Review of the COSEWIC 2012 assessment of Western Screech-Owl (*kennicottii* subspecies)

by

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December 2014

Executive Summary

The most recent update status report for the Western Screech-Owl *kennicottii* subspecies for coastal BC estimated a population of 1500-3000 mature individuals and a decline of 20 to 30% over the previous 15 years (COSEWIC 2012). As such, COSEWIC recommended a status of Threatened in May 2012, referencing criterion C1, which specifies a population of fewer than 10,000 mature individuals, coupled with a continuing decline of at least 10% over 10 years. This status recommendation was subsequently questioned during the public review process under SARA, largely on the basis that the population size may have been underestimated in the report. In particular, the appropriateness and reliability of detectability estimates and habitat modeling parameters were challenged, as they may have been biased towards a smaller population size. Also, the relative proportion of the population formerly occurring in the BC South Coast was used in the report as a basis for trend estimation, but was not sufficiently substantiated and may not have been representative of the population density along the mainland coast.

In response to these challenges, the Birds Species Specialist Subcommittee (SSC) formally reassessed the population and trend estimates for the *kennicottii* subspecies that had been provided in COSEWIC (2012). The resulting report provides:

- A range of population estimates based on a range of plausible assumptions derived from available literature; and
- A population trend estimate for the past 10 years, derived from existing literature and data from ongoing surveys (i.e., Christmas Bird Count and BC Nocturnal Owl Survey).

Population Size Estimate: At the conclusion of this exercise, the Birds SSC determined that detectability was indeed probably overestimated in the COSEWIC (2012) report, resulting in what was probably an unrealistically small population estimate for the *kennicottii* subspecies. Whereas the 2012 report assumed that all owls within 800 m of survey stations were detected, a more realistic detection radius for the species is 400 to 500 m, and recent studies suggest that detectability rates tend to range between 0.2 and 0.3. Although some Western Screech-Owls occur between 300 and 600 m elevation, it is unclear how many; estimating that density is half as great as below 300 m is a guess, but perhaps closer to reality than assuming either none above 300 m or a uniform density up to 600 m. Finally, while very little is known about the distribution and abundance of the mainland population, it seems likely that the Vancouver Island density is at least twice as great as originally surmised.

Based on these adjustments alone, most calculations predict a population well above 10,000 individuals. However, the actual suitability of much of the potentially available habitat is unknown, and it is difficult to suggest the degree to which the estimates should be reduced. The most plausible unadjusted estimates, based on recent (2006-2007) data from large-scale systematic surveys, suggest a wide range

of between 4300 and 47,000 individuals. Moreover, if only 20% of potential habitat is not occupied for whatever reason, the low end of most estimates would fall below 10,000 birds. Furthermore, the estimates are based on data from 2006-2007. If the population has continued to decline since then (which seems to have happened), then population estimates would need to be reduced further.

Also, despite just a few parameters involved in generating population estimates (detection radius, detection rate, and selection of source data), estimated population sizes vary by more than an order of magnitude, and therefore it is important to acknowledge the relatively low level of certainty associated with any estimate.

Moreover, it is important to recognize that the owl population likely fluctuates substantially from year-to-year in response to variation in weather conditions and prey availability, and that such natural variation should be accounted for in any population estimate. Given all of the above, there may be more than 10,000 birds in some years. And in others, there may be fewer. Embracing this level of uncertainty is an important component of how COSEWIC assesses species status.

Population Trend Estimate: While there is still considerable uncertainty over a population estimate for the *kennicottii* subspecies in British Columbia, all sources for trend estimates suggest that the Vancouver Island population has declined by at least 50% during the past decade. This is supported by results from the most recent surveys that indicate declines in the Campbell River and Nimpkish Valley regions. The mainland population has been monitored in much less detail, but on balance, it seems reasonable (and precautionary) to conclude that the overall rate of decline for the entire *kennicottii* population in British Columbia is likely to be at least 30% over the past decade. Therefore, even if the most liberal population estimates (see above) are too large for criterion C1 to apply, then the rate of decline is still sufficiently great to warrant Threatened status under criterion A2b (estimated >30% reduction in number of mature individuals over the last 10 years, with the causes not well understood and possibly not ceased).

As an outcome of the review, the Birds SSC suggests that a reasonable precautionary interpretation of all the available data leads us to maintain that the subspecies was indeed correctly designated as Threatened in the most current status report -- whether under criterion C1 and/or under criterion A2b. Moreover, trends in adjacent jurisdictions suggest that rescue effect cannot be invoked, as the species appears to be reducing its range in southeastern Alaska and declining rapidly in Washington State.

Background

The most recent status report for the Western Screech-Owl *kennicottii* subspecies for coastal BC estimated a population of 1500-3000 mature individuals and a decline of 20 to 30% over the previous 15 years (COSEWIC 2012). COSEWIC recommended a status of Threatened in May 2012, referencing criterion C1, which specifies a population of fewer than 10,000 mature individuals and a continuing decline of at least 10% over 10 years. The status recommendation was questioned during the public review process under SARA, largely on the basis that the population size may have been underestimated in the report. In particular, the appropriateness and reliability of detectability estimates and habitat modeling parameters were challenged, as those used may have been biased toward a smaller population size. Also, the relative proportion of the population formerly occurring in the BC South Coast was used in the report as a basis for trend estimation, but was not sufficiently substantiated and may not be representative of the population density along the mainland coast.

The objectives of this review are to reassess the population and trend estimates for the *kennicottii* subspecies provided in COSEWIC (2012). Specifically, this review will:

- Provide population estimates (i.e., current number of mature individuals) based on a range of plausible assumptions derived from available literature;
- Identify the most plausible range of estimates, accompanied by rationale explaining their basis; and
- Provide a population trend estimate for the past 10 years, derived from existing literature and data from ongoing surveys (i.e., Christmas Bird Count and BC Nocturnal Owl Survey).

Available data

Several systematic breeding season surveys of the BC population of the *kennicottii* subspecies were conducted between 1995 and 2014 (Setterington 1998, Preston and Campbell 2001, Matkoski 2006, Tripp and Menzies 2008, Davis and Doyle 2014). Additionally, in-depth studies of the southeast Alaskan population were reported by Kissling and Lewis (2009) and Kissling et al (2010; see Appendix 1). Other recent literature on Western Screech-Owls in BC includes a discussion of the population decline in the lower mainland by Elliott (2006) and a multi-year study of the *macfarlaneii* subspecies in the Kootenay region by Hausleitner and Dulisse (2009). In addition, data for *kennicottii* in BC are available through the Christmas Bird Count, BC Nocturnal Owl Survey, BC Breeding Bird Atlas, and eBird databases. Collectively, these data sources provide some insight into the detectability, distribution, and population trends of the *kennicottii* subspecies in British Columbia.

Breeding season surveys

Setterington (1998) conducted focused surveys for Western Screech-Owls in the Nimpkish Valley annually from 1995 to 1997 at over 300 locations each year. With two visits per station in 1995 and 1997, cumulative encounter rates per station were 18% and 24% respectively; with five visits per station in 1996 the cumulative encounter rate per station increased to 30%.

Preston and Campbell (2001) undertook a comprehensive survey for Western Screech-Owls on Vancouver Island, with 561 stations between Victoria and the Nimpkish Valley. It is important to acknowledge that their survey, while extensive, surveyed stations only once each and only in one year (2000). Only 26 screech-owls were detected, for an encounter rate of 4.6% (Table 1). Preston and Campbell also surveyed 156 stations on the Sunshine Coast the same year, but did not detect any screech-Owls there (Table 1).

Two surveys of the *kennicottii* subspecies on Vancouver Island spanned multiple years, and both indicated a drop in numbers beginning around 2006 (Table 1). In the first instance, Matkoski (2006) surveyed stations in the Nimpkish Valley, reporting encounter rates per survey of 12.0% in 2003, 10.0% in 2004 and 15.1% in 2005, but only 6.0% in 2006. However, it should be noted that the surveys reported by Matkoski (2006) did not include playing screech-owl broadcasts at stations where Northern Saw-whet Owls were found. Because there was an increase in saw-whet owl detections in 2006, there was a decrease in the number of stations where broadcasts for screech-owls were actually made that year. Hence, declines of screech-owls in the Nimpkish Valley could be questionable. Even so, surveys conducted there more recently also showed much lower encounter rates than previously (falling to 5.2% in 2013 and 4.5% in 2014; Table 1).

Meanwhile, Tripp and Menzies (2008) surveyed stations in the Campbell River area of Vancouver Island, with encounter rates of 8.9% to 11.7% per survey in 2000, 2002, and 2003, but these fell to 0.8% in 2007. Low encounter rates (1.8%) were also reported by Davis and Doyle (2014) for the Campbell River area (Table 1), suggesting that the population in that region has not recovered since 2007. Even though encounter rates for the Lower Sunshine Coast – Clowhom River region (north of Vancouver) were still

quite high in 2013-14 (8.6%), there were no owls detected in the Lower Sunshine Coast for the nearby Egmont to Langdale region in 2014 (Table 1). This indicates a patchy distribution.

In addition to the systematic surveys summarized in Table 1, another multi-year study was reported by Elliott (2006). The author periodically surveyed 22 locations in the Vancouver area between 1998 and 2002, with success at five sites over the first three years, but no subsequent observations, and concluded that Western Screech-Owls were absent from all sites by 2002.

In addition to surveys on Vancouver Island, Davis and Doyle (2014) also undertook targeted surveys of the mid-coast and north coast of BC in 2014, as far north as Terrace (see Figure 1), but failed to record any screech-owls on the mainland coastal surveys (Table 1).

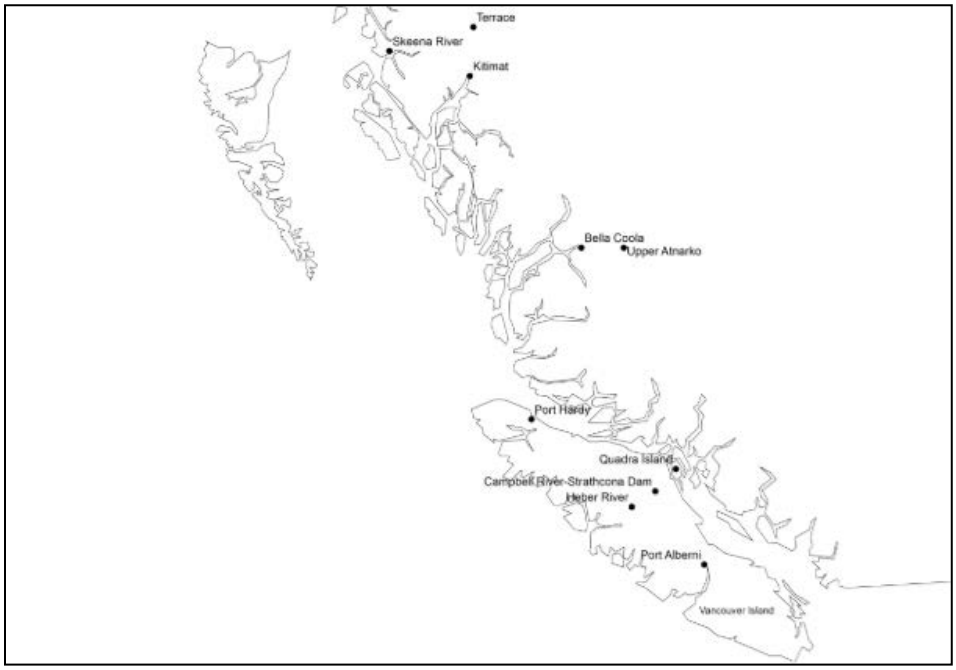

Figure 1. Locations surveyed for Western Screech-Owls in 2014 (from Davis and Doyle 2014).

British Columbia Nocturnal Owl Survey

The British Columbia Nocturnal Owl Survey is a volunteer-run program started in 2000 to monitor trends in owl populations through a roadside survey modeled after the Breeding Bird Survey. Observers drive a fixed route each spring, stopping to listen for two minutes at 10-30 fixed stations 1.6 km apart; since 2004 the stops on coastal routes have been expanded to five minutes, including two 30-second broadcasts of Western Screech-Owl calls (D. Cannings, pers.comm.). Survey coverage is admittedly quite spotty in the central and north coast regions of BC, so does not give a complete picture (Figure 2).

Table 2 summarizes detections of Western Screech-Owls from Vancouver Island and South Coast routes on the Nocturnal Owl Survey from 2000 through 2012. Survey effort tapered off after the first few years, especially on Vancouver Island. However, there was a strong bias to abandoning routes with few owls and retaining productive surveys, therefore the number of owls per route tends to be biased high for more recent years. At the same time, there is little potential to see an increase in owls, given that places where zero were found were abandoned. In addition, surveys that incorporate screech-owl broadcast result in significantly higher detectability (Kissling and Lewis 2009). Thus, the use of broadcasts from 2004 onward would have accordingly increased detectability in the later parts of the

time series of the Nocturnal Owl Survey. As such, the lower number of detections in the post-2004 years (Table 2) becomes all the more striking.

Table 1: Encounter rates from surveys of the *kennicottii* subspecies in British Columbia since 2000.

Location	Year	# owls detected[1]	# stations	Encounter rate per survey	Source
Sunshine Coast – southern mainland BC	2000	0	156	0%	Preston & Campbell (2001)
Vancouver Island – Victoria to Nimpkish Valley	2000	26	561	4.6%	Preston & Campbell 2001)
Central Vancouver Island – Campbell River	2000	16	180	8.9%	Tripp & Menzies (2008)
	2002	21	180	11.7%	Tripp & Menzies (2008)
	2003	16	180	8.9%	Tripp & Menzies (2008)
	2006	8	107	7.5%	Tripp & Menzies (2008)
	2007	1	126	0.8%	Tripp & Menzies (2008)
	2014	1	56	1.8%	Davis & Doyle (2014)
Northern Vancouver Island – Nimpkish Valley	2003	12	100	12.0%	Matkoski (2006)
	2004	30	299	10.0%	Matkoski (2006)
	2005	45	299	15.1%	Matkoski (2006)
	2006	18	299	6.0%	Matkoski (2006)
	2013	13	252	5.2%	J. Deal pers. comm. to Davis & Doyle (2014)
	2014	8	177	4.5%	J. Deal pers. comm. to Davis & Doyle (2014)
Vancouver Island	2014	4	125	3.2%	Davis & Doyle (2014)
Mid-coast	2014	0	64	0.0%	Davis & Doyle (2014)
North Coast	2014	0	145	0.0%	Davis and Doyle (2014)
Quadra Island	2014	1	45	2.2%	Davis & Doyle (2014)
Vancouver Island – North	2008	16	353	4.5%	Jackett et al. (2008)
Lower Mainland – Alouette River	2012-13	0	147	0.0%	Mitchell (2013)
Lower Sunshine Coast – Clowhom River	2013-14	8	93	8.6%	M.Evelyn, pers. comm. to Davis & Doyle (2014)
Lower Sunshine Coast – Egmont to Langdale	2014	0	62	0.0%	M.Evelyn, pers. comm. to Davis & Doyle (2014)

[1] includes stations surveyed multiple times

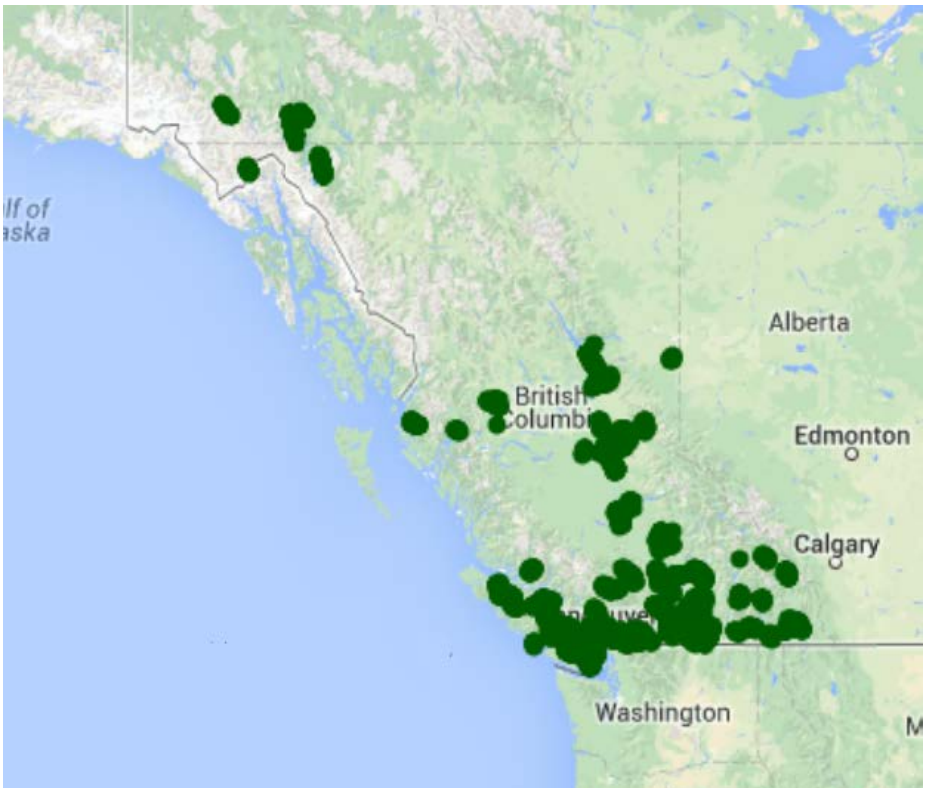

Figure 2. Locations of routes surveyed by the BC Nocturnal Owl Survey (2000-2013).

On Vancouver Island, the count of Western Screech-Owls was greatest during the first two years, but fairly consistent overall until 2006, except for a low point in 2002. Counts then dropped to zero in 2007 and 2008 before rebounding a bit from 2009 through 2012. However, 7 of the 11 Western Screech-Owls observed from 2010 through 2012 were at North Saltspring or Mayne Island, locations that were not surveyed previously (except for Saltspring in 2001, when one Western Screech-Owl was detected). Omitting these two routes, the annual total across the more consistently surveyed routes would have been 3 in 2010, 1 in 2011, and 0 in 2012.

On the South Coast, results were fairly consistent at a low level from 2001 through 2006, but observations also fell to zero in 2007. In contrast to Vancouver Island though, there were no further records in the five subsequent years of surveying, despite relatively consistent effort.

Table 3 summarizes the difference in results before and since 2007 for both Vancouver Island and the South Coast. Across all Vancouver Island routes, the mean annual number of owls per route declined only slightly from 0.3 to 0.2, but adjusting for the majority of records from 2010 through 2012 being from routes not previously surveyed (see footnote in Table 3), the observation rate dropped by over two-thirds. On the South Coast, there have been no observations on any of the 54 surveys run since 2007, compared to a mean count of 0.1 owl per route in previous years.

Table 2: Annual count of routes surveyed and Western Screech-Owls observed on Nocturnal Owl Survey routes on Vancouver Island and within the South Coast region from 2000-12.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Vancouver Island	**# routes**	30	41	37	31	22	13	11	9	8	12	15	13	16
	# WESO	9	13	3	6	5	6	6	0	0	2	7	3	1
	#/route	0.3	0.3	0.08	0.2	0.2	0.5	0.5	0	0	0.2	0.5	0.2	0.06
South Coast	**# routes**	12	25	15	10	11	10	10	11	10	8	8	9	8
	# WESO	0	1	2	2	2	2	3	0	0	0	0	0	0
	#/route	0	0.04	0.1	0.2	0.2	0.2	0.3	0	0	0	0	0	0

Table 3: Comparison of overall and mean detection rates for the Nocturnal Owl Survey on Vancouver Island and in the South Coast region, for the periods 2000-2006 and 2007-2012.

		2000-2006	2007-2012
Vancouver Island	**Mean # owls / year**	6.9	2.1
	Mean # owls / route / year	0.3	0.2
	Adjusted mean # owls / route / year[1]	0.3	0.08
South Coast	**Mean # owls / year**	1.7	0
	Mean # owls / route / year	0.1	0

[1] – omitting Saltspring Island (only surveyed 2001 and 2010-2012) and Mayne Island (only surveyed 2010-2012)

Christmas Bird Count

Six British Columbia Christmas Bird Count circles within the range of the *kennicottii* subspecies have regularly (in at least 50% of years) included owling effort over the past 30 years: Duncan, Nanaimo, and Victoria on Vancouver Island, and Sunshine Coast, Vancouver, and White Rock on the South Coast. Ladner has also documented owling effort on roughly one quarter of counts. Specific information on the extent to which call playback is used for surveying owls in the CBC is not available. It is probably an increasingly common practice, given the competitive nature of this survey program.

Table 4 summarizes the raw counts of Western Screech-Owls from these seven counts, showing a sharp distinction between 1983-1996 (mean count 13.7; range 8 to 28) and 1997-2012 (mean count 1.4; range 0 to 3). The pattern was similar for the Vancouver Island and South Coast counts, although the decline was most evident for Victoria, which had by far the greatest total number of observations over the past 30 years.

Table 4: Raw counts of Western Screech-Owls on four coastal and three Vancouver Island Christmas Bird Counts from 1983 through 2012. Blank cells are years in which counts took place, but no owls were recorded.

	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12
Duncan	3							1	1	1	2	4	1														1			
Nanaimo		1				1		1							1			1			1									
Victoria	2	10	5	7	7	9	9	14	23	9	14	1	9	6		2	1	1			1	1	1		1				3	1
Ladner						2	2	2									1													
Sunshine Coast	2											1											1		1					
Vancouver			5	1	2	4	3	2	2	2	5	1	2	1	1		1	1												
White Rock	2			1		1	1		2	1	1	1	1	1									1							
TOTAL	9	11	10	9	9	17	15	20	28	13	22	8	13	8	2	2	3	3	0	0	2	1	3	0	2	0	1	0	3	1

Figure 3 shows the combined results for the seven Christmas Bird Counts, standardized to number of Western Screech-Owls per party hour of owling effort. Although the overall pattern of decline is similar to that shown by Table 4, it appears to begin three years earlier in 1994, but this in part is a function of the record high owling effort in 1995 and 1996 driving down the rate of owls per party hour.

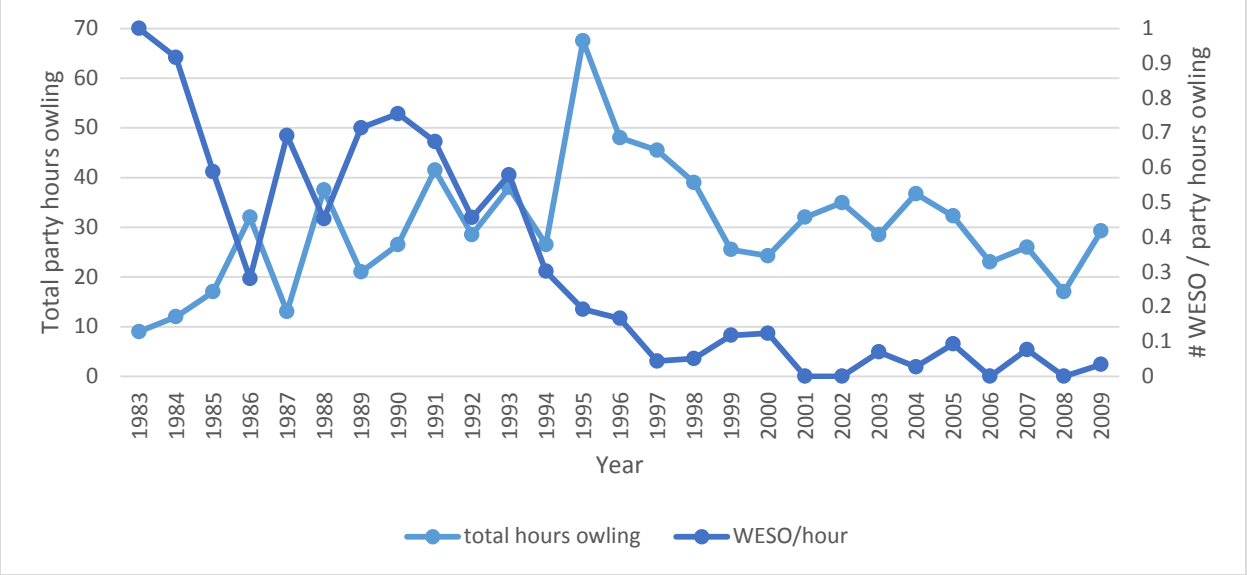

Figure 3. Pattern of observer effort and detection rate of Western Screech-Owls per party hours owling on seven coastal and Vancouver Island Christmas Bird Counts, 1983 through 2009.

eBird

Especially in recent years, many observers have been reporting sightings of all bird species to eBird, supplementing the more temporally-focused citizen science efforts such as the Nocturnal Owl Survey and Christmas Bird Count. Figure 4 indicates the location of all Western Screech-Owl records documented for British Columbia as of August 2014. Within the range of the *kennicottii* subspecies, all British Columbia observations are either on Vancouver Island or along the South Coast. Although the distribution of the species has hitherto presumed to be contiguous with the population in southeast Alaska, there are very few records in BC that are north of Vancouver Island. Access to much of the BC coast is limited and the lack of observations is likely at least in part a consequence of limited search effort. Nonetheless, the results are consistent with the paucity of records along the Sunshine Coast (e.g., Preston and Campbell 2001), and the complete absence of records in the northwestern part of the province (Campbell et al. 1990). Indeed, we have been unable to substantiate Cannings and Angell's (2001) depiction of this species' occurrence in northwestern BC; the authors seem to have assumed that the species' range in BC is contiguous with that of southeastern Alaska. In addition, despite the absence of screech-owl records in the northwestern part of BC, there are records of Barred Owls and other species of owls there (Figure 5), so this region has received at least some bird survey coverage over the years.

It is noteworthy that the screech-owl records from extreme southeastern Alaska lie within a different ecoregion (Coastal Western Hemlock Forest) than exists in adjacent BC (Pacific Coastal Mountains; see Figure 6). Unlike the Coastal Western Hemlock Forest, most of the Pacific Coastal Mountain region would lay at elevations that are higher than screech-owls prefer. This at least partially explains their apparent absence from that region.

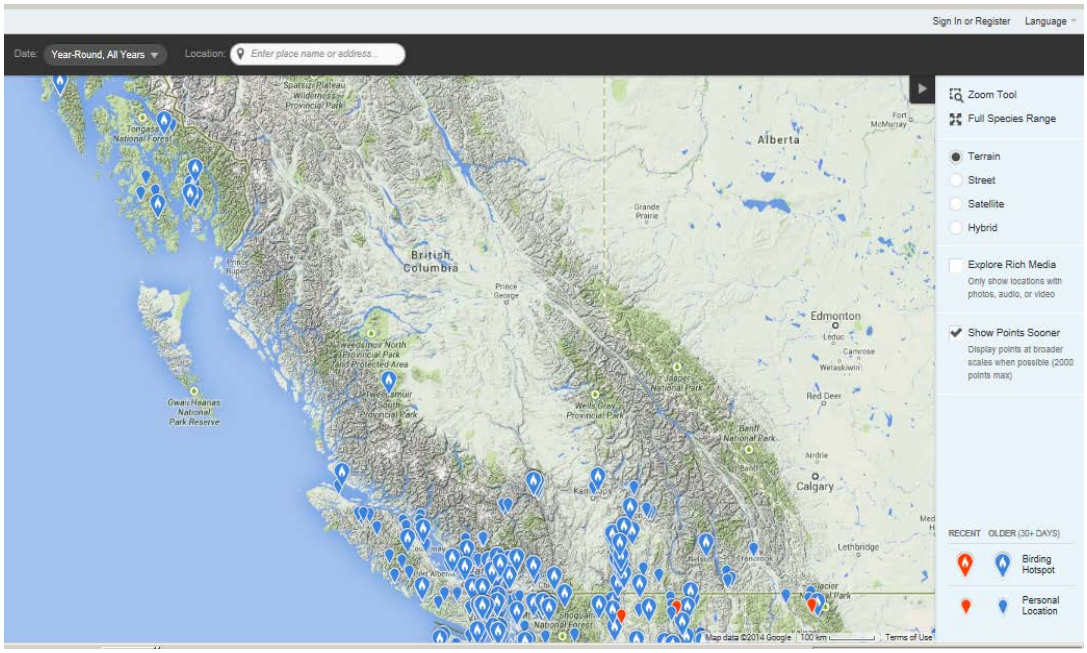

Figure 4. August 2014 screenshot from eBird showing all documented records of Western Screech-Owl in British Columbia. Note the absence of records in the coastal central and northwestern parts of the province, but presence in southeastern Alaska.

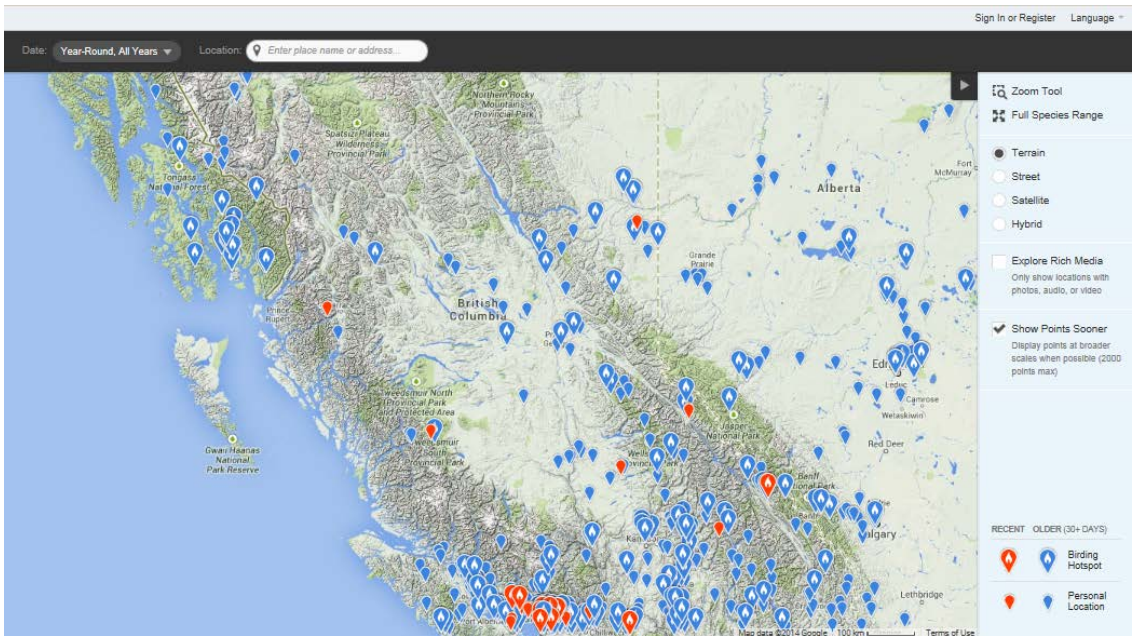

Figure 5. August 2014 screenshot from eBird showing all documented records of Barred Owl in British Columbia. Though there are apparent geographic gaps in survey coverage, note the <u>presence</u> of records in the coastal central and northwestern parts of the province, in regions that were largely devoid of Western Screech-Owl records (see Figure 4).

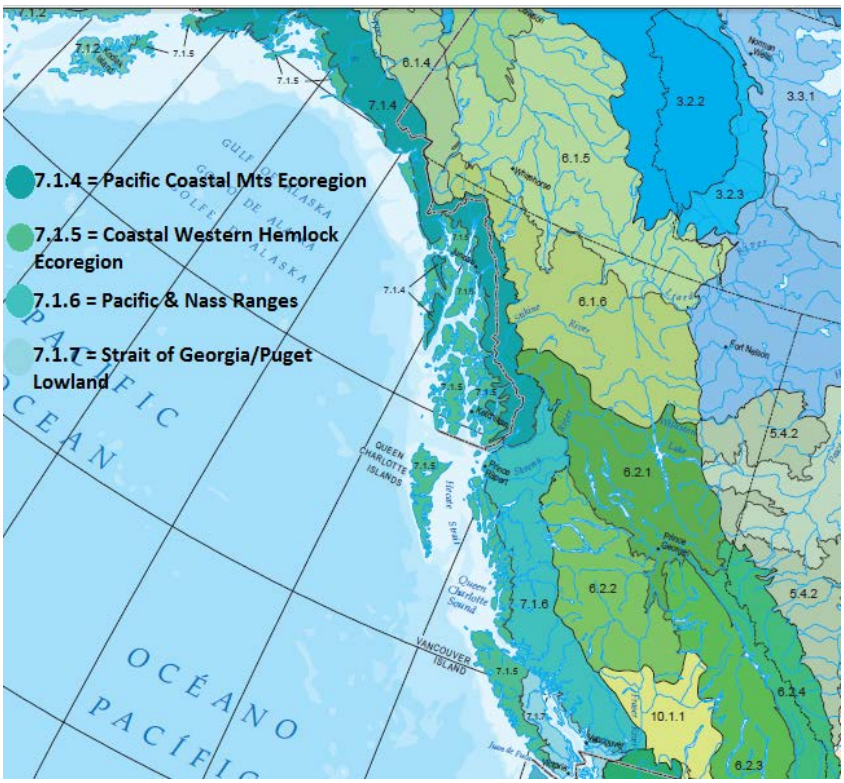

Figure 6. Map of the ecoregions in the Pacific northwest (adapted from Wiken et al. 2011).Western Screech-Owls are rare to absent within ecoregion 7.1.4 (Pacific Coastal Mountains) in the northwest.

BC Breeding Bird Atlas

In order to better understand the level of survey coverage for Western Screech-Owl, Figure 7 shows the distribution of this species from 2008-2012, relative to that of other nocturnal species that were detected during the most recent breeding bird atlas project in western BC. While it does support the contention that survey coverage has not been extensive north of the Sunshine Coast, it also shows that coverage in this region has not been entirely lacking, given the occurrence of records of other owl species within the purported range of the *kennicotti* subspecies of screech-owl in BC.

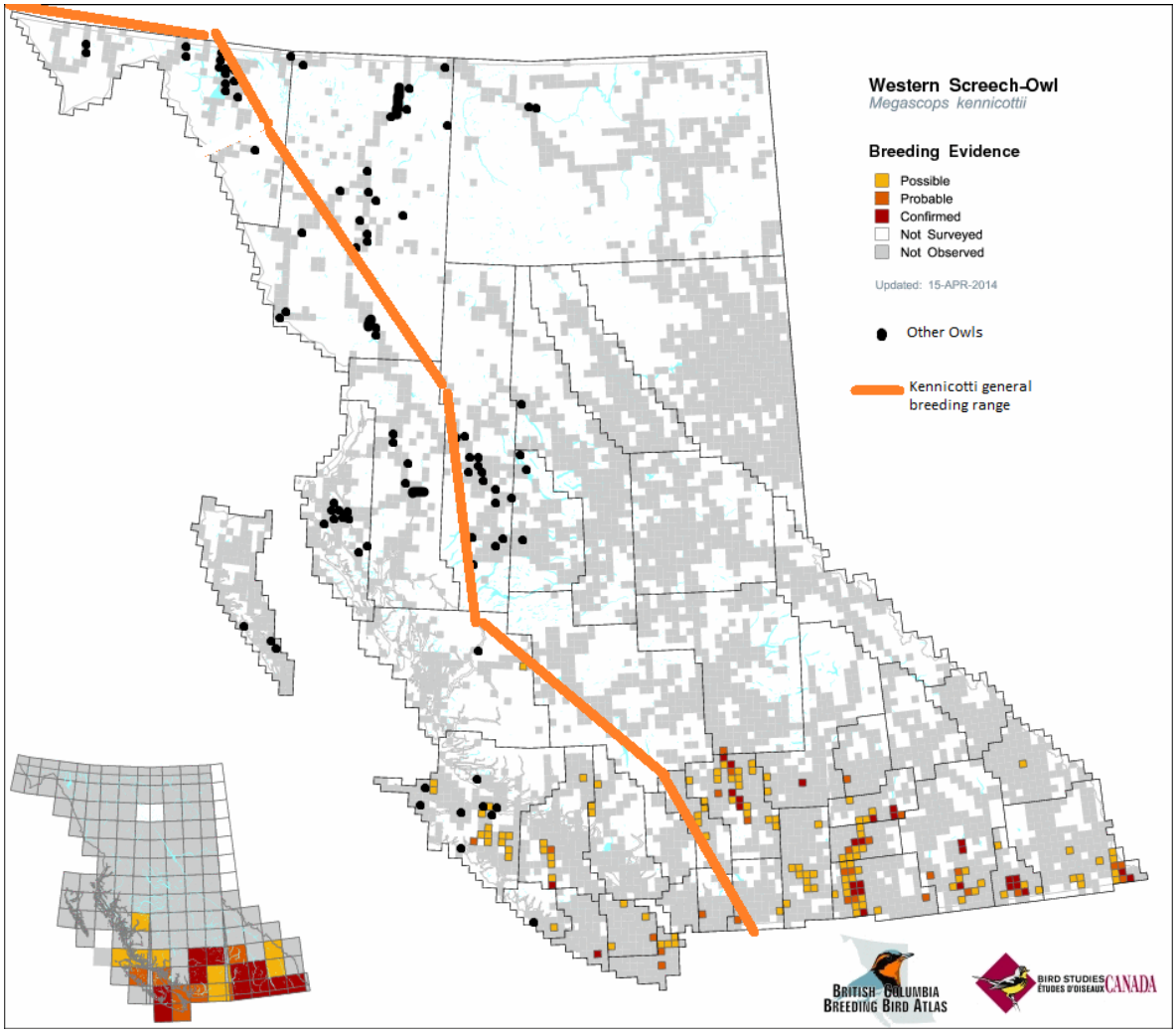

Figure 7. Locations of breeding season records for Western Screech-Owl (WESO) across BC, versus occurrence records of all other nocturnal owls within the purported breeding range of WESO. For other owl species, only data within and north of central Vancouver Island are plotted. Data are from the BC Breeding Bird Atlas project from 2008 to 2012. Note the gap in records of WESO outside southern BC, despite records of other owl species in the north.

Detectability

Results from Kissling and Lewis (2009) in Alaska indicate that detectability of Western Screech-Owl is lowest among the owls studied, including Northern Saw-Whet Owl and Barred Owl. Without broadcasts, detectability is very low – around 13%. We do not know the extent to which broadcast surveys were done for CBC or the eBird observations. To achieve a CV of 20-25% for an occupancy estimate, Kissling and Lewis (2009) recommend three replicate broadcast surveys at 180-200 stations. This level of effort has not been attempted across the species' range in BC, so information on abundance is not as reliable as it otherwise would be. However, as long as the level effort has remained the same, information on trends is likely not as heavily affected by detectability issues, though effort would affect statistical power.

Comments received during the SARA listing consultations from Western Forest Products (WFP 2013) suggest that decreases in screech-owl detections might be caused by a change in behaviour in response to the presence of Barred Owls rather than a change in abundance. They also state that other inventory methods are needed to corroborate declines. The notion of behavioural change appears also in the literature. Elliott (2006) suggested that screech-owls may vocalize less often than in the past in order to elude Barred Owls. Kissling and Lewis (2009) also indicated that they couldn't distinguish between the impacts of Barred Owls on detectability and occupancy. Hence, while the presence of large owls could partially explain the overall low detection probability for Western Screech-Owl, the alternative precautionary assumption would be to assume that reduced occupancy (and hence population size) is also a credible explanation.

The COSEWIC (2012) report based its density estimate of one owl per 5515 ha on Preston and Campbell's (2001) survey results and an assumption that they were detecting all male screech-owls within 800 m. Preston (pers.comm.) believes that the effective detection radius was likely closer to 400 m, based in part on not detecting the same individuals at adjacent survey stations 800 m apart. Participants in the Nocturnal Owl Survey estimated distance for 69 Western Screech-Owls they detected; 60 (87%) were within 400 m, and 67 (97%) were within 500 m. While it is impossible to know how accurate those distance estimates are, it seems likely that using a detection radius of 800 m would underestimate the density of owls (a detection radius of 800 m covers four times as much area as one of 400 m, and over 2.5 times as much area as one of 500 m). Table 5 summarizes the estimated densities of owls based on survey results for Vancouver Island by Preston and Campbell (2001), Matkoski (2006), and Tripp and Menzies (2008), for estimated detection radii of 400, 500, and 800 m.

The assumption that Preston and Campbell (2001) were detecting all male screech-owls present also appears to be flawed. While Setterington (1998) did not specify detection rates, he had cumulative encounter rates of 18 to 24% when visiting each station twice in 1995 and 1997, compared to 30% when he surveyed each site five times in 1996. Although the possibility of a year effect cannot be ignored, there is undoubtedly a positive correlation between number of surveys and detectability.

Table 5: Estimated density of Western Screech-Owl pairs on Vancouver Island based on data from three surveys (two subdivided into pre- and post-2006) and assuming three different detection radii.

Source	Survey year(s)	# owls detected	# survey points	Estimated ha / owl pair		
				400 m (area =50.24 ha)	**500 m** (area =78.5 ha)	**800 m** (area =201 ha)
Preston and Campbell (2001)	2000	26	561	1085	1695	4338[1]
Tripp and Menzies (2008)	2000-03	53	540	512	800	2049
	2006-07	9	296	1652	2582	6611
Matkoski (2006)	2004-05	75	598	401	626	1522
	2006	18	299	834	1304	3339

[1] – note that this differs from 5515 ha reported in COSEWIC (2012), as it appears that estimate took into account the null results from the Sunshine Coast surveys

More recently, studies in British Columbia and Alaska have explicitly addressed estimates of detectability for Western Screech-Owls. Hausleitner and Dulisse (2009) conducted broadcast surveys at 821 locations from April to August over four years (2003-2005, 2007) in the Kootenay region (focusing on the *macfarlanei* subspecies). They used patch occupancy modeling to estimate a detection rate of 0.23. They added 423 further surveys at 170 stations in 2008, and extended the season to September, resulting in an overall detection rate of 0.27. However, the authors determined that this rate was inflated by an increase in territorial defence and vocalization corresponding with juvenile dispersal in late summer / early autumn, and with the September surveys excluded, the detectability for the 2008 season was 0.20.

In Alaska, Kissling and Lewis (2009) derived three estimates of detectability. An intensive study of 50 survey sites in southeast Alaska in 2005 revealed that detectability was much higher when Western Screech-Owl calls were broadcast during a survey, and varied over the course of the season. With roughly ten replicates per site, detectability at the optimal survey period within the field season was estimated at 0.30. An expanded survey of 346 locations from 2005 through 2008 resulted in an overall detectability of 0.13, or 0.28 for surveys that included call broadcasts. They also used a small sample (n=8) of radio-marked birds to evaluate the detection rate of broadcast surveys, and reported a rate of 0.12 from that trial.

While the Kissling and Lewis (2009) study using radio-marked birds was the most objective with respect to comparing detection with actual occupancy, the sample size was small compared to their other surveys. All of the other estimates reported for Alaska and British Columbia by Kissling and Lewis (2009) and Hausleitner and Dulisse (2009) range between 0.20 and 0.30.

Table 6 summarizes how the estimates of owl density vary at each of the previously discussed detection radii for detection rates of 0.12, 0.20, and 0.30. It illustrates that for any source data, density estimates vary by a full order of magnitude from lowest (assuming 0.30 detectability over a radius of 800 m) to highest (assuming 0.12 detectability over a radius of 400 m), and therefore the selection of these two parameters can have a significant influence on population estimates. Unfortunately neither has been specifically assessed for the Vancouver Island population, and it is therefore some level of uncertainty will surround any estimate. However, the range of plausible values can be narrowed down to some

degree. As discussed previously, it is unlikely that Western Screech-Owls can be regularly detected reliably over a distance of 800 m, and either 400 m or 500 m likely seems more realistic. Similarly, although detectability was as low as 0.12 in one study, the weight of evidence suggests that detectability is more typically between 0.20 and 0.30. This 2x2 subset of more probable parameters is highlighted within Table 6; among these, the high estimate is only slightly more than double the low one.

Table 6: Estimated Western Screech-Owl density at three detection radii for each of three levels of detectability, using encounter data from three Vancouver Island surveys; the most probable values are shaded in light gray.

	Survey year(s)	# owls detected	Detectability	Estimated ha / owl pair (by detection radius)		
				400 m	500 m	800 m
Preston and Campbell (2001)	2000	26	0.12	130	203	521
			0.20	217	339	868
			0.30	326	509	1301
Tripp and Menzies (2008)	2000-03	53	0.12	61	96	246
			0.20	102	160	410
			0.30	154	240	615
	2006-07	9	0.12	241	377	965
			0.20	402	628	1608
			0.30	603	943	2413
Matkoski (2006)	2004-05	77	0.12	47	73	188
			0.20	78	122	313
			0.30	118	184	470
	2006	19	0.12	95	149	381
			0.20	159	248	635
			0.30	238	372	953

Distribution

Currently, the *kennicottii* subspecies is primarily associated with the Coastal Western Hemlock biogeoclimatic zone (formerly also was found in numbers in the Coastal Douglas-fir biogeoclimactic Zone, but it is virtually extirpated from this area). As discussed earlier, there is little evidence that this owl occurs in northwestern BC adjacent to the population that occurs within a different ecological zone in extreme southeastern Alaska.

The population estimate in COSEWIC (2012) assumed suitable habitat was limited to below 300 m, although Campbell et al (1990) described the species occurring up to 540 m, and both Setterington (1998) and Preston and Campbell (2001) had observations at elevations between 300 and 600 m. There have even been occasional reports of birds at up to 800 m (J. Deal pers. comm. 2014 to D. Fraser), though this is a rare occurrence. Table 7 summarizes the extent of habitat available below 300 m and below 600 m on both Vancouver Island and mainland British Columbia. Expanding the elevational limit to 600 m increases available habitat by nearly 80% on Vancouver Island and by 57% on the mainland and associated islands. The areas specified in Table 7 should be considered upper limits, and somewhat unrealistic as they include urban development, clearcuts, dense second-growth and other areas that are not actually suitable for Western Screech-Owls but are difficult to map or quantify reliably. In addition, the mainland areas include large parts of northwestern BC, where the species is either very rare or entirely absent.

Table 7: Area of Coastal Western Hemlock habitat on Vancouver Island and in Mainland British Columbia over two elevational spans.

	0 – 300 m (ha)	0 – 600 m (ha)
Vancouver Island only	1,084,952	1,934,956
Vancouver Island + associated islands	1,182,221	2,057,350
Mainland British Columbia only	2,081,240	3,627,130
Mainland British Columbia + associated islands	3,183,036	4,985,313

Data gaps

Both spatial and temporal data gaps limit the reliability of population and trend estimates. COSEWIC (2012) estimated that all of the survey effort for *kennicottii* has probably covered less than 10% of available habitat in BC. Although multiple Western Screech-Owl surveys have targeted the *kennicottii* subspecies in British Columbia, most have been on Vancouver Island or the lower mainland, and the majority were between 2000 and 2007. Despite what appeared to be a steep drop in numbers around 2006 as shown by both Matkoski (2006) and Tripp and Menzies (2008), few intensive surveys of the species have occurred since 2007. The main exception is the work conducted by Davis and Doyle (2014) in 2014, which failed to find any screech-owls on the mid-coast or north coast, and few birds on Vancouver Island in the Campbell River area. Davis and Doyle (2014) also reference additional surveys that were conducted by the forest industry in the Nimpkish Valley region of Vancouver Island in 2013 and 2014, in the same area surveyed previously by Matkoski in 2003-2006.

Other recent data come from the Christmas Bird Count and BC Nocturnal Owl Survey databases. While these are of some value, especially with respect to long-term analysis, both are based on relatively small sample sizes, and the Christmas Bird Count especially has a limited geographical extent, with many of the count circles in parts of the lower mainland or southern Vancouver Island where the population appears to have declined significantly in the 1990s. Nevertheless, these data sources help form the basis for estimating recent population trends. On balance, data upon which to establish both the abundance and population trend of Western Screech-Owls in the majority of British Columbia's *kennicottii* range must be extrapolated from the small subset of the population that has been monitored to some extent.

Status determination

Population size

The British Columbia *kennicottii* population has consistently been estimated at 10,000 or fewer individuals. The most recent status assessment estimated a population of 1500 to 3000 individuals, based on extrapolation from Vancouver Island surveys (COSEWIC 2012), although as discussed in this review, some of the assumptions involved appear to have been flawed. Prior to that, the previous status assessment estimated a population of between 3000 and 10,000 individuals, with the upper limit justified by the large amount of habitat available on both Vancouver Island and the mainland coast, but not supported by any calculations (COSEWIC 2002). That report also summarized previous population estimates for Western Screech-Owl in BC, including a range of 1000 to 2000 individuals suggested by Kirk *et al. (*1995).

The current size of the *kennicottii* population can be estimated as a function of density (factoring in encounter rates and detectability) and extent of available habitat. As discussed under the "Detectability" section, the most plausible range of parameters includes a detection radius of 400 to 500

m and a detection rate of 0.20 to 0.30. Available habitat likely extends above 300 m elevation, although occupancy in the 300 m to 600 m range is probably somewhat lower given that this species has an affiliation with river valleys.

The selection of source data for population estimates is also important. COSEWIC (2012) used the results from Preston and Campbell (2001). However, given the apparent sharp decline in the Vancouver Island population as reflected in Nocturnal Owl Survey data as well as in the reports by Matkoski (2006), Tripp and Menzies (2008) and Davis and Doyle (2014), extrapolation from pre-2006 data would considerably overestimate current numbers. Matkoski (2006) did not consistently broadcast for Western Screech-Owls, and therefore may have detected them at a lower rate, given that Kissling and Lewis (2009) demonstrated that broadcasting calls increases detectability. Thus, Matkoski (2006) may underestimate numbers to some extent. Despite this limitation, Matkoski (2006) reported a higher encounter rate in 2006 than Tripp and Menzies (2008). For the purpose of comparison, Table 8 presents population estimates for Vancouver Island, assuming that each male detected represents the presence of a pair.

The population estimates presented in Table 8 range from a low of 2302 individuals on Vancouver Island [using 2006-2007 survey data from Tripp and Menzies (2008), assuming a detection rate of 0.30 over a detection radius of 500 m, and all individuals occurring below 300 m elevation], to a high of 49,613 (based on Matkoski's (2006) 2004-2005 surveys, a detection rate of 0.20 over a detection radius of 400 m, and an equal probability of occurrence up to 600 m). It is probably realistic that density is lower above 300 m, given that the species is closely associated with river valleys. Using estimates from Table 8 for a 50% lower occupancy between 300 m and 600 m, the range between low and high estimates is reduced to roughly one order of magnitude (between 3203 and 38,713 birds).

Estimates in Table 8 should be considered upper limits for several reasons. First, the relatively low encounter rates reported for Vancouver Island by Tripp and Menzie (2008) were also reported by Davis and Doyle (2014). Second, not all habitat within the Coastal Western Hemlock biogeoclimatic zone is equally suitable for Western Screech-Owls. In addition to areas of high elevation, areas that have been urbanized, heavily logged, are early successional (<30 years), or otherwise modified are likely to have few, if any, owls. At a minimum, there is evidence from the Nocturnal Owl Survey, Christmas Bird Count, and other surveys (e.g. Elliott 2006) that Western Screech-Owls have largely disappeared from areas around Victoria and Vancouver.

The vast majority of calculated population sizes in Table 8 are far greater than all previous reported population estimates. While most previous estimates did not explicitly describe the assumptions considered, it is likely that they concluded a substantial portion of theoretically available habitat is suboptimal for Western Screech-Owls due to previous logging or other disturbances. For example, Long *et al.* (2011) estimated the loss of mature and old forests (sea level to 900 m) from logging and fire at 18.5-22% over the past 30 years. Statistics for loss of second growth forests are not available, but most of the logging on Vancouver Island now takes place in older second growth forest. Clearcuts and dense forests less than 30 years of age are not apparently preferred by Western Screech-Owls. Coastal Western Screech-Owls are also apparently no longer able to persist in suburban and urban landscapes on Vancouver Island and the lower mainland. Hence, the amount of unsuitable habitat is probably larger than 20% and potentially even more than 40%.

All told, some degree of downward adjustment seems appropriate for the population estimates presented, but there is no clear basis for assigning a particular adjustment factor.

Also worth noting is that some of the extrapolations in Table 8 are based on a very small number of observations. This is particularly true for the 2006-2007 results reported by Tripp and Menzies (2008), which involved only 9 owls. A single extra owl observed during that two-year survey period would have increased the population estimate by as much as 835 individuals (for a detection rate of 0.20 and detection radius of 400 m, assuming a 50% occupancy rate between 300 m and 600 m).

Table 8: Population estimates for the *kennicottii* population on Vancouver Island, assuming equal density from 0 to 600 m elevation, or an average of 50% fewer owls between 300 and 600 m elevation. Note: not corrected for unsuitable habitat.

Source	Detection radius	Detectability	Population estimates by breeding elevation		
			0 – 300 m	0 – 600 m	0 – 300 m (100%) 300 – 600 m (50%)
Preston and Campbell (2001) 2000 survey	400 m	0.20	10000	17834	13916
	400 m	0.30	6656	11870	8259
	500 m	0.20	6400	11413	8906
	500 m	0.30	4264	7604	5934
Tripp and Menzies (2008) 2000-2003 surveys	400 m	0.20	21274	37939	29604
	400 m	0.30	14090	25127	19607
	500 m	0.20	13562	24186	18872
	500 m	0.30	9042	16125	12583
Tripp and Menzies (2008) 2006-2007 surveys	400 m	0.20	5398	9627	7512
	400 m	0.30	3598	6417	5007
	500 m	0.20	3456	6163	4809
	500 m	0.30	2302	4105	3203
Matkoski (2006) 2004-2005 surveys	400 m	0.20	27820	49613	38713
	400 m	0.30	18390	32796	25591
	500 m	0.20	17786	31719	24750
	500 m	0.30	11792	21029	16409
Matkoski (2006) 2006 survey	400 m	0.20	13648	24339	18992
	400 m	0.30	9118	16261	12688
	500 m	0.20	8750	15604	12176
	500 m	0.30	5834	10404	8118

Estimating a population size for the mainland is even more difficult than for Vancouver Island. Only three individuals have been observed on Christmas Bird Counts in the lower mainland over the past decade, supporting the suggestion by Elliott (2006) that the species has largely disappeared from the area. North of Vancouver there are very few records along the coast on eBird, and Preston and Campbell (2001) had no success in surveys of the Sunshine Coast in 2000. No doubt the species occurs between Vancouver and Alaska, but there are no data from which to extrapolate abundance. While the species does occur in extreme southeastern Alaska, this region is very different ecologically and climatically from adjacent BC, so using data from there (e.g., Kissling and Lewis 2009) to extrapolate to BC would not be valid. Table 9 summarizes overall population estimates assuming that density on the mainland is the same as on Vancouver Island (Vancouver Island represents 25% of the population, based on having roughly one-quarter of the total suitable habitat in BC), the density on Vancouver Island is twice as great as on the mainland (40% of the population), three times higher (50%) and nine times higher (75%).

The population estimates presented in Table 9 range from a low of 4271 individuals (assuming a detection rate of 0.30 over a radius of 500 m, based on the 2006-2007 survey data by Tripp and Menzies (2008) and 75% of the population on Vancouver Island) to a high of 154,852 (based on Matkoski's (2006) 2004-2005 surveys, a detection rate of 0.20 over a radius of 400 m, and 25% of the population on Vancouver Island). Given that the Nocturnal Owl Survey, Christmas Bird Counts, and Preston and Campbell's (2001) surveys all suggest a lower density of Western Screech-Owls on the mainland, it seems unlikely that Vancouver Island represents only 25% of the population, therefore the range of estimates from 40 to 75% is more realistic. Even so, the population could be as high as 96,783 individuals. However, limiting the estimates to those based on data from 2006-2007, the overall population estimates range from roughly 4300 to 19,000 using results from Tripp and Menzies (2008), or 11,000 to 47,000 using data from Matkoski (2006).

Table 9: Estimates of overall population size for *kennicottii* in British Columbia, assuming occupancy between 300 m and 600 m is 50% of that below 300 m.

Source	Detection radius	Detectability	% of population on Vancouver Island			
			75	50	40	25
Preston and Campbell (2001)	400 m	0.20	18555	27832	34790	55664
	400 m	0.30	11012	16518	20648	33036
	500 m	0.20	11875	17812	22265	35624
	500 m	0.30	7912	11868	14835	23736
Tripp and Menzies (2008) 2000-2003 surveys	400 m	0.20	39472	59208	74010	118416
	400 m	0.30	26143	39214	49018	78428
	500 m	0.20	25163	37744	47180	75488
	500 m	0.30	16777	25166	31458	50332
Tripp and Menzies (2008) 2006-2007 surveys	400 m	0.20	10016	15024	18780	30048
	400 m	0.30	6676	10014	12518	20028
	500 m	0.20	6412	9618	12023	19236
	500 m	0.30	4271	6406	8008	12812
Matkoski (2006) 2004-2005 surveys	400 m	0.20	51617	77426	96783	154852
	400 m	0.30	34121	51182	63978	102364
	500 m	0.20	33000	49500	61875	99000
	500 m	0.30	21879	32818	41023	65636
Matkoski (2006) 2006 survey	400 m	0.20	25323	37984	47480	75968
	400 m	0.30	16917	25376	31720	50752
	500 m	0.20	16235	24352	30440	48704
	500 m	0.30	10824	16236	20295	32472

Population trend

Relatively limited data are available for trend estimation, but the existing sources consistently show a significant decline. The longest-term data set available is the Christmas Bird Count, with relatively regular effort for seven count circles on Vancouver Island and the lower mainland. Both the absolute number of owls and number of owls observed per party hour of owling effort declined abruptly in the mid-1990s and have not recovered; estimates since that time are roughly 90% lower than over the previous 14 years (Table 4 and Figure 3). The Nocturnal Owl Survey only began in 2000 after that initial drop in numbers, but reflects another sudden decline occurring around 2006, with no observations on South Coast routes from 2007 through 2012, and a drop of roughly two-thirds on Vancouver Island routes during the same period compared to the first seven years of the program. In addition, D. Fraser (pers. comm. to R. Boles 2013) has noted that in the lower mainland and southeast Vancouver Island, there have been almost no visual observations of screech-owls nor road-kill reports in recent years. D.

Fraser (pers. comm. to J. McCracken 2013) has noted dramatic declines on southern Vancouver Island since the 1990s (see Appendix 2). These, along with other information (Appendix 3) provide additional lines of evidence supporting a decline in abundance in BC. Last, the recent report by Davis and Doyle (2014) also provides additional support for the two contentions that the subspecies has not only declined substantially on Vancouver Island, but is rare in areas on the mainland.

The Christmas Bird Count is heavily biased toward urban areas and it is possible that results might be inconsistent with trends in more natural areas. However, vehicle collisions, habitat loss, and predation by Barred Owls have been suggested as causes behind the decline in Western Screech-Owls (Cannings and Angell 2001, Elliott 2006, Preston and Powers 2006) and these could largely apply outside urban areas too. The Nocturnal Owl Survey samples a relatively small part of the province, and is biased towards road-accessible areas in the south. As shown by the addition of routes on Mayne and Saltspring Islands in 2010, results can easily be skewed by changes in route coverage, given the small number of owls detected annually. Nevertheless, two large-scale surveys on Vancouver Island also detected substantial drops in population occurring around 2006, with Matkoski (2006) recording a 50% lower encounter rate in 2006 compared to 2004-2005, and Tripp and Menzies (2008) a 75% lower encounter rate in 2006-2007 compared to 2000-2003. Unfortunately, with only six Western Screech-Owls observed over six years of the Nocturnal Owl Survey since 2007, and seven individuals on Christmas Bird Counts during the same period, data are too scarce to evaluate whether the population has stabilized following the decline around 2006, or has decreased further. Indeed, based on the relatively short time series of data that are available, it is hard to assess the extent to which the population is displaying a long-term pattern of decline vs short-term annual oscillations. Nevertheless, in the absence of any evidence to the contrary, it appears that the Vancouver Island population may have declined by over 50% in the past decade.

Although roughly three-quarters of potentially suitable habitat is on the mainland, far less monitoring has taken place there. Trends from the Christmas Bird Count are similar; the decline indicated by the Nocturnal Owl Survey is even more drastic, with no observations over the past six years, but given that only three individuals were recorded in the peak year, it is difficult to ascribe significance to that change. Along the Sunshine Coast, there were already zero detections in 2000 (Preston and Campbell 2001) suggesting that density may already have been lower on the mainland opposite Vancouver Island. It is worth pointing out that there only ever have been few and sporadic detections on the Sunshine Coast from the CBC, and these were recorded both before and after Preston and Campbell's survey. And again, Davis and Doyle (2014) failed to find any screech-owls on their recent surveys of the mainland, nor have there been many records submitted for this region through the breeding bird atlas or ebird.

Table 10 presents various scenarios for the overall rate of decline in British Columbia. Unless the rate of decline of the mainland population is under 10% and population density is at least half as great as on Vancouver Island, or the mainland population decline is under 23% and the population density is the same as on Vancouver Island, the overall rate of decline for the BC *kennicottii* population is expected to exceed 30% for the past decade, assuming a minimum 50% rate of decline on Vancouver Island.

Table 10: Inferred overall rate of decline of the British Columbia *kennicottii* population, assuming a 50% decline on Vancouver Island.

% of population on Vancouver Island	% decline of mainland population			
	0	**10**	**30**	**50**
75 (density on Vancouver Island ~9 times higher than on mainland)	38	40	45	50
50 (density on Vancouver Island ~3 times higher than on mainland)	25	30	40	50
40 (density on Vancouver Island ~2 times higher than on mainland)	20	26	38	50
25 (density on Vancouver Island approximately equal to on mainland)	13	20	35	50

A logical question is the extent to which the population trend in remote, less-fragmented habitat is similar to that of more urbanized areas. Surveys that show declines in Western Screech-Owls on Vancouver Island happened sooner in the southern areas, which are presumably disproportionately situated where habitat is fragmented by urban development. If rates of decline are lower in more remote, less-fragmented habitats, which make up a substantial proportion of the owl's total range, then the pattern of decline would be over-estimated. Note, however, that every study in the area noted increasing numbers of Barred Owls – a main predator/competitor. In Southeastern Alaska, which consists of relatively unfragmented habitat, Kissling and Lewis (2009) were unable to detect a change in occupancy for Western Screech-Owl between 1986-1992 and 2005-2008. However, they also reported found birds from the 2005-2008 survey period in only one of three areas that had been found to be occupied in the earlier survey period, indicating that a range reduction in the southern portion of the study area may have occurred.

Populations of at least some species of owls are known to fluctuate considerably from year to year in response to populations of their small mammal prey (e.g., Korpimaki and Hakkarainen 2012). If such fluctuations occur in the Western Screech-Owl, then this would negatively affect the extent to which results from any survey program can reveal linear population trends.

Overall, while there are uncertainties relating to the screech-owl's population trend in BC, all available data suggest that a population decline of at least 30% has taken place over the past decade, which leads to an appropriately applied precautionary interpretation.

Trends in Adjacent Jurisdictions

The trend in adjacent jurisdictions can be used to provide context regarding the situation in Canada, as well as assisting in deciding whether COSEWIC should modifying status due to "rescue effect".

Western Screech-Owls have been documented declining in both Alaska and Washingon State. Kissling and Lewis (2009) characterise the population trend as "stable", but, they document the loss of Western Screech-Owl from several Alaskan Islands at the south edge of the range (i.e., adjacent to Canada) where they were formerly common (reducing both EO and IAO in that state). Acker (2012) documented the decline to extirpation on Bainbridge Island in the Washington State San Juan Islands during the period 1995-2010. Washington State Christmas Bird Counts also show a steady decline from 1990 to 2012 (Figure 8).

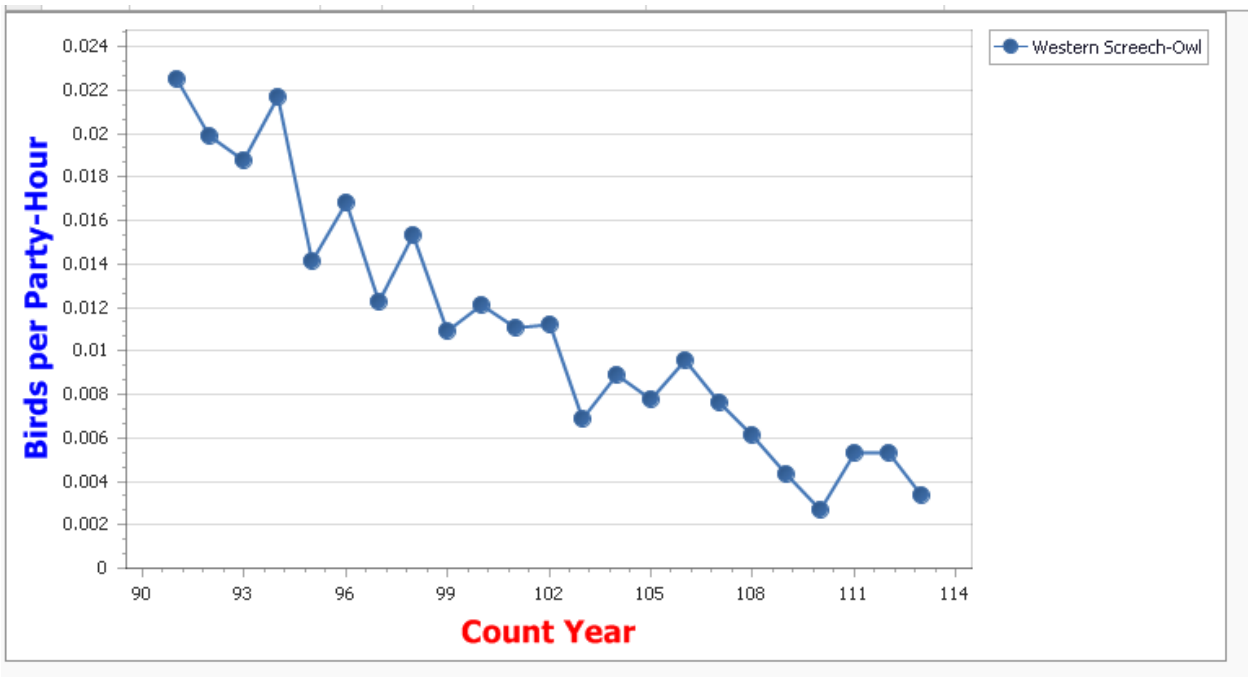

Figure 8. Christmas Bird Count trend for Western Screech-Owl in Washington State 1990-2012.

Conclusions

Detectability was overestimated in the COSEWIC (2012) report, resulting in what was probably an unrealistically small population estimate for the *kennicottii* subspecies. Whereas the 2012 report assumed that all owls within 800 m of survey stations were detected, a more realistic detection radius for the species is 400 to 500 m, and recent studies suggest that detectability rates tend to range between 0.2 and 0.3. Although some Western Screech-Owls occur between 300 and 600 m elevation, it is unclear how many; estimating that density is half as great as below 300 m is a guess, but perhaps closer to reality than assuming either none above 300 m or a uniform density up to 600 m. Finally, while very little is known about the distribution and abundance of the mainland population, it seems likely that the Vancouver Island density is at least twice as great.

Based on these adjustments alone, most calculations predict a population well above 10,000 individuals. However, the actual suitability of much of the potentially available habitat is unknown (but it is clearly much smaller than 80%), and therefore it is difficult to suggest the degree to which the estimates should be revised downward. Also, despite just a few parameters involved in generating population estimates (detection radius, detection rate, and selection of source data), results vary by more than an order of magnitude, and therefore it is important to acknowledge the relatively low level of certainty associated with any estimate. The most plausible unadjusted estimates, based on the most recent (2006-2007) data from large-scale systematic surveys, suggest a range of 4300 to 19,000 individuals (based on Tripp and Menzies 2008) or 11,000 to 47,000 individuals (based on Matkoski 2006). However, if only 20% of potential habitat is not occupied for whatever reason, the low end of both estimates would fall below 10,000 birds. Furthermore, these estimates are based on data from 2006-2007; if the population has continued to decline over the years since then, the population estimate would need to be reduced further. Moreover, it is important to recognize that the owl population likely fluctuates substantially

from year-to-year in response to variation in weather conditions and prey availability, and that such natural variation should be accounted for in any population estimate.

While there is considerable uncertainty over a population estimate for the *kennicottii* subspecies in British Columbia, all sources for trend estimates suggest that the Vancouver Island population has declined by at least 50% during the past decade. The mainland population has been monitored in much less detail, and its population density is also largely unknown. Even so, it seems reasonable (and precautionary) to conclude that the overall rate of decline for the *kennicottii* population in British Columbia is likely to be at least 30% over the past decade. Therefore, even if the most liberal population estimates are too large for criterion C1 to apply, the rate of decline is sufficiently great to warrant Threatened status under criterion A2b (estimated >30% reduction in number of mature individuals over the last 10 years, with the causes not well understood and possibly not ceased).

On balance, we suggest that a reasonable precautionary interpretation of the available data leads us to conclude that the subspecies was correctly designated as Threatened in the most current status report, under criterion C1 and/or criterion A2b. Moreover, trends in adjacent jurisdictions indicate that rescue effect cannot be invoked, as the species appears to be reducing its range in southeastern Alaska and declining rapidly in Washington State.

Acknowledgements

This review was supported by Environment Canada. We especially thank David Fraser (BC Ministry of the Environment) and Ruben Boles (Environment Canada) for their assistance in providing information and for critically reviewing earlier versions of this document. Thanks also to Darren Irwin and John Reynolds for their informative comments and submissions of unpublished information.

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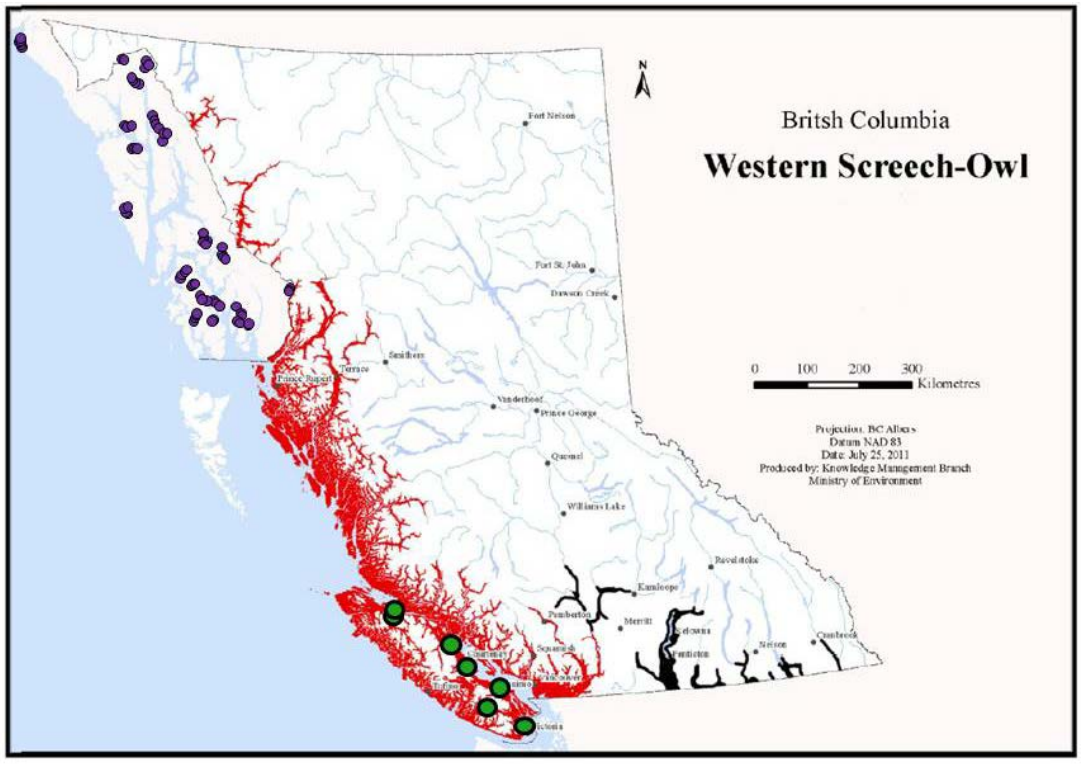
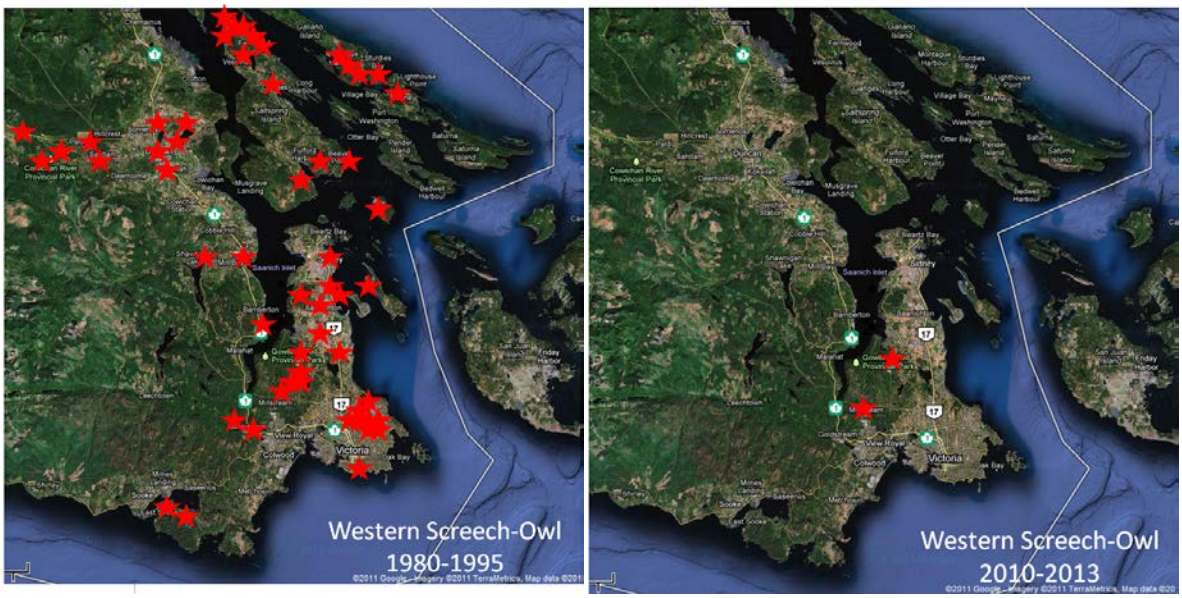
Appendix 1. Search effort and distribution of Western Screech-Owl in SE Alaska.

Figure 1 from the 2012 COSEWIC Status Report is re-created below with modifications, including potential habitat and some of the survey effort for Western Screech-Owl, *kennicottii* subspecies. Red shading shows all land in B.C. below 300 m (excluding Haida Gwaii), which simply represents potential habitat only within this altitudinal band, and not taking into account any other environmental attribute. Green dots on Vancouver Island represent approximate locations of the survey stations in Preston and Campbell (2001). Purple dots in southeastern Alaska show approximate (hand-placed) locations of survey stations from Chapter 2 of Kissling and Lewis (2009), not all of which supported screech-owls. Figure provided by R. Boles (Environment Canada).



Appendix 2. Although David Fraser's personal records of Western Screech-Owl from southern Vancouver Island and adjacent islands span two different time periods, they suggest dramatic declines between 1980-1995 and 2010-2013 (source: David Fraser, pers. comm. 2013).



Appendix 3. Other evidence indicating declines of Western Screech-Owls in BC (compiled by D. Fraser, pers. comm. 2014).

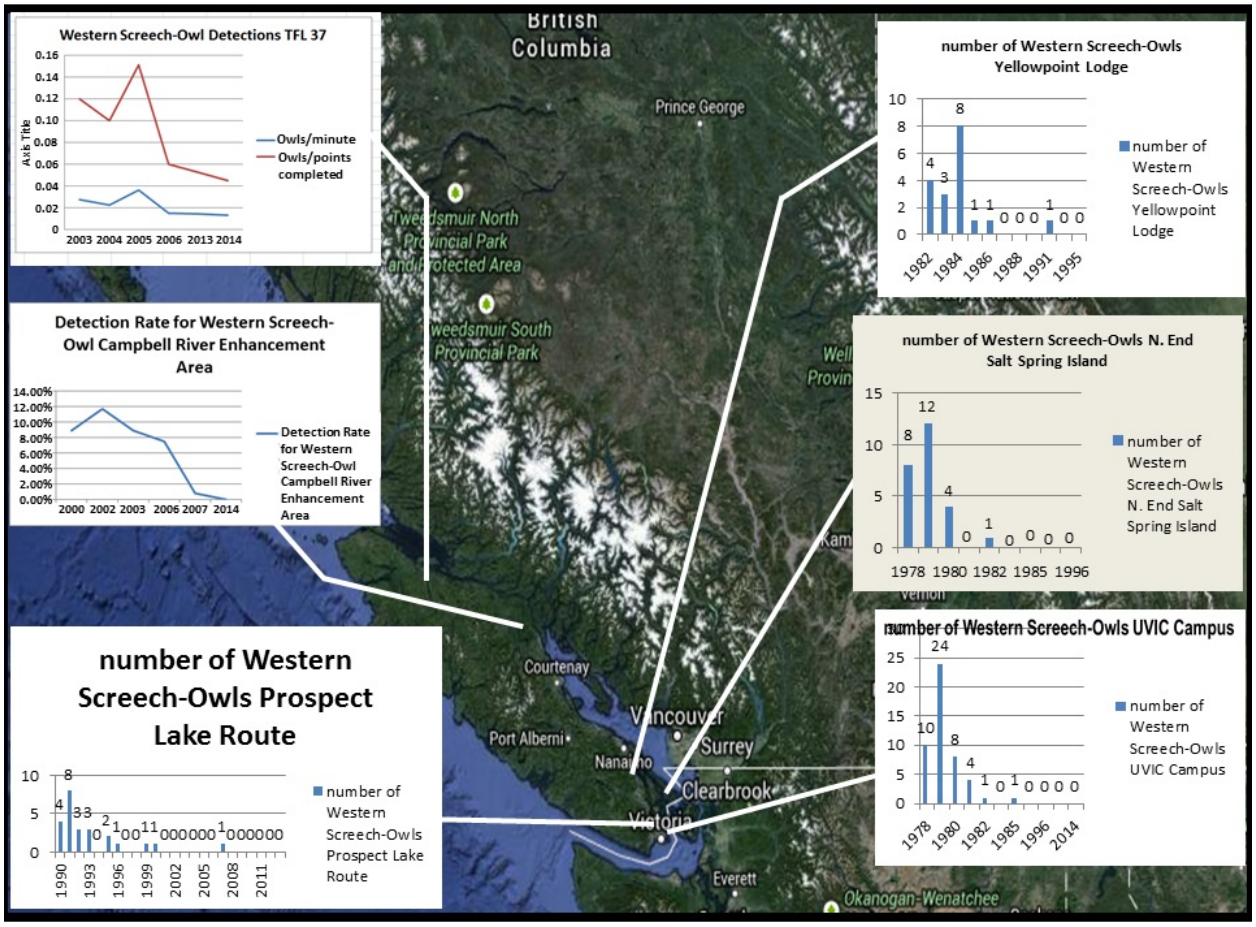


Figure A3-1: Region-specific trend data for Western Screech-Owl, *kennicottii* subspecies. The upper-left panel presents results from Nimpkish Valley surveys (J. Deal pers. comm. to Davis & Doyle 2014 and to D. Fraser 2014; see also Table 1, this report). The middle left panel shows the results of the Campbell River surveys (Tripp & Menzies 2008; Davis & Doyle 20014; see also Table 1, this report. The remaining panels are unpublished data from D. Fraser, all call playback responses. Prospect Lake survey done in mid-late December, Yellowpoint Lodge, late April, Salt Spring Island and UVIC campus surveys done in February-March.

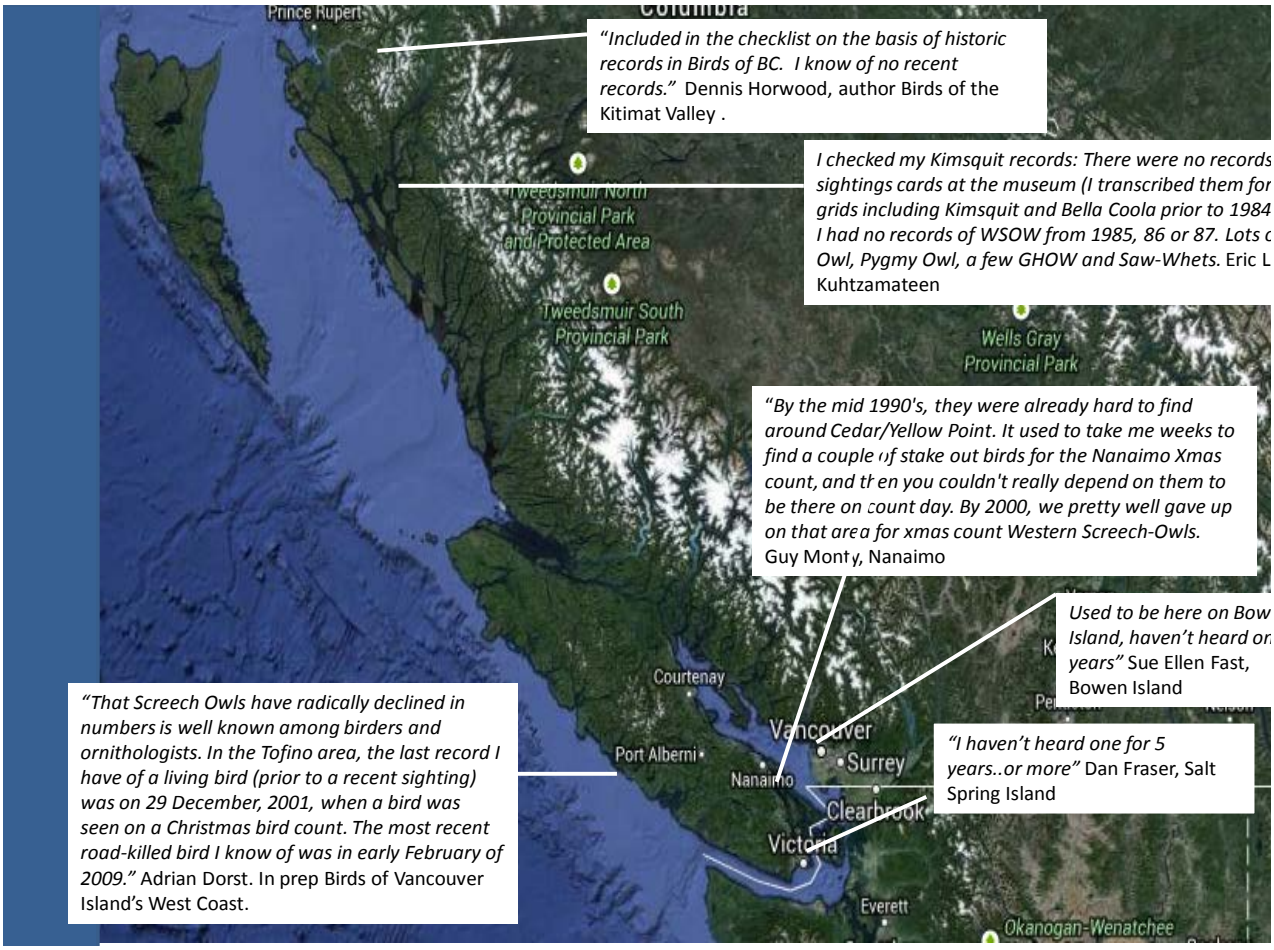


Figure A3-2: Anecdotal reports from birders from 2013.