, unpublished data).

²Total possible N based on assumed 400-m radius of sampling. However, allocation is not sensitive to this column should this radius be something different.

In 2010 probability of detection was found to be relatively low (0.312 with 95% CI of 0.194-0.469, Pickard and Ainsworth 2011). Given this relatively low detectability, 5 repeats of each sample site in 2011 were recommended to increase precision of the occupancy estimates (Pickard and Ainsworth 2011).

Sampling at fully random points in 2010 was found to be relatively inefficient, with 5-9 points completed per day on average largely because of the time spent walking into sites. A quick examination of the 2010 data (Pickard, pers. comm.) found that no differences in occupancy based on distance to road of <400 m or >400 m. Therefore an Access stratum was added in 2011 where the points on roads would be considered to sample all habitats within 400 m of roads and non-road points would sample habitats >400 m from roads. A GIS road coverage was made of the WISA Areas of Occupancy based on the public road and forest tenure road coverages (available from the Land and Resource Data Warehouse of the B.C. Integrated Land Management Bureau <http://www.lrdw.ca/>). This road coverage was modified where roads were known to be no longer drivable. Roads were also added from the B.C. Digital Road Atlas for other non-status resource roads that are not in the other two road coverages but that were known to be passable by regular 4WD vehicle.

An optimal allocation formula (Thompson 2002, p. 123) that included sample variation and cost was implemented in Excel to assign effort to each strata in 2011 (Table 1). Assumed was that sampling would be split evenly between the West and Okanagan-Boundary, and funding would limit sampling to 50 field days in total in 2011. And since each sample point was to be repeated 5 times, all points had to be sampled within 10 field days. Sampling cost was assumed to be 5 non-road points in one field day, and 20 road points in one field day (although in fact, these would be mixed in any given real field day).

Ten of the 2010 sample points on or near roads were randomly selected in each of the regions and repeated in 2011 to determine annual extinction and colonization rates. All points had to be >800 m from any other sample point to be independent. After selection of

the 2010 points to be resampled, the remaining points were randomly selected in a GIS coverage of the suitability models. For this purpose, the many small polygons were dissolved into large polygons by habitat suitability. Road points were selected randomly on roads within the dissolved habitat suitability polygons, and then the suitability of the habitat within a 225-m radius calculated. To be considered for random selection, Moderate points had to have at least 75% Moderate habitat within the radius, and Low had to have at least 70% Low habitat. Non-road points were selected such that points were at least 200 m from the habitat polygon boundary, i.e., sampled relatively uniform Moderate or Low suitability habitat.

After the 52 points in the Okanagan-Boundary and 51 points in the West were spatially located, it was realized that additional sampling could be done on the same roads that were going to be traveled anyway at no additional cost. Therefore 10 points in the Okanagan-Boundary and 13 points in the West were randomly allocated along these roads in either Moderate or Low habitat strata. These points were intended to be used to increase sample size for calculating detection rates, but would not be valid for estimating occupancy rates as they may be spatially correlated with the previously randomly selected points.

In 2010, detectability was relatively low (0.31) and was thought to be because most sampling was in the incubation and nestling periods (May 25-June 20) when relative density estimated from CPB were known to be about half compared to earlier in May (Gyug et al. 2007). Therefore sampling in 2011 was to be between April 15 and May 15 to attempt to sample WISA in the pre-nesting period when detectability was assumed to be relatively higher. However, other events prevented funding from being available in April. The Okanagan-Boundary sampling began on May 9 and continued until May 28. West sampling began on May 25 and continued until June 8. Each local set of points that could be sampled in a day were sampled as quickly as possible to keep the sampling within one reproductive stage (e.g. pre-nesting) when detection rates and occupancy were unlikely to change.

Field Methods

This work was intended to continue with the baseline monitoring begun in 2010 (Gill 2010, Ohanjanian 2010, Steeger 2010) therefore the same call playback methods were used. Pre-selected CPB points were entered into GPS units to facilitate navigating to points. At each CPB point, date, time of day, ambient temperature, wind speed (Beaufort), cloud cover (1-4 scale where 1 = clear, 2 = <50% clouds, 3 = >50% clouds, 4 = overcast) and precipitation (None, Drizzle, Light Rain) were recorded each time the point was sampled. On the first visit to each CPB point, the type of access (road or walk) and the time required to walk to each site were recorded. Sampling was conducted after sunrise but before dusk (although actual sampling hours were between 517 h and 1715 h), only if winds were <Beaufort 4, and not in heavy rain. Each CPB point sample consisted of one minute of silent listening, three broadcasts of a 10-15 second Williamson's Sapsucker drum and call combination repeated three times over in three directions, and then a silent listening period of 3 minutes. Playbacks were ceased once a WISA was detected from a point, and not initiated if a WISA was detected during the silent listening period.

At each sampling point, the estimated distance (m) and direction (degrees from a compass reading) to the initial detection of every WISA were recorded. In open areas or over

very short distances where the stand or tree where the WISA was detected could be seen, the distance was measured using a laser rangefinder, by walking to the point and taking a GPS reading, or later on digital orthophotos. In closed forest, distances were estimated based on the volume attenuation of the drum or call, and were not considered reliable. If more than one WISA was recorded at a point, and birds were not seen, the behaviour of each bird was noted to try to determine if birds were a mated pair. Where two adults were detected in close proximity to each other, but both were not necessarily seen, they were assumed to be a pair if no antagonistic interactions were noted.

Data Submission

Field data was entered into a WISA Excel file template designed for submission to the Wildlife Species Inventory (WSI) Species Inventory (SPI) system of the BC Ministry of Environment. The same data was reformatted to fit into two shapefiles (one for CPB points, one for WISA observations) used to analyze and store WISA data. The same data from 2011 was also reformatted to fit into an Excel file suitable for direct copying into the analysis software program PRESENCE.

Data files submitted with this report include:

1. WISA 2011 Ok-Bdy and West SPI Data.xls The SPI Excel template format containing data from both the Okanagan-Boundary and West regions from 2011. This file has been quality checked for formatting and for data entry errors.
2. WISA_CPB_1996_2011b Point GIS ESRI shapefile set in BC Albers projection of all WISA call playbacks from 1996 to present. This set includes a metadata WORD document. It does not yet include any East Kootenay data from 2011 which would be in a “c” or later version.
3. WISA_OBS_1994_2011d Point GIS ESRI shapefile set in BC Albers projection of all WISA observations within the Ministry of Environment, Environment Canada and other forest licensee WISA projects from 1994 to present. This set includes a metadata WORD document. It does not yet include any East Kootenay data from 2011 which would be in an “e” or later version.
4. WISA_Analysis_CPB_2011.xls The 2010 and 2011 WISA CPB data formatted for direct copy into software program PRESENCE.
5. Optimal Allocation WISA CPB pts 2011 LG The optimal allocation formula of Thompson (2002, p. 123) in Excel format that can be used in the future to allocate WISA CPB effort by sampling strata within a sampling year.

Occupancy and Detection Analyses

Occupancy (ψ) and detection rates (p) were analyzed using the software program PRESENCE 3.1 (Hines 2006). An important assumption of the method is that occupancy does not change over the course of each sampling period when repeat sampling is done within the sampling period. However, occupancy may change between sampling periods (e.g. between years) which allows patch extinction and colonization rates to be determined if each sampling point is considered a patch. Each point must be independent of other sampled points. Each

sample at a given point was considered a positive detection and assigned a “1” if a WISA was detected. If no WISA were detected, a “0” was assigned.

Sampling covariates examined for influence on detection rates included date, time-of-day, ambient temperature, wind, cloud cover, and precipitation. Site covariates included Region (West and Okanagan-Boundary), Habitat and Access (road, non-road). PRESENCE does not analyze categorical variables directly but instead the estimated values for occupancy and detection rates must be compared separately using their standard errors (se) and 95% confidence intervals (CI). To include habitat in the direct analysis, it was converted from a categorical to an ordinal variable using the average habitat suitability score within a 225-m radius of each sample point in the original habitat suitability coverages. Habitat suitability scores are on a scale of 0-1, with benchmark habitat being set as 1 (see any of Gyug 2009, 2010a, 2010b, 2010c). The midpoints of habitat suitability score classes are 0.88 for High, 0.63 for Moderately High, 0.38 for Moderate, 0.16 for Low, 0.03 for Very Low, and 0.00 for Nil.

Possible estimation of extinction and colonization rates from 2010 to 2011 for the 20 points sampled in both years was limited because only a subsample of points were repeat sampled within 2010 (see Appendix 2). This analysis was not undertaken and not reported here.

RESULTS

Occupancy (ψ) was significantly higher in the Moderate than in the Low suitability habitats in both 2011 and in 2010, although the magnitude of the difference between Moderate and Low was not as high in 2011 as in 2010 (Table 2). There was no significant difference in occupancy between the Okanagan-Boundary and West regions, and between road and non-road sites in 2011 (Table 2).

Probability of detection was significantly different for road and non-road sites (Table 3). Since it was not immediately apparent why this should have occurred, this was examined further. The road layer was found to be not entirely accurate as there were many unmapped old roads, many of which were still drivable by small high clearance 4WD vehicles. We therefore could drive to a number of points which were pre-selected as non-road points. I examined the actual access type of each point to determine the type of points with low detectability. There were 13 Moderate points and 21 Low points that required a walk of >1 minute. Occupancy (ψ) was 0.89 (se 0.22) for the Moderate and 0.51 (se 0.12) for the Low. Detectability (p) was 0.26 (se 0.08) for the Moderate and 0.41 (se 0.08) for the Low. Therefore this low detectability was only at Moderate points in the non-road sampling, and in particular 4 of the 13 points where WISA were detected only once in the five visits in 2011. At two of these points, single WISA detected were estimated to be >400 m from the sample point (which only occurred for 5 of the total 188 WISA detections). If these two detections are deleted, then occupancy is 0.63 (se 0.18), i.e., the same as in Table 2, but detectability is still only 0.32 (se 0.09), i.e. lower than in Table 3.

Table 2. WISA probability of occupancy (ψ) of categorical strata estimated in a naïve manner and using PRESENCE software including the estimate of standard error (SE). Only originally allocated random CPB points were used in the analysis.

Stratum	CPB Pts	Pts with WISA	Naïve Occupancy	Probability of Occupancy		
				ψ	SE	95% CI
						($\pm 1.96 \times \text{SE}$)
Ok-Bdy	52	28	0.538	0.549	0.071	0.410-0.688
West	51	22	0.431	0.485	0.082	0.325-0.646
NonRoad	33	18	0.545	0.614	0.104	0.411-0.817
Road	70	32	0.457	0.469	0.061	0.349-0.588
Moderate	33	20	0.606	0.640¹	0.092	0.460-0.819
Low	70	30	0.429	0.445¹	0.062	0.324-0.567
Moderate 2010	29	16	0.552	0.833¹	0.221	0.400-1.267
Low 2010	25	4	0.160	0.168¹	0.078	0.016-0.321

¹ Pairs of ψ shown in bold are not contained within the 95% CI of each other. Note that 2010 estimates calculated in same manner as in 2011, without using zero-inflated binomial model as in Pickard and Ainsworth (2011).

Table 3. WISA probability of detection (p) of categorical strata estimated in a naïve manner and using PRESENCE software including the estimate of standard error (SE). All CPB points were used in the analysis.

Stratum	CPB Pts	Pts with WISA	Detections	Naïve Detectability	Probability of Detection		
					p	SE	95% CI
							($\pm 1.96 \times \text{SE}$)
Ok-Bdy	62	35	92	0.526	0.511	0.040	0.432-0.590
West	64	34	80	0.471	0.446	0.042	0.364-0.528
NonRoad	33	18	36	0.400	0.356¹	0.059	0.240-0.471
Road	93	51	136	0.533	0.520¹	0.033	0.454-0.585
Moderate	44	31	73	0.471	0.447	0.044	0.360-0.533
Low	82	38	99	0.521	0.506	0.039	0.429-0.582
Overall	126	69	172	0.499	0.480	0.029	0.422-0.537

¹ Pairs of p shown in bold are not contained within the 95% CI of each other.

Table 4. WISA probability of detection (p) by date estimated in a naïve manner, and using PRESENCE software on each date period. Note there were five visits to each site in 2011 but only three in 2010.

Sampling Dates	CPB Pts	Pts with WISA	Detections	Naïve Detectability	Probability of Detection		
					p	SE	95% CI
May 9-13	14	8	24	0.600	0.593	0.081	0.435-0.751
May 15-21	31	12	31	0.517	0.501	0.069	0.365-0.637
May 21-30	27	19	44	0.463	0.437	0.056	0.326-0.548
May 30-June 8	54	30	73	0.487	0.465	0.044	0.378-0.553
May 25-June 20, 2010	54	20	30	0.500	0.382	0.084	0.218-0.546

Table 5. Site and sampling covariates affecting WISA site occupancy (ψ) and detectability (p) of WISA in 2011 using 103 originally allocated sites sampled 5 times each.

Model terms	K	AIC	Δ_i	ω_i	Model Likelihood	-2*LogLikelihood
$\psi(\text{habitat}), p(\text{day of year, cloud})$	5	481.4	0	0.4569	1.0000	471.40
$\psi(\text{habitat}), p(\text{cloud})$	4	483.61	2.21	0.1513	0.3312	475.61
$\psi(.), p(\text{day of year, cloud})$	4	483.64	2.24	0.1491	0.3263	475.64
$\psi(\text{habitat}), p(\text{day of year})$	4	484.43	3.03	0.1004	0.2198	476.43
$\psi(.), p(\text{cloud})$	3	485.94	4.54	0.0472	0.1033	479.94
$\psi(.), p(\text{day of year})$	3	486.69	5.29	0.0324	0.0710	480.69
$\psi(\text{habitat}), p(.)$	3	486.78	5.38	0.031	0.0679	480.78
$\psi(.), p(.) = 1$ group, constant p	2	489.18	7.78	0.0093	0.0204	485.18

In 2011, probability of detection was higher in the second week of May than the third, and both were higher than the last week of May and first week of June (Table 4). Probability of detection was almost identical in 2011 and in 2010 comparing the same time periods. In the second week of May, all sites that were occupied were known by the second sampling visit, i.e., the third to fifth sampling rounds provided no new occupancy information. In the third week of May, all occupied sites were known by the third visit. In the fourth week of May and first week of June, 80% of the occupied sites were known by the third visit, and 96% by the fourth visit. The fifth visit provided new occupancy information at only 2 of 81 sites sampled in the last week of May and first week of June.

The probability of detection shown in Table 4 for 2010 used the same method as in 2011, but did not use the zero-inflated binomial model of Pickard and Ainsworth (2011). Note that the use of the zero-inflated binomial model produced a different detection probability for 2010 (0.31) compared to that calculated without it (0.38).

The best model fit included the effect of habitat on occupancy (ψ), and of day-of-year and cloud cover on detectability (p) (Table 5). Test of goodness-of-fit showed the best model to be a good fit to the data, i.e., not overdispersed, with $\hat{c}$ of 1.168, i.e. nearly 1 ($p = 0.27$). Occupancy increased with increasing habitat suitability scores, i.e. Moderate habitat suitability (mean suitability rating $\pm$ sd, 0.397 ± 0.121) occupancy was higher than for Low habitat suitability (suitability rating, 0.153 ± 0.013). This difference in habitats using ordinal suitability scores was similar to the difference shown using categorical comparison of habitats (Table 2). Day-of-year had a negative effect on detectability as also shown in the categorical comparison (Table 4). As the breeding season proceeded into the incubation and nestling phases, detectability decreased.

Cloud cover had a significant negative effect on detectability with higher detectability on clear days. In the data used for the analyses in Table 5, WISA were detected on 28% of samples when there were no clouds (Cloud cover = 1), 22-25% of samples when partially cloudy (Cloud cover = 2 or 3), and 20% of samples when completely overcast (Cloud cover = 4). In the extra data (23 points sampled 5 times each), this cloud cover effect was even more

pronounced with WISA detected at 61% of samples when Cloud =1, 39-45% when Cloud = 2 or 3, and only 23% when Cloud = 4.

Hour of the day, wind, habitat and temperature had no discernable effects on detectability, and were not included in the global model considered in Table 5. Within the constraints already put on data collection (wind <4), wind had no effect on detectability. However, very few samples were collected when the wind was 3 (28 of 515 samples), and the naïve detectability was 0.13 compared to 0.23-0.26 for wind speeds of 0-2. Given more samples at wind speeds of 3, I suspect that wind speeds of 3 would have been shown to have a significant negative effect on detectability.

The 2010 CPB data was re-examined for sampling covariate effects on detectability. No significant effects were found for environmental covariates including cloud cover, wind, precipitation and hour of the day.

DISCUSSION

Occupancy and Detectability

Relative densities by strata in the West and Okanagan-Boundary regions were in the order expected, i.e., highest in Moderate and lower in Low, although the absolute difference was not as pronounced as in 2010.

Day-of-year had a negative effect on detectability, i.e., detectability decreased as the breeding season progressed. If sampling could be run during mid-April to mid-May, then detectability (p) is about 0.60 or higher, and only two repeat visits are required to achieve a per-site detectability of 0.84, i.e., $1-(1-p)^2$, and three repeat visits gives a per-site detectability of 0.94, i.e., $1-(1-p)^3$. Detectability may be even higher during the territory establishment phase (about March 20 to early or mid-April), and WISA are often detected spontaneously drumming even without any CPB. Spontaneous drumming and calling decreased from 38/hour during the territory establishment phase, to 10/hour during nest excavation phase, and to only 1-2/hour during the incubation and nestling phases (Crockett 1975).

However, most access roads are snow covered during the mid-March to mid-April period. During that period some areas will only be accessible by snow machine and/or snowshoe. Random sampling of the AO would require a combination of over-snow travel, travel on roads partially melted out from snow cover, and travel on the very few snow-cleared roads within the WISA AOs. These could be sampled as another sampling stratum similar to the road/non-road stratum used in 2011.

Cloud cover, and particularly fully overcast conditions, had a negative effect on detectability only in 2011. This was also my impression during 2011 field sampling—WISA appeared to be detected more frequently on clear days. Cloud cover was not found to have any effect in the CPB data analyses done in preparation for Gyug et al. (2007) (Gyug, unpublished data), and had no effect in 2010. Future sampling should continue to examine for environmental sampling covariate effects to see if the effect of cloud cover on detectability in 2011 was an anomaly or a real effect.

No behavioural reason as to why detectability should be significantly lower away from roads was apparent. As long as occupancy is the parameter of interest, then this should not affect monitoring results. The low detectability may have been an anomaly of the relative few samples in the Moderate non-road stratum. If this low detectability in Moderate non-road points is the same in further years, then it would bear examining further.

The necessity of modeling the WISA data with zero-inflated binomial models needs to be reexamined. Detectability appeared to be very low when estimated using these models in 2010, compared to the unadjusted estimates in 2010 and 2011 presented here. The appropriate method to model this WISA occupancy data to remove any possible modeling/distribution bias needs to be determined. It may have appeared that the data was inflated with zeros in 2010 when no WISA were detected in Very Low habitats and infrequently in the Low, but the 2011 dataset data appeared relatively normal.

Presence/Absence vs Count Data

The number of WISA detected from each point at each sample was not used for this analysis (see Pickard and Ainsworth 2010) but may be in the future. Of 630 point samples (126 points sampled 5 times each), WISA were detected on 172 point samples, with >1 WISA detected at 15% of those samples (26 of 172). However, based on behavioral clues, I estimated that only 5 of 126 points detected >1 WISA territory, with the others detecting both members of a mated pair. These multiple territories at a point accounted for only 7 of the 26 occasions when >1 WISA was detected at a point. Should WISA densities increase significantly, or occupancy be estimated in local sites where a number of territories occur adjacent to each other, then the Royle-Nichols adjustment using counts rather than just detection/non-detections may be justified. However, this would still likely require behavioural estimation of whether detections involved adjacent territories, or both members of a pair, and would require careful definition of what was considered occupancy.

Sampling Site Choice

Sites should be selected fully randomly from within each stratum at all times. When I added extra sites on roads we were going to be traveling anyway to increase sample size for detectability, these were randomly selected only within certain bounds, and expected to be spatially correlated with the other pre-selected random points. However, occupancy turned out to be much higher in these extra points than in the fully randomly selected sites: WISA were found at 100% of the 11 Moderate sites added, and 67% of the 12 Low sites added. Unwittingly, I had only added sites in locales where I thought there would be a good chance of detecting WISA. This type of bias of site choice must be avoided if the results are to be extrapolated across the entire AO. However, the higher occupancy rates in certain locales did indicate that there may be higher levels of suitability/occupancy in certain portions of the AO that have not been recognized in the habitat suitability modeling.

Occupancy Assumptions

Occupancy modeling was designed for patch occupancy, i.e., occupancy is determined within a known area. Point counts are variable radius sampling, and do not sample a known area. Distance sampling methods to handle variable radius sampling have been well

developed, with readily available software to assist in analyses (e.g., program DISTANCE, Thomas et al. 2009). In forested sites where birds may be hundreds of meters away, but sight lines are generally only about 50 m at best, the distance to all detections is impossible to estimate accurately. Therefore, even if other assumptions or concerns about distance sampling can be dealt with, the impossibility to accurately estimate distances would make it difficult to apply distance sampling methods to WISA detections.

I suspect that the size of the occupancy patch also changes over the course of the breeding season, i.e., WISA respond from further distances earlier in the breeding season. This will frustrate any comparisons made in different phases of the breeding season as the patch occupancy will change if the effective detection radius also changes.

Finally, if one wishes to calculate absolute density (not just relative density) from variable radius point counts, these methods assume that the birds do not approach the observer before being detected. WISA regularly violate this assumption, often being first detected only several meters from the observer after approaching silently. I also can never recall any situation where a WISA was detected further away than its nest, i.e., they only respond from half of their breeding territories. If they are on the far side of the territory relative to the observer when a CPB is done, they either do not respond, or move to the nest site before responding, or move closer to the observer than the nest site before responding. This particular behaviour will not allow us to ever use CPB results to directly estimate WISA absolute densities. If absolute densities or population numbers are desired, then it would appear to be necessary to do censuses where either nests or territory centers are enumerated within pre-determined areas, or CPB are used only to determine WISA presence in order to initiate nest and/or territory center searches.

LITERATURE CITED

- Crockett, A.B. 1975. Ecology and behavior of the Williamson's Sapsucker in Colorado. Ph.D. Thesis, University of Colorado, Boulder, CO
- Gill, C. 2010. Williamson's Sapsucker Baseline Population Monitoring in the Western Region Area of Occupancy. Report prepared by Kestrel Consulting for Canadian Wildlife Service, Environment Canada, Delta, BC.
- Gyug, L.W. 2009. Final species account for species-habitat model for Williamson's Sapsucker in the Boundary. BC Timber Sales, Kootenay Business Region, Nelson, BC.
- Gyug, L.W. 2010a. Final species account for species-habitat model for Williamson's Sapsucker in the East Kootenay. Report prepared for Environment Canada, Canadian Wildlife Service, Delta, BC, and Ministry of Environment, Victoria, BC.
- Gyug, L.W. 2010b. Final species account for species-habitat model for Williamson's Sapsucker in the Okanagan. Report prepared for Weyerhaeuser Co. Ltd., Princeton, BC

- Gyug, L.W. 2010c. Final species account for species-habitat model for Williamson's Sapsucker west of Okanagan Lake. Report prepared for Environment Canada, Canadian Wildlife Service, Delta, BC, and Ministry of Environment, Victoria, BC.
- Gyug, L.W., I.P. Ohanjanian, C. Steeger, I.A. Manley, and P.W. Davidson. 2007. Distribution and density of Williamson's Sapsucker in British Columbia, Canada. *British Columbia Birds* 16: 2-15.
- Hines, J.E. 2006. PRESENCE2-Software to estimate patch occupancy and related parameters. USGS-PWRC. URL: <http://www.mbr-pwrc.usgs.gov/software/presence.shtml>
- MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83(8): 2248-2255.
- Marmorek, D. and D. Pickard. 2010. Adaptive Monitoring Framework (AMF) for Assessing the Status and Trend of Williamson's Sapsucker (WISA). Report prepared by ESSA Technologies Ltd., Vancouver, B.C. for Environment Canada-Canadian Wildlife Service.
- Ohanjanian, P. 2010. Williamson's Sapsucker (*Sphyrapicus thyroideus*) Baseline Population Monitoring in the East Kootenay. Report prepared for Canadian Wildlife Service, Environment Canada, Delta, BC.
- Pickard, D. and L. Ainsworth. 2011. DRAFT Statistical Analysis of 2010 data to inform the Adaptive Monitoring Framework (AMF) for assessing the Status and Trend of Williamson's Sapsucker (WISA). Report prepared by ESSA Technologies Ltd., Vancouver, B.C. for Environment Canada-Canadian Wildlife Service.
- Steeger, C. 2010. Baseline Population Monitoring for the Williamson's Sapsucker (*Sphyrapicus thyroideus*) – Okanagan Boundary Area. Report prepared by Pandion Ecological Research Ltd. for Canadian Wildlife Service, Environment Canada, Delta, BC.
- Thomas, L., J.L. Laake, E. Rexstad, S. Strindberg, F.F.C. Marques, S.T. Buckland, D.L. Borchers, D.R. Anderson, K.P. Burnham, M.L. Burt, S.L. Hedley, J.H. Pollard, J.R.B. Bishop, and T.A. Marques. 2009. Distance 6.0. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. <http://www.ruwpa.st-and.ac.uk/distance/>
- Thompson, S.K. 2002. Sampling 2nd Ed. Wiley and Sons Inc., New York, NY.

Appendix 1. 2011 WISA baseline monitoring detection histories formatted for occupancy and detection rate estimation in Program PRESENCE. 1 indicates WISA detection, 0 indicates not detected at that visit. Sites in italics were added after initial allocation to increase sample size for estimate of detection.

Sample Site	Visit Number					R11BLR013	0	0	0	0	0	R11WLR003	0	0	0	0	0
	1	2	3	4	5												
R10BL01	0	0	0	0	0	R11BLR014	0	0	0	0	0	R11WLR004	0	0	0	1	0
R10BL05	0	0	0	0	0	R11BLR015	0	0	0	0	0	R11WLR005	1	0	0	1	1
R10BL07	0	0	0	0	0	R11BLR016	1	0	1	0	0	R11WLR006	0	0	0	0	0
R10BL36	0	0	0	0	0	R11BLR017	1	1	1	0	1	R11WLR007	0	0	0	0	0
R10BL44	1	0	0	0	1	R11BLR018	0	0	0	0	0	R11WLR008	0	0	0	0	0
R10BM01	0	1	0	1	0	R11BLR019	1	1	0	1	1	R11WLR009	0	0	0	0	0
R10BM07	1	1	1	1	0	R11BLR020	1	0	1	0	0	R11WLR010	1	0	0	1	1
R10BM08	0	0	0	0	0	R11BLR021	0	0	0	0	0	R11WLR011	0	0	0	0	0
R10BM13	1	1	1	1	1	R11BLR022	1	1	0	0	0	R11WLR013	0	0	1	1	0
R10BM44	0	0	0	0	0	R11BLR023	1	1	1	0	1	R11WLR014	1	1	1	1	0
R10WL18	1	1	1	1	0	R11BLR024	0	0	1	0	0	R11WLR015	0	0	0	0	0
R10WL21	0	0	1	1	1	R11BLR025	0	0	0	0	0	R11WLR016	0	0	0	1	1
R10WL25	0	0	0	0	0	R11BLR026	0	0	0	0	0	R11WLR017	0	1	0	0	0
R10WL34	0	0	0	0	0	R11BLR027	0	0	0	0	0	R11WLR018	0	0	0	0	0
R10WL37	0	0	0	0	0	R11BMN001	1	0	1	0	0	R11WLR019	0	0	0	0	0
R10WL40	0	0	0	0	0	R11BMN002	1	1	0	0	1	R11WLR020	1	1	1	1	1
R10WL53	0	0	0	0	1	R11BMN003	0	0	1	1	0	R11WLR021	0	0	0	0	0
R10WM24	1	0	1	1	1	R11BMN004	0	0	1	1	0	R11WLR022	1	0	0	0	0
R10WM29	1	0	0	0	0	R11BMN005	0	1	0	0	0	R11WLR023	1	0	0	0	0
R10WM31	0	0	0	0	1	R11BMN006	0	0	0	0	0	R11WLR024	1	1	1	1	1
R11BLN001	1	1	1	1	0	R11BMN007	0	0	0	0	0	R11WLR025	1	1	1	1	1
R11BLN002	0	0	0	0	0	R11BMR001	0	1	1	0	1	R11WMN001	0	0	0	1	0
R11BLN003	0	0	0	0	0	R11BMR002	1	1	0	1	1	R11WMN002	0	0	0	0	0
R11BLN004	0	1	1	1	1	R11BMR003	0	1	0	0	0	R11WMN003	0	0	0	0	0
R11BLN005	0	0	0	0	0	R11BMR004	0	1	1	1	0	R11WMN004	0	1	1	0	0
R11BLN006	0	0	1	1	1	R11BMR005	0	0	0	0	0	R11WMN005	0	0	0	0	0
R11BLN007	0	1	1	1	1	R11BMR006	0	0	1	0	0	R11WMN006	1	0	0	0	0
R11BLN008	0	0	0	0	0	R11BMR007	0	0	1	0	0	R11WMN007	0	0	0	1	0
R11BLN009	0	0	0	1	0	R11BMR008	0	0	1	1	1	R11WMR001	0	0	0	0	0
R11BLR001	1	0	0	0	0	R11BMR009	0	0	1	1	0	R11WMR002	0	0	0	0	0
R11BLR002	0	0	0	0	0	R11WLN001	0	0	0	0	0	R11WMR003	0	0	0	0	0
R11BLR003	0	0	0	0	0	R11WLN002	0	0	0	0	0	R11WMR004	0	0	0	0	0
R11BLR004	0	0	0	0	0	R11WLN003	0	1	0	0	0	R11WMR005	0	0	0	0	0
R11BLR005	1	1	1	1	1	R11WLN004	0	0	0	0	0	R11WMR006	0	1	1	1	1
R11BLR006	1	1	1	0	0	R11WLN005	0	0	0	0	0	R11WMR007	1	0	1	0	1
R11BLR007	0	0	0	0	0	R11WLN006	0	0	0	0	0	R11WMR008	1	0	1	1	0
R11BLR008	0	0	0	0	0	R11WLN007	0	1	0	0	0	R11WMR009	1	1	0	1	0
R11BLR009	0	0	0	0	0	R11WLN008	0	1	0	0	0	R11WMR010	0	0	0	1	0
R11BLR010	0	0	1	0	0	R11WLN009	0	0	0	0	0	R11WMR011	1	1	1	1	1
R11BLR011	0	0	1	1	0	R11WLN010	1	0	0	1	0	R11WMR012	0	0	0	1	1
R11BLR012	1	1	1	0	1	R11WLR001	0	0	0	0	0	R11WMR013	0	0	0	1	1
						R11WLR002	0	0	0	0	0						

Appendix 2. Detection history of WISA CPB points sampled with 3 repeats in 2010. 1 indicates WISA detection, 0 indicates not detected at that visit.

CPBSTATION	1	2	3	Mean Sampling Date
R10BM07	0	0	0	June 5
R10BM08	0	0	0	June 3
R10BM13	0	1	0	June 5
R10BM19	0	1	0	June 15
R10BM22	0	0	0	June 12
R10BM30	0	1	0	May 28
R10BM39	1	0	1	June 3
R10BM42	0	0	0	June 3
R10BM43	0	0	1	June 3
R10BM44	0	0	1	June 12
R10BM45	0	0	1	May 28
R10WM07	0	0	0	May 30
R10WM09	1	1	1	May 28
R10WM13	0	0	0	May 28
R10WM14	0	0	1	May 28
R10WM16	1	1	1	May 28
R10WM18	0	0	1	May 30
R10WM20	1	1	0	May 28
R10WM23	0	0	0	May 28
R10WM24	0	0	0	June 4
R10WM25	1	0	0	May 28
R10WM27	0	0	0	May 28
R10WM32	0	0	0	May 30
R10WM35	1	0	0	May 28
R10WM39	1	0	0	May 28
R10WM40	0	0	0	June 4
R10WM47	0	0	0	May 28
R10WM48	0	0	0	May 28
R10WM52	1	0	0	May 31

CPBSTATION	1	2	3	Mean Sampling Date
R10WL44	0	0	0	May 28
R10WL01	0	0	0	June 4
R10WL08	0	0	0	June 4
R10WL10	0	0	0	May 28
R10WL16	0	1	1	May 30
R10WL20	0	0	0	May 30
R10WL22	0	0	0	June 4
R10WL24	0	1	0	May 30
R10WL36	0	0	0	June 4
R10BL01	0	0	0	June 3
R10BL05	0	0	0	June 3
R10BL12	0	0	0	June 15
R10BL13	0	0	0	June 12
R10BL15	0	0	0	June 15
R10BL17	1	1	0	June 12
R10BL18	1	1	1	June 5
R10BL24	0	0	0	June 12
R10BL28	0	0	0	June 3
R10BL30	0	0	0	June 3
R10BL35	0	0	0	June 15
R10BL41	0	0	0	June 3
R10BL44	0	0	0	June 5
R10BL45	0	0	0	June 3
R10BL46	0	0	0	June 3
R10BL47	0	0	0	June 5

Appendix 3. Detection histories of WISA CPB points repeated in 2010 and 2011. 1 indicates WISA detection, 0 indicates not detected at that visit, - indicates site not sampled in that sampling round (in 2010 only a subsample of sites were repeat sampled). “1-ext” indicates that the site had an extended search on the first visit, which for these purposes was considered another visit.

Sample Site	2010				2011				
	1-1	1ext-1	2-1	3-1	1-2	2-2	3-2	4-2	5-2
R10BM01	0	-	-	-	0	1	0	1	0
R10BM07	0	1	0	0	1	1	1	1	0
R10BM08	0	-	0	0	0	0	0	0	0
R10BM13	0	-	1	0	1	1	1	1	1
R10BM44	0	0	0	1	0	0	0	0	0
R10WM24	0	0	0	0	1	0	1	1	1
R10WM29	0	-	-	-	1	0	0	0	0
R10WM31	0	0	-	-	0	0	0	0	1
R10BL01	0	0	0	0	0	0	0	0	0
R10BL05	0	-	0	0	0	0	0	0	0
R10BL07	0	-	-	-	0	0	0	0	0
R10BL36	0	0	-	-	0	0	0	0	0
R10BL44	0	0	0	0	1	0	0	0	1
R10WL18	0	-	-	-	1	1	1	1	0
R10WL21	0	-	-	-	0	0	1	1	1
R10WL25	0	-	-	-	0	0	0	0	0
R10WL34	0	-	-	-	0	0	0	0	0
R10WL37	0	-	-	-	0	0	0	0	0
R10WL40	0	0	-	-	0	0	0	0	0
R10WL53	0	0	-	-	0	0	0	0	1