

Williamson's Sapsucker Monitoring 2014: Okanagan, Boundary and West

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ABSTRACT

Trend monitoring of the Endangered Williamson's Sapsucker (WISA) began in 2010 and 2011 based on random call-playback (CPB) points stratified by habitat suitability in the Okanagan-Boundary and West Areas of Occupancy (AO). Detectability on these late May and June surveys was on the order of 50%. Detectability was thought to be much higher, making for more efficient sampling, when WISA establish breeding territories in April. However, sampling is difficult in April because many roads are still snowbound. In 2012, CPB points were established at 800-m spacing on all public roads kept open all year. All 213 of these points within 300 m of Low or better suitability habitat were sampled twice each in April in 2012, 2013 and 2014. To determine if these road points were representative of the AOs at large, in 2014 the AOs were divided into 800- x 800-m cells, adjacent cells were aggregated by fours into 2.56 km² patches, and 20% of these patches selected for CPB sampling as early as possible in the WISA breeding season of 2014.

Relative abundance from the road monitoring of 213 CPB pts has not changed over the 2012-2014 period but relative abundance did vary by date of the survey within April requiring adjustment by date for this road monitoring. It is recommended to continue one sampling round of 229 Road Monitoring Points, preferably in the first week of April each year. After the sampling round of 2015, trend analyses will be possible as there will then be >3 sampling years.

The relative abundance stratified by Low or Moderate habitat suitability in 2014 patch monitoring was not significantly different from the relative abundance of the road monitoring or from prior years of CPBs. Sampling patches compared to isolated single CPB points provides logistical efficiency and will better allow future correlation of possible relative abundance changes with habitat changes. Patch monitoring need not be annual given the similar results to the road monitoring points and the relatively low cost of the road monitoring, which can be completed with 5 person-days effort.

Habitat changes since the habitat mapping of 2009-2010 and that may affect WISA habitat suitability were noted at 24% of the patches and road monitoring points in the West AO and about 5% in the Okanagan-Boundary AO. Updated habitat suitability mapping will not likely be feasible until there are new aerial photo surveys of these areas since these habitat changes have taken place since the most recent aerial photo coverages of 2004-2005.

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INTRODUCTION

Williamson's Sapsucker (WISA) 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 population monitoring begun in 2010 using call playback (CPB) methods (Marmorek and Pickard 2010).

WISA monitoring began in 2010 and 2011 using responses from random call-playback (CPB) points stratified by habitat suitability and conducted in May and June in the Okanagan-Boundary and West Areas of Occupancy (AO). In 2010 some CPB were repeated three times or extended for an extra 5 minutes to determine detectability (Gill 2020, Steeger 2010, Pickard and Ainsworth 2011). In 2011, CPB were repeated 5 times each on separate days to determine detectability (Gyug 2011). 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). Occupancy as the long-term monitoring metric also had relatively high variance (CV ~15%) that would make annual monitoring quite costly to detect small population changes. CPBs also sample an unknown and variable radius so that occupancy-type analyses may not be appropriate to determine detectability. However, unless monitoring is at exactly the same time each year, then adjustments must be made for changes in detectability over the course of the breeding season.

Detectability was thought to be much higher in April when WISA establish breeding territories but sampling of the entire AOs is not possible at that time as many roads are still snowbound. In April 2012, CPB points were set at 800-m spacing on all public roads kept open all year in the Okanagan-Boundary and West AOs. All such points within 300 m of Low or better suitability habitat were intended for long-term sampling. These points were sampled twice in April 2012 and twice in April 2013, and twice again in April 2014 as part of this project. As long as CPB are only conducted in April, then detectability should be relatively constant across years and need not be adjusted for.

Since all-year roads are not a random sample of the AO, we did not know if the road sampling conducted in April was representative of the entire AO. Therefore population monitoring of the entire AO was proposed to determine if the relative abundance index from road monitoring was comparable to the remainder of the AO. This project was intended to fill that role, i.e., sampling of the entire AO taking place as early as possible in the breeding season when detectability would be highest.

In March 2014, a WISA-monitoring workshop was sponsored by CWS. At that workshop, it was decided to move away from the single CPB point sampling that had been conducted in 2010 and 2011. The results from single CPB points were not very meaningful for habitat and long-term monitoring as negative results are hard to interpret because they could be either non-occupancy or non-detectability, each within an unknown radius. Sampling larger areas by several CPB points was suggested as a more efficient approach in terms of the logistics of field sampling, the ability to ramp up monitoring to absolute abundance methods including territory mapping or nest censuses, correspondence with the Index of Area of Occupancy used by COSEWIC to measure trends, and better ability to correlate changes in abundance to possible habitat changes.

Table 1. WISA long-term monitoring Panel Design. Okanagan-Boundary and West AOs. The target sampling for 2014 was 20% of patches in Low and Moderate strata.

Average Suitability	Sampling Stratum	Patches with ≥ 3 cells	Total cells	2014 Sampling Patches	Private Land dropped from Sample 2014
Not estimated	Edge Cells	0	96	0	-
0 – 0.049	Very Low	(90)	344	0	-
0.05 – 0.149	Low	337	1302	68	13
>0.149	Moderate	129	505	25	0
Total		466	2247	93	13

METHODS

Study Design

Road monitoring of the same CPB points annually began as a volunteer effort in 2012, continued supported by CWS in 2013 using contracted and in-house staff, and continued as part of this project in 2014. Road maintained by the BC Ministry of Transportation and Highways and open all year within the AOs, but excluding four-lane highways, were identified and points placed along these roads in GIS at 800-m road distances. Only points that were within 300 m of Low or better suitability habitat were sampled.

WISA habitat suitability mapping of these AOs had been completed in 2009 (Gyug 2009) and 2010 (Gyug 2010a, 2010b). This mapping was done according to BC Resources Inventory Standards Committee (RISC 1999) standards that define densities in relation to a benchmark. For WISA, a 6-class system was used: High densities were 76-100% of the benchmark, Moderately High 51-75%, Moderate 26-50%, Low 6-25%, Very Low 1-5% and Nil 0% of the benchmark. All forest cover or (more recently) Vegetation Resource Inventory mapped polygons within the AOs were assigned to one of the 6 WISA suitability classes using a habitat suitability model and aerial photo interpretation. For this project, where a square cell or a given radius defines an area around a CPB point, the average suitability is the weighted average by area of the midpoints of the suitability class of each of the polygons within the defined area.

There were 229 such points. At 16 of these points, recent mountain pine beetle salvage clearcuts had changed the habitat suitability since mapping was done in 2009 so that only 213 of these points were sampled at every sampling round (twice in April 2012, April 2013 and April 2014). These 213 sample points can be sampled in three calendar days (as long as weather conditions remain suitable), taking about 40 hours in total. All 229 sample points were only sampled in the first round of April 2014.

I divided the Okanagan-Boundary and West AOs into 2247 800-m by 800-m cells, only using cells with their center point within the AOs. I grouped adjoining 4 cells into square 1.6-km x 1.6-km patches (area = 2.56 km²). At AO edges, I aggregated adjacent cells groups into angled or other shapes to include edge areas in the sampling frame wherever possible. Only patches with at least 3 cells in them were considered for monitoring, which

excluded 96 cells from sampling (Table 1). I then averaged the habitat suitability in each patch and grouped the patches with at least 3 cells into 3 suitability groups (Table 1). The target sampling effort for 2014 was 20% of the patches in Low and Moderate habitat strata given the available funding. No 2014 monitoring was planned in the Very Low habitat stratum because in 2010 sampling in that stratum had detected no WISA at all in 96 CPB points. The portion of the population in the Very Low stratum was felt to be so low that there would be no method that could efficiently sample it.

I selected patches for sampling in 2014 using a spatially balanced design. I grouped five adjacent patches together to form 93 groups. One patch in each group was selected randomly for sampling in 2014. Patches were sampled by CPBs at the center points of the cells within selected patches. For most patches this was 4 CPBs although for some at edges of the AO it was only three (Figure 1).

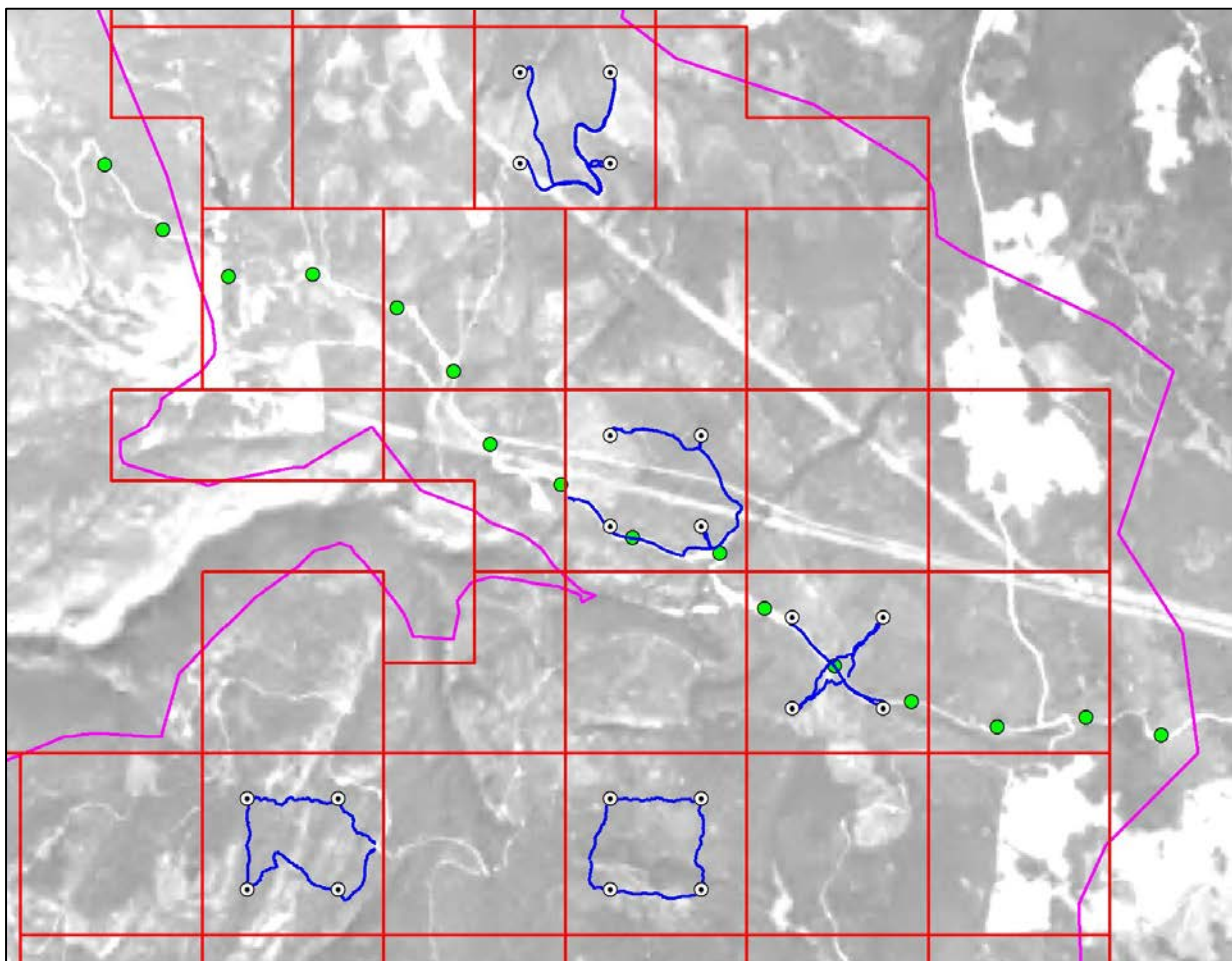


Figure 1. Example map of 2014 WISA monitoring in a section of the Okanagan AO east of Oliver. Patches are red outlines of 1.6-km x 1.6-km blocks, which were not necessarily square at the edge of the WISA AO (magenta outline). White dots with black centers are Patch CPB points in patches selected for sampling in 2014; Green dots are April Road Monitoring CPB points along the Camp McKinney Road east of Oliver; Blue lines are GPS tracks from actual patch CPB sampling in April 2014.

We did not sample on posted land or First Nations lands without obtaining landowner permission. CWS does not keep a list of property owners within the AO. With further lead time, such a list could have been obtained from the BC government provincial partners in the WISA project. This should be done in the future and should also include First Nations groups. Some owners were known to me and contacted for permission, some were known and contacted but refused access for WISA sampling, and some owners could not be found or contacted. We still sampled patches if there were at least 3 CPB points on public land, or where we had permission on private lands, or where points were near to roads and could still be effectively sampled from public roads. In total, 13 of the 93 patches did not have at least 3 points that we could sample in 2014 and were dropped from the sampling.

Field Methods

Road CPB sampling was done during April. Each round of 213-229 points was completed in as few consecutive days as possible. In 2014, the first round of sampling began on the afternoon of March 31 and was completed by the late afternoon of April 3 by one surveyor in one vehicle. In the prior sampling, one round had been completed in early April, and one round in the second to third week of April. The second round of April sampling was delayed until late April in 2014 to provide some sampling in the 2012-2014 period in late April. Two surveyors in two separate vehicles were used for part of the second round of road monitoring in 2014. The second round of sampling began on April 29 and was completed by late morning of May 1. Complications with getting a broken fuel pump replaced on a vehicle did not allow us to complete the second round by the end of day on April 30 as was planned.

Patch CPB sampling began on April 6, 2014. At that date, virtually all patches had some snow remaining on the ground. Snowshoes were used for access where needed, but generally lower elevations patches were sampled first where snowshoes were not required. During April, most days tend to be well above freezing by midday and the snowpack becomes rotten and “bottomless” daily, and then often becomes firmer at night through mid-morning. Access would have been much easier in May, both in terms of ease of foot travel and in how close we could drive to sites, but the tradeoff is in the lower detectability of WISA in May. Sampling beginning in early April was not as logistically efficient as sampling in May would have been since every site in a given locality could not be sampled at once. We had to return to many high elevation localities later after the nearby low-elevation patches had already been sampled earlier. All sampling ($n = 37$ patches) in the West AO was completed by 2 May, 2014. 81% of sampling (35 of 43 patches) was completed in the Okanagan-Boundary AO from April 10 to May 1. Four more patches were completed on May 6, and the final four on May 14-15. At all patches completed after April 30, snow had prevented earlier access attempts.

Average time to complete CPB sampling of a single patch was 1.78 hours. Sampling at 78% of patches (62 of 80) was completed in 1.0 - 2.5 hours. The longest sampling time for one patch was 9.58 hours and the next longest was 4.13 hours. Including commuting time and travel time between patches, average time to complete a single patch was 4.02 hours.

Call playback equipment used included FoxPro 416B, NX3 and NX4 playback (mp3) units through a FoxPro SP108 speaker (a large megaphone with front bell dimensions of 25-cm x 17-cm). Using this equipment, the CPB could easily be heard by a person at 400 m, and sometimes from 800 m. A WISA male was observed to respond from 800 m away in one instance where two surveyors were sampling the cells of one patch simultaneously. In that case, the bird I was observing from a CPB point (done just prior to the second point) flew out of sight towards the second surveyor 800 m away but did not respond vocally or by drumming to the second surveyor. The second surveyor could not hear that bird drumming and calling in the vicinity of the first CPB 800 m away.

In another instance, I was waiting at the truck 373 m from the second surveyor who performed the CPB. I heard a WISA drum fairly quietly in response at 400 m from the second surveyor (and 27 m from me) and two other WISA start calling that were 350-400 m from the second surveyor. However, the second surveyor could not hear any of these WISA from the CPB point as there was a stream about 40 m away from the second surveyor. This CPB point was moved about 15 m from the pre-selected position so that it would not be in the creek gully, but the stream still probably interfered with hearing ability at the point. In ideal quiet conditions, these WISA would probably have been detectable from the survey point.

CPB points at the centers of cells selected for sampling were entered into GPS units to facilitate navigating to points. Pre-selected points were moved out of deep gullies, inaccessible topographic features (e.g., cliffs) or where flooding streams prevented access. If moved, the new location was recorded as the CPB point. 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, Light Snow) were recorded. Sampling was conducted from around sunrise until before dusk (actual sampling hours in 2014 were between 527 h and 1842 h), only if winds were <Beaufort 4, and not in heavy rain. Each CPB point sample consisted of three broadcasts of a 10-15 second Williamson's Sapsucker drum and call combination repeated three times in three directions, and then a silent listening period of 3 minutes.

For each WISA detection we recorded the time (sec) from the beginning of the CPB of the initial response. If we detected a WISA from a point before CPB started, it was given a time of 0 sec. CPB were still done at a point even if a WISA was detected before a CPB started because frequently the CPB prompted additional WISA to begin calling or drumming. We recorded the sex (male, female, unknown or pair), the number and the type of responses (visual, drum and/or call), the estimated distance (m) and direction (degrees from a compass reading) to each WISA. In open areas or over very short distances where the stand or tree where the WISA was first detected could be seen, we measured the distance using a laser rangefinder. In closed forest, we estimated distances based on the volume attenuation of the drum or call, which was not as reliable an estimate as when the WISA could be seen.

Analyses

Road monitoring CPB points were examined first by ANCOVA to determine if there were differences by date of survey and by year. Regression analysis was used to determine the relationship between survey date in April and relative abundance (WISA detected/CPB point), and to develop an adjustment factor by date of survey for the road monitoring points.

At the patch level, an adjustment factor for relative abundance was based on CPB points done prior to 2014 by assigning all such points to the patch they were in, and calculating relative abundance for each patch. For all patches with >2 CPB pts, the mean relative abundance by date was calculated for each habitat suitability stratum from which a date adjustment factor was developed.

Once patch relative abundance was adjusted by survey date, the 2014 patch sampling results were compared to the 2014 road sampling and pre-2014 sampling results using ANOVA. These were compared at the patch level (groups of 3-4 adjacent 800-m x 800-m cells) and also at the individual CPB point level.

For comparison to future patch sampling, and to develop a single relative abundance estimate for entry into a trend analysis, a relative abundance estimate was produced for the entire AO sampling frame. This was done using the separate habitat strata, as well as if considered a single random sample to illustrate the variance reduction due to habitat stratification. For the overall relative abundance, the mean and variance of the sampled patches were extrapolated to the entire sampling frame. The coefficient-of-variation (CV) was the standard error (SE) divided by the abundance.

Habitat notes were made at sites where there had been recent habitat changes since the habitat suitability mapping of 2009-2010, which was based on aerial photos from 2004-2005 with some updates from Landsat and SPOT satellite images from 2006-2008. The types of habitat changes were tallied for road monitoring points and for patches, and the % of patches or road monitoring pts with some changes tallied for each AO.

Field data was entered into a single WISA Excel file template designed for submission to the Wildlife Species Inventory (WSI) Species Inventory (SPI) system of the BC Ministry of Environment. This file has been quality checked for formatting and for data entry errors. The file also contains some preliminary data summaries.

RESULTS and DISCUSSION

Using ANCOVA, the total number of WISA detected on April road monitoring points did not differ significantly between years from 2012 to 2014 ($F_{1,2} = 1.46$, $p = 0.41$) but did differ significantly by date of sampling round ($F_{1,2} = 18.74$, $p = 0.049$) (Table 2). Assuming that there has been no actual population change in the 2012-2014 period so that the three years could be grouped, the regression of WISA detected by sampling date was significant ($F_{1,5} = 14.93$, $r^2 = 0.79$, $p = 0.02$; Figure 2). The same pattern was apparent in each of the two AOs.

Table 2. WISA detected on April Road Monitoring CPB Points, 2012-2014. Total detections were adjusted to April 15 based on the regression equation of Figure 2.

Year	Sampling Dates	Mean Date (April 1 = 0)	Total AO		Okanagan- Boundary	West
			WISA Detected	Adjusted to April 7		
	<i>n CPB Pts</i>		213		73	140
2012	April 4-9	5.5	89	87.9	34	55
	April 17-21	18	83	91.3	30	53
2013	April 3-5	3	99	96.0	35	64
	April 8-14	10	86	88.3	30	56
2014	March 31-April 3	1	102	97.5	41	61
	April 29-May 1	29	79	95.6	31	48

For longer-term monitoring (i.e., > 3 years), the data can be entered into a trend analysis. However, an alternate approach is to use the 90% prediction limits of the regression (Figure 2) as a baseline. Any given survey round of the same CPB points in future years only need be examined to see if the result is within the predicted limits of Figure 2. If outside the prediction limits, the survey round should be repeated in the same year to verify the results. If still outside the prediction limits, then a population change has probably occurred, the cause of which would need to be investigated further.

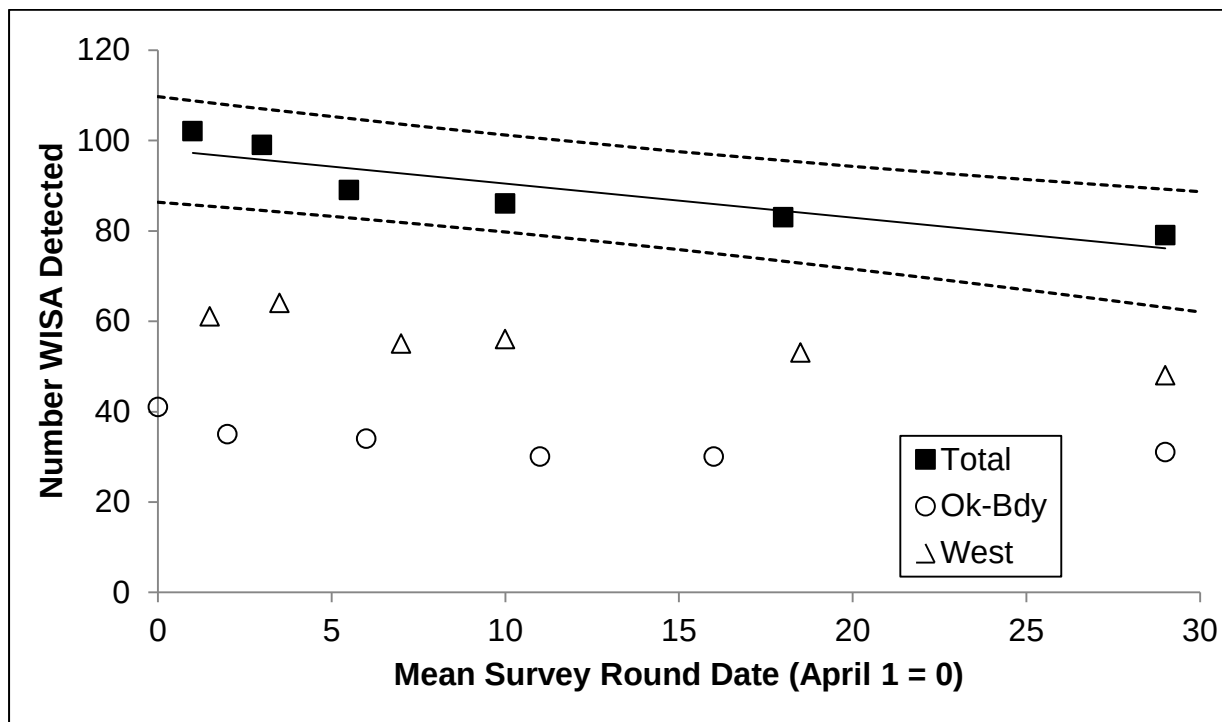


Figure 2. Regression of WISA detected on April Road Monitoring CPB Points, 2012-2014, on survey date. N = 213 CPB pts per survey round of which 73 were in the Okanagan-Boundary and 140 in the West. of the total regression are shown. Regression line shown is $y = -0.756x + 98.04$ including 90% prediction limits (dashed lines).

I adjusted each survey round result to April 7 using the regression equation of Figure 2. The adjusted mean of the two survey rounds 2012, 2013 and 2014 respectively increased each year but with only 3 years there is no trend analysis possible yet. The within-year CV (SE/Mean) was 0.020, 0.044 and 0.010 in 2012, 2013 and 2014 respectively. This within-year CV consistently below 0.05 indicates that the sampling method is likely consistent and repeatable, that the sampling error is quite low, and therefore the method is suitable for long-term monitoring. April 7 was picked as the end of the first week of April and the median date of the available samples, but similar results are achieved should one wish to adjust to any other date within April, so that April 7 need not be used as a target date.

The regression equation of Figure 2 is particular to those 213 survey points and can't be used to adjust WISA CPB surveys by date-of-survey generally. The relative change in relative abundance is different across date for Moderate and Low CPB pts (Figure 3). The regression of relative abundance by date will change depending on the exact mix of Moderate and Low CPB pts in any particular set of points.

For patch-level data, an adjustment factor for the 2014 patch sampling based on date and habitat suitability was developed using all CPB pts other than the patch samples of 2014. Relative abundance was higher in April and early May than after May 7th for both Moderate and Low CPBs (Figure 3). The adjustment factor applied to Moderate patch CPBs to make the results comparable to April was 1.2 (i.e., 0.66/0.55) for survey dates of May 1-7 and 2.5 (i.e., 0.66/0.26) for May 8 and later. No adjustment factor was applied to Low patch CPBs for May 1-7 but the adjustment factor to make the results comparable to April was 2.1 (i.e., 0.39/0.19) for survey dates of May 8 and later. In total the relative abundance of very few patches needed to be adjusted: only 3 of 25 Moderate patches were surveyed in May 2014, and only 3 of 55 Low patches were surveyed after May 7th.

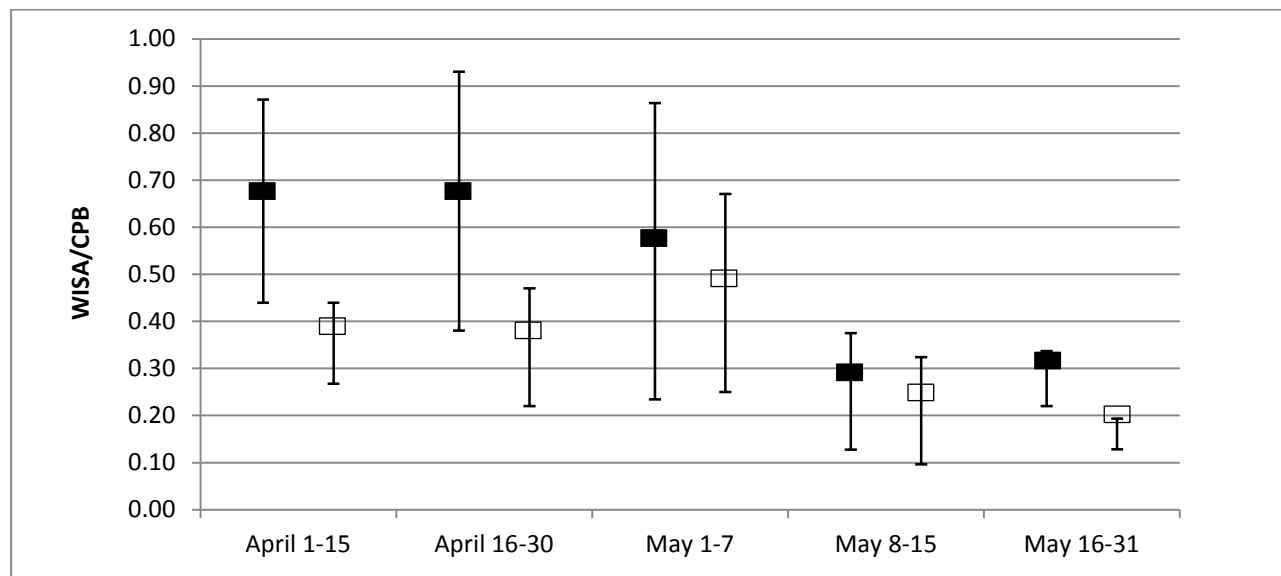


Figure 3. WISA Relative Abundance (WISA/CPB) in patches using CPB data from 1997-2014 but not including the specific patch CPBs done in 2014. Filled boxes are Moderate suitability Patches, empty boxes are Low suitability Patches. 95% Confidence Intervals are shown.

Table 3. WISA relative abundance in 2.56 km² patches sampled by at least 3 CPBs in 2014, incidentally sampled by road monitoring CPBs in 2014, and incidentally sampled by all other CPBs in prior years. CV within groups is SE/Mean but is SD/Mean for the group average.

Habitat Stratum	Survey	N Patches	Mean WISA/CPB	SD	SE	CV
Moderate	Patches 2014	25	0.732	0.636	0.127	0.174
	Road 2014	16	0.624	0.401	0.100	0.161
	Other CPB pre-2014	18	0.646	0.468	0.110	0.171
	Total (n = 3)		0.668	0.057		0.085
Low	Patches 2014	55	0.319	0.421	0.057	0.180
	Road 2014	48	0.378	0.392	0.057	0.150
	Other CPB pre-2014	81	0.347	0.391	0.043	0.125
	Total (n = 3)		0.346	0.032		0.093

Almost 50% (27 of 55) of the Low patches sampled in 2014 had no WISA detected on the CPBs (Figure 4). In 5 of these patches, WISA were detected elsewhere in the patch incidentally, so that a zero on the 4 CPBs conducted in a patch did not necessarily mean that WISA was absent from a patch. Should true relative abundance be between 0 and 0.25, this relative abundance is not measurable with only 4 CPBs in a patch as 0.25 is the lowest estimate possible other than zero. WISA were not detected at 16% (4 of 25) of the Moderate patches.

There were no significant differences in WISA relative abundance among the three “patch” groups including the patches sampled in 2014, the patches incidentally sampled by road monitoring CPBs in 2014, and patches incidentally sampled by all other CPBs prior to 2014 (Table 3). ANOVA statistics for the Moderate stratum were $F_{2,58} = 0.24$, $p = 0.79$ and for the Low stratum were $F_{2,183} = 0.33$, $p = 0.71$.

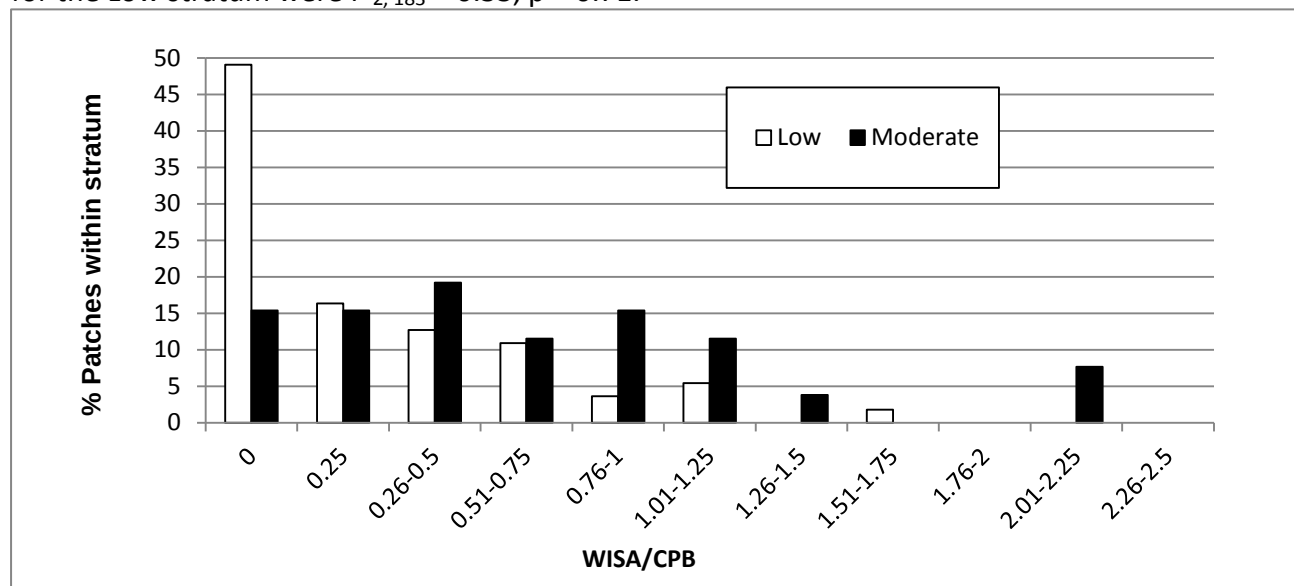


Figure 4. WISA Relative Abundance (WISA/CPB) in patches sampled in 2014.

Table 4. WISA relative abundance by habitat stratum on a point-by-point basis for patch CPBs sampled in 2014 compared to road monitoring points sampled 2012-2014. CV is SE/Mean.

Habitat Stratum and Survey	N Pts	N CPBs per Pt	Mean WISA/CPB	SD	CV	ANOVA statistics for contrast to Patches		
						F	df	p
Moderate								
Patches 2014	105	1	0.638	0.921	0.141			
Road 2014	45	2	0.667	0.812	0.182	0.03	1, 148	0.85
Road 2012-14	45	6	0.659	0.651	0.147	0.02	1, 148	0.89
Low								
Patches 2014	168	1	0.393	0.718	0.141			
Road 2014	140	2	0.382	0.631	0.140	0.02	1, 304	0.89
Road 2012-14	140	6	0.394	0.523	0.112	0.001	1, 304	0.98
Very Low								
Patches 2014	35	1	0.143	0.430	0.509			
Road 2014	28	2	0.250	0.500	0.378	0.84	1, 59	0.36
Road 2012-14	28	6	0.173	0.266	0.292	0.11	1, 59	0.74

There were 621 Very Low cells (28%), 1104 Low cells (49%) and 522 Moderate or better (23%) in the West and Okanagan-Boundary AOs based on the average habitat suitability within 300 m of the sample point. I conducted an analysis of individual CPB points that ignored for the moment that they were grouped together and therefore not independent, which would cause the variance here to be lower than variance of a fully random sample. The patch sampling and road sampling both undersampled the Very Low by design and sampled the Moderate differently (21% of road CPB pts vs. 34% of patch CPB pts) (Table 4). While the road monitoring sampled fewer Moderate cells than were present in the sampled patches, there were essentially no differences in relative abundance between the road and full AO samples within any habitat strata (Table 4). This was true whether the entire road sample from 2012-2014 was contrasted with the patches or whether just the road sampling from 2014 was compared to the patches from 2014 (Table 4).

Table 5. Relative abundance of patches sampled in 2014 extrapolated to the entire AO sampling frame. 13 of 69 Low habitat patches could not be sampled, so the size of the sampling frame has been adjusted downwards proportionately for Low from 337 to 274 total patches. For the Simple Random Sample, the sampling frame of 466 patches was adjusted downwards based on 13 of 93 patches that could not be sampled. “Abundance” is the sample mean times the total patches times the mean number of CPB pts in each patch.

Habitat Stratum	Total Patches	Sampled Patches	CPB/ Patch	Relative Abundance (WISA/CPB)		“Abundance”			
				Sample Mean	Sample Variance	Total	SE ²	SE	CV
				$\bar{x}$	S^2				
Moderate	129	25	3.96	0.732	0.404	374	216.8	14.7	0.157
Low	274	55	3.74	0.319	0.178	327	193.8	13.9	0.170
Total	403	80				701	410.5	20.3	0.111
Simple Random Sample	401	80	3.81	0.444	0.281	679	452.1	21.3	0.125

Relative abundance was estimated from the 2014 patch sample and extrapolated to the remainder of the sampling frame (Table 5). Stratifying the habitats achieved a slight reduction in CV to 0.111 compared to a simple random sample where the CV was 0.125. Should the same patches be sampled in the future, the expected CV may be as low as for the road monitoring points, i.e., in the range of 0.05 or lower. Should a different set of spatially balanced random patches be sampled, then the expected CV is in the range of 0.11. This is essentially not different than the within-year CV of relative abundance of single CPB pts of 0.12 estimated in 2011 (Gyug 2011). Therefore there have been no reductions in CV because of the aggregation of CPB pts into patches. However, gains in logistical efficiency, ability to ramp up to more intensive sampling methods if required, and increase in ability to interpret habitat changes relative to changes in relative abundance all recommend the patch sampling be continued as a monitoring method rather than single isolated CPB pts.

It is not known if the inability to sample 13 of the planned 93 patches in 2014 may have biased results. All were in the Low stratum, so no bias would have been possible to the Moderate stratum. I examined the 13 unsampled patches in GIS for prior presence of WISA and relative abundance adjusted to April as previously outlined. Based on sampling in previous years, WISA would have been expected in 6 of the 13 patches, would not have been expected in 5 of the 13 patches, and two of the patches had no prior CPB sampling history. The lack of WISA in 45% of the 11 unsampled patches that had a sampling history was similar to the proportion lacking WISA in the sampled patches (49%; Figure 3). The relative abundance of the 8 Low patches with >2 CPB per patch and that were selected but not sampled in 2014 was 0.34 WISA/CPB (SD 0.32, SE 0.11). This was not significantly different from the 0.32 WISA/CPB observed in the other Low patches (Table 3). Therefore, not being able to sample these particular patches in 2014 did not appear to bias the results.

Table 6. Habitat changes noted at CPB sampling points since habitat suitability mapping of 2009-2010. Half scores were given to patches that were affected by >1 type of habitat change.

AO and Sampling Type	Total N	Type of Habitat Change					% Habitat Changed
		Partial Cut	Extensive MPB kill	MPB/Burn salvage	Clearcut or right-of-way clearing	Rock Quarry	
West							
Road CPB Pts	156	0	8	29	0	1	24%
Patches	37	0	3.5	2.5	3	0	24%
Okanagan-Boundary							
Road CPB Pts	73	2	0	0	2	0	5%
Patches	43	2.5	0	0	0.5	0	7%

Mountain Pine Beetle (MPB) outbreaks have killed many ponderosa and lodgepole pines and caused the habitat to change dramatically in much of the southern interior of B.C. Compared to MPB tree kill and the salvage logging that has accompanied it, there have been relatively few cutblocks within the sampled area as part of the normal course of forestry operations. Changes due primarily to the MPB outbreak have affected 16-24% of the West AO patches and road monitoring points (Table 6). During the sampling of 2012, I noted that WISA nest populations appeared to be particularly high in the West AO in some places where there was extensive MPB kill but where there had been no salvage logging, e.g. near Dodds Lake south of Aspen Grove, and near the height-of-land 6 km southwest of Merritt. In areas that have been MPB salvaged, WISA presence depended on the amount of retained trees: where few mature trees were retained, WISA was generally absent.

Relatively few habitat changes have taken place in the Okanagan-Boundary where ponderosa pine is a very minor component of the stands occupied by WISA compared to the West AO (Table 6). The % habitat changed cannot be extrapolated to the entire AO as the habitat change often did not affect the entire patch or entire area around a CPB point. However, these results do highlight that habitat changes from MPB have been extensive in the West and that the habitat suitability may need to be revisited. There has been no updated aerial photo coverage of the Okanagan-Boundary and West since 2004-2005, so general revisions to the habitat suitability mapping should wait until such coverage is available. Any updated suitability modeling would have to take into account the effect of MPB and MPB salvage operations on WISA relative abundance.

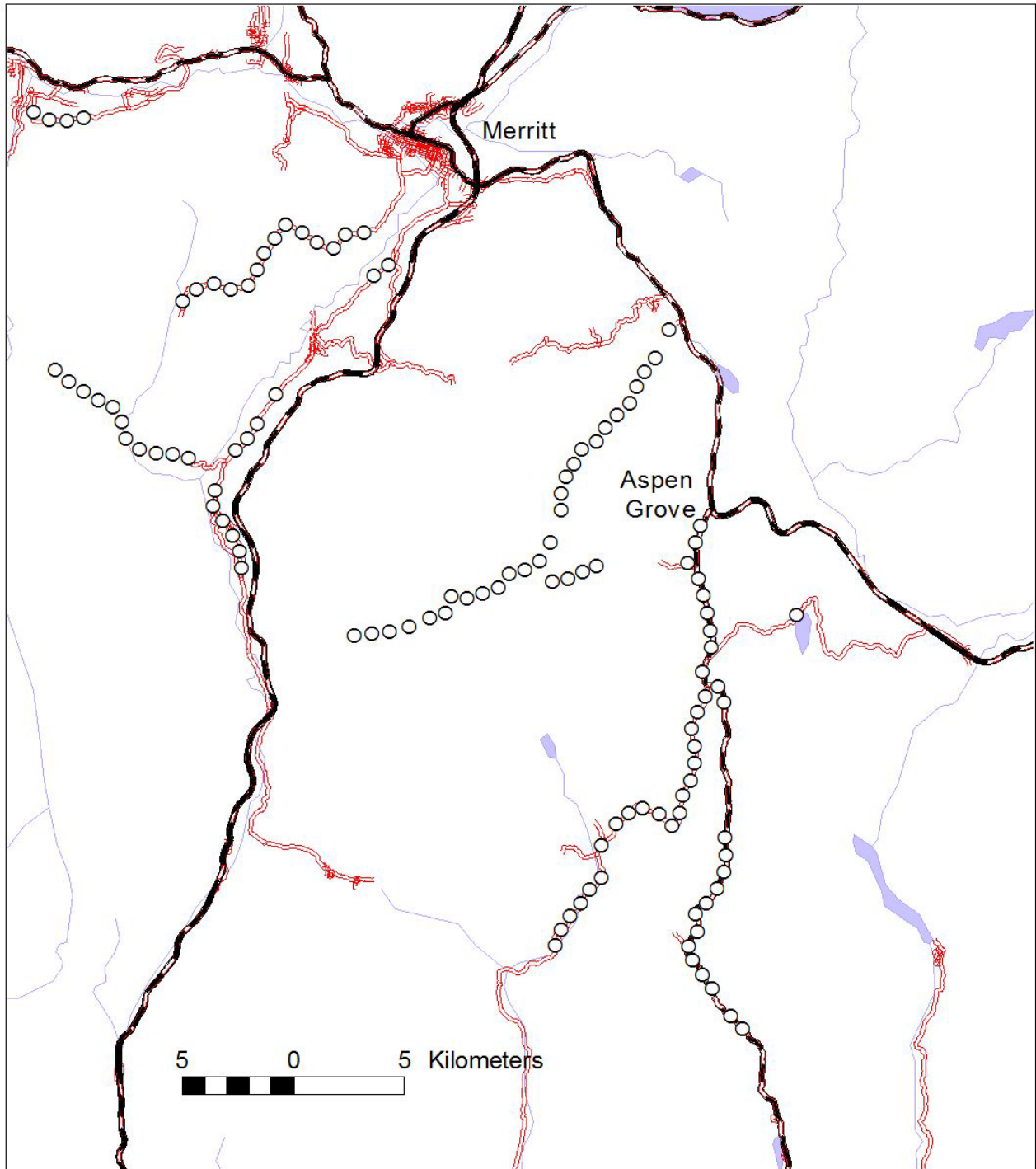
RECOMMENDATIONS

1. Continue annual road monitoring in early April of the 229 CPB pts on public roads open all year round. Only 1 survey round ($n = 229$ pts) may be necessary because of fairly low variance. If the result of this single survey round is outside the predicted 90% limits of the regression of Figure 2 (using the 213 pts surveyed on every survey round to date), then the entire survey round should be repeated as soon as practicable. If still outside the predicted limits, then further investigation will be required to determine the cause of the population change.
2. Trend analysis will become possible once >3 years of road monitoring has been undertaken, and will need to be added to the analysis methods beginning in 2015.
3. Monitoring of the entire AO, i.e., in addition to the annual road monitoring, should continue to be in patches, i.e. groups of 4 CPB points, rather than the single isolated CPB points that were selected in 2010-2011.
4. As the patch monitoring showed very similar results to the road monitoring in terms of relative abundance and habitat monitoring, it is not necessary to sample the patches annually. Whenever the patches are sampled again, a decision can be made as to the most statistically effective way to sample. This may include re-randomizing the sample, or developing a panel design that re-samples some of the same patches and selects others randomly for new sampling.
5. Consider extending the April road monitoring points in some years beyond the AO boundaries to determine if the AO is static in extent. The Adaptive Monitoring Framework (Marmorek and Pickard 2010) recommended some sampling up to 10 km outside the current AOs but this has yet to be implemented. Incidental records in the Merritt and Princeton areas indicate that the AO may be expanding. Incidental WISA records in the Okanagan-Boundary indicate WISA occurs in some areas not sampled or poorly sampled on the surveys prior to 2007 that delineated the AO. To define the most fruitful areas to be sampled within 10 km of the AOs, the habitat suitability model algorithms used within the AOs will need to be extended outside the current AO boundaries in a desktop GIS exercise.
6. Habitat changes have taken place over about 5% of the Okanagan-Boundary and up to 24% of the West. These should be accounted for in revised habitat suitability modeling and mapping once up-to-date aerial photo coverages are available for these AOs (replacing the current 2004-2005 coverages). This revised modeling particularly needs to address the impacts of the recent Mountain Pine Beetle epidemic and associated pine death and salvage logging on Williamson's Sapsucker habitat suitability.

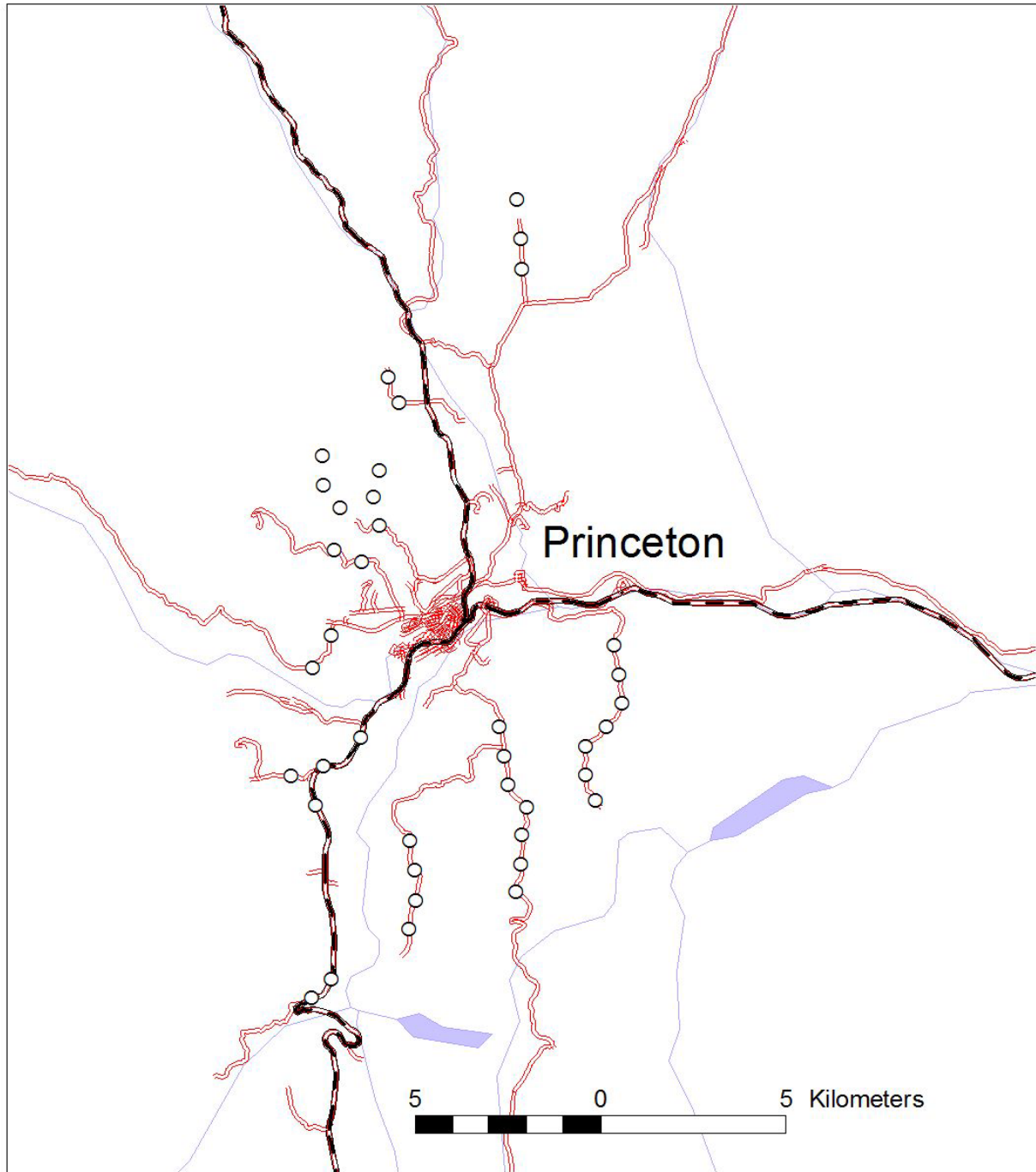
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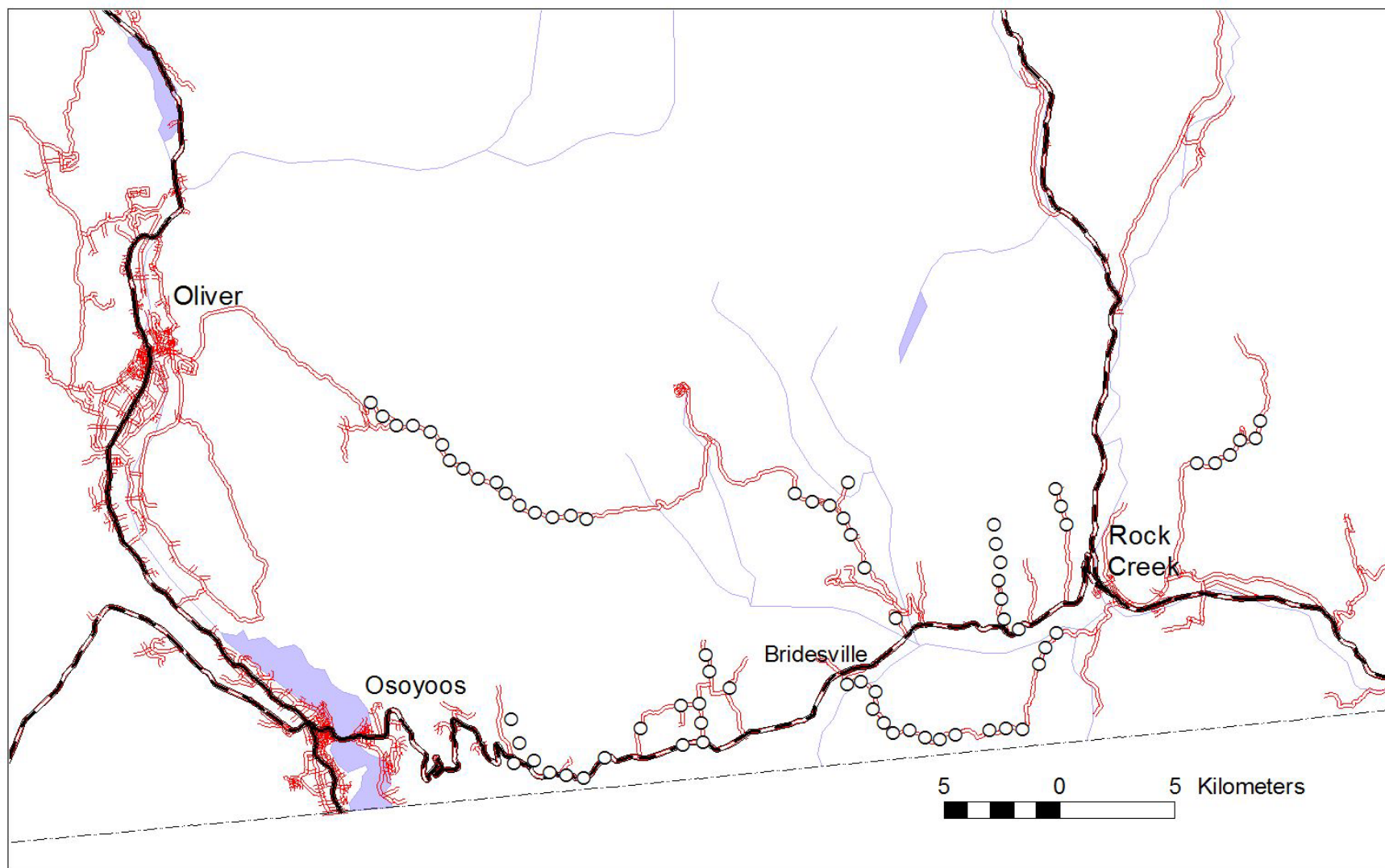
APPENDIX 1. MAPS



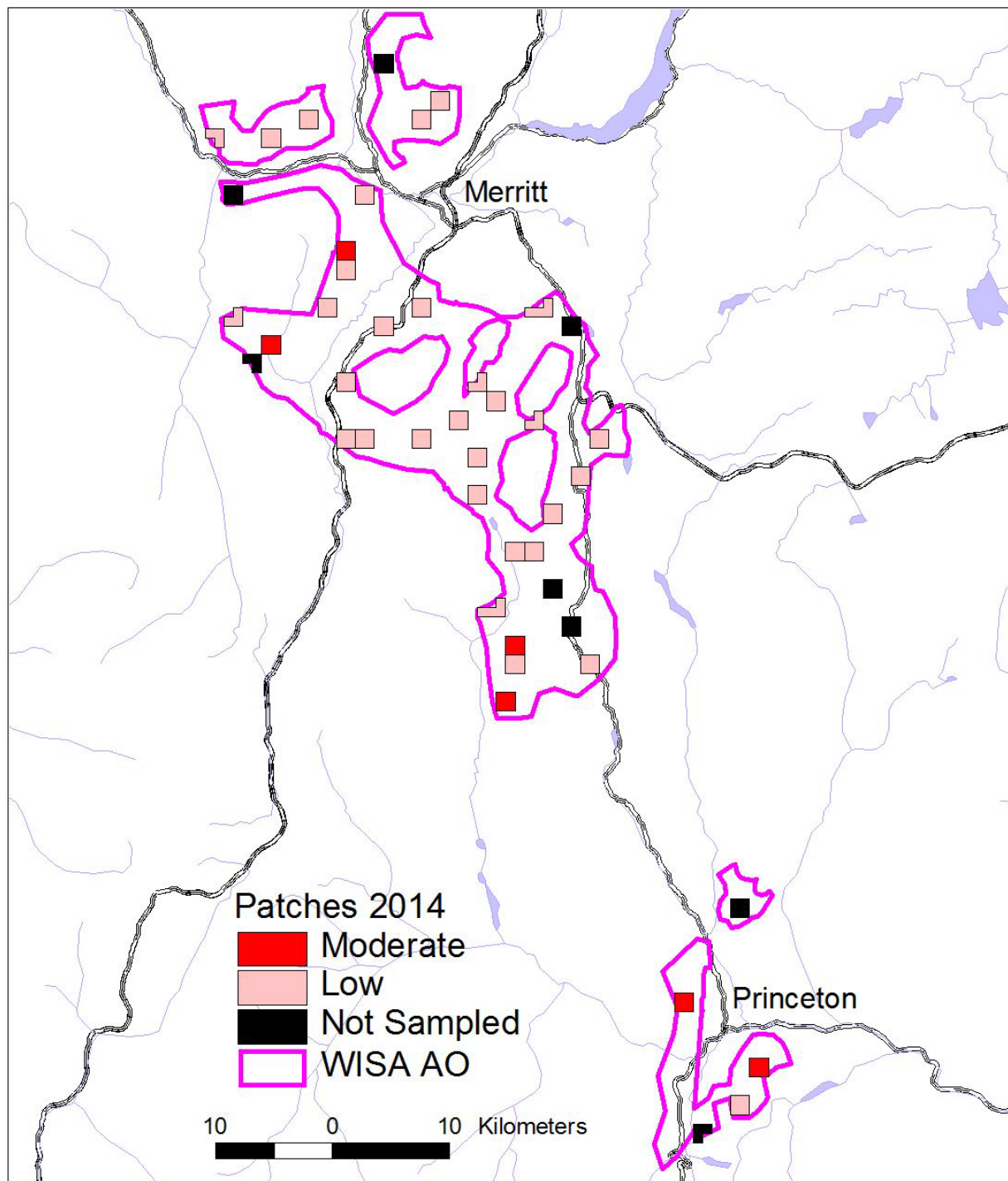
Map 1A. Merritt Area (West AO) April Road Monitoring CPB Points.



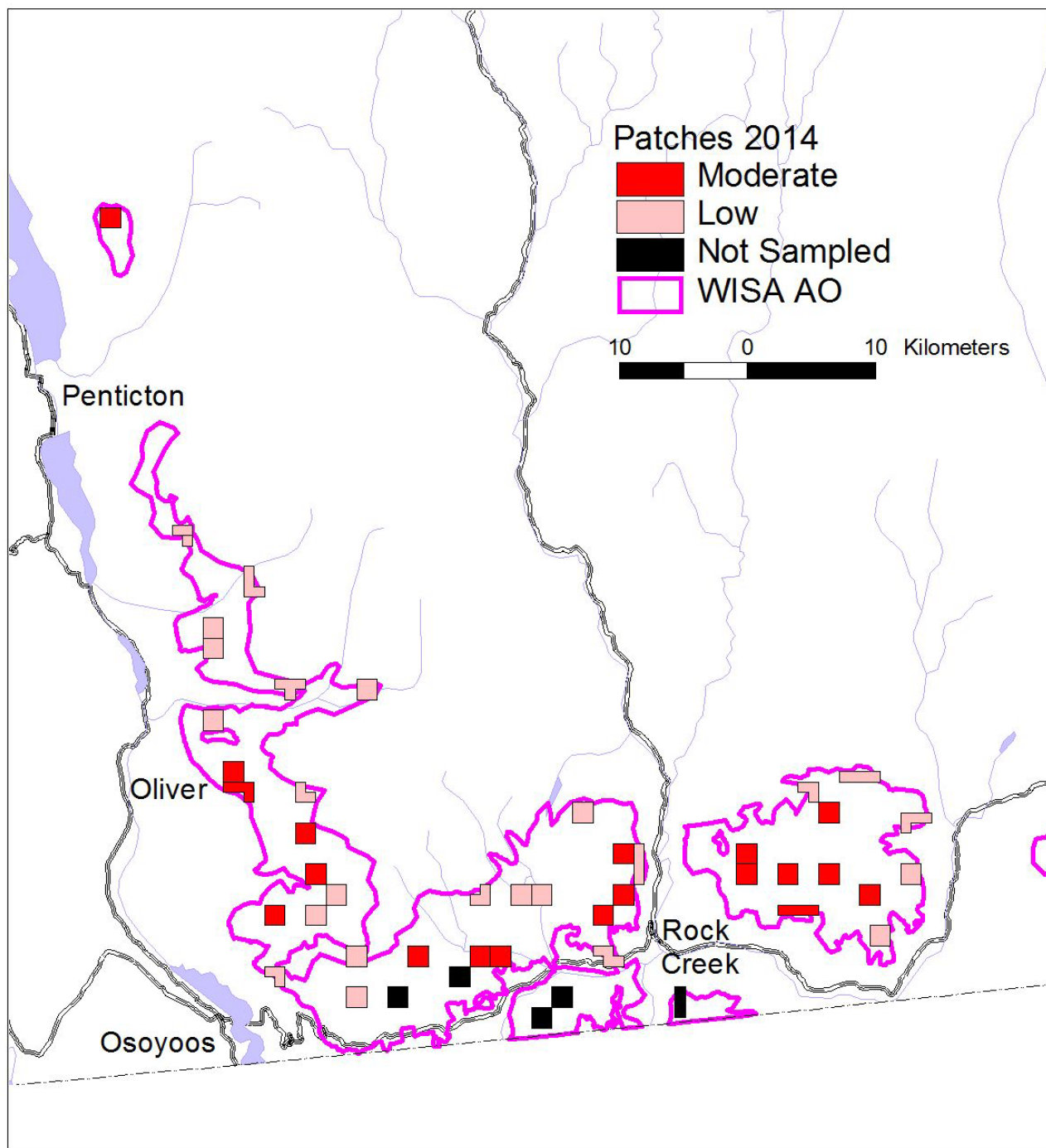
Map 1B. Princeton Area (West AO) April Road Monitoring CPB Points.



Map 1C. Okanagan-Boundary AO April Road Monitoring CPB Points.



Map 1D. 2014 Patches Monitored in the West AO (Merritt and Princeton areas).



Map 1E. 2014 Patches Monitored in the Okanagan-Boundary AO.