British Columbia Community Bat Program

Annual Bat Count (2012-2019)

Update: February 2020

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Photo: Sunshine Coast Wildlife Project

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Executive Summary

White-nose syndrome is an emerging fungal disease that results in high mortality of susceptible bat species. It has not yet been detected in British Columbia but occurs and is spreading in nearby Washington State. It is expected in BC in the near future. The BC Annual Bat Count is one method to assist with monitoring the spread of the disease, identify species-specific impacts, and track recovery of affected species. The BC Annual Bat Count offers good potential for monitoring population trends in some species of bat that use human structures for roosting, such as the federally-endangered Little Brown Myotis (*Myotis lucifugus*) and the widespread Yuma Myotis (*Myotis yumanensis*).

The Annual Bat Count is currently the only long-term roost-monitoring program in the province. It can contribute to the North American Bat Monitoring Program, covers much of BC, and is cost-effective due to the large volunteer component and regional coordinators who implement the Count as part of the BC Community Bat Program. The Annual Bat Count has been conducted between 2012 – 2019, is growing each year, and has data on seven bat species at 580 sites.

Key successes of the Annual Bat Count in 2019 are:

- continued increases in volunteer participation,
- a continued increase in the number of sites monitored in the regions where WNS is expected imminently (Fraser Valley/ Vancouver, Sunshine Coast, Vancouver Island /Gulf Islands) and across the province, and
- an increased proportion of sentinel sites where the species of bat has been identified by genetics or acoustics.

This report provides a summary of the data available to-date, to identify gaps and prioritize future data collection efforts. Review of the data up to 2019 has highlighted the need to continue to emphasize the same key actions, to ensure that the Annual Bat Count develops into a more effective, robust monitoring program. These recommendations for 2020 include:

- improving sample sizes and multi-year data collection first at sentinel sites and then across all regions and for all species. To achieve this, we need to:
    - communicate and follow-up (including an early-June check-in) with regional coordinators and volunteers to ensure priority sites are counted and secure other counters if needed,
    - emphasize conducting **two** counts in the pre-pup period especially at sentinel sites, to better estimate maximum colony size, and
    - emphasize annual, multi-year sampling especially at sentinel sites, for data to contribute to trend analysis,
- identify species, particularly at sentinel sites and other sites with multi-year monitoring, by communicating (to regional coordinators and volunteers) where there are data gaps and directly encouraging sample collection and submission,

- improve retention of all interested homeowners and volunteers through communication and outreach, to increase the number of multi-year samples,
- continue to work with the North American Bat Monitoring Program (NABat) and the BC government to incorporate count data into NABat and initiate analyses, and
- develop consistent methodology to flag sites showing potential population declines (e.g. significant percent decrease in maximum pre-pup counts) in a timely way for immediate action (e.g. swabbing sites for Pd, testing preventions/cures).

To achieve current Annual Bat Count objectives and address the recommendations for 2020, the Community Bat Program needs ongoing funding for coordination, data management, analysis and reporting. We also require funding for regional coordinators to conduct counts, engage, train and coordinate volunteers, communicate and provide feedback to volunteers to encourage retention in the program, and funds for DNA analysis, acoustic monitoring equipment, and acoustic analysis. The Annual Bat Count is one component of the BC Community Bat Program. As the Annual Bat Count has grown, it has required more resources from the CBP, and other funding and partnerships must be secured to maximize the conservation and research value of this multi-year project.

Photo: Peachland Bat Education and Ecological Protection Society

Table of Contents

List of Tables

List of Figures

Introduction

White-nose syndrome (WNS) is an emerging, invasive disease of North American bats caused by the introduced fungus, *Pseudogymnoascus destructans* (Pd). The disease has killed over six million bats in eastern North America since 2006. It has nearly extirpated (90% -100% mortality) some previously abundant species (e.g. Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*M. septentrionalis*)), in some areas. These two species are now listed by the Species at Risk Act (SARA) as endangered in Canada (B.C. Conservation Data Centre 2020). In March 2016, WNS was detected for the first time west of the Rocky Mountains, in Washington State within 150 km of the British Columbia (BC) border, putting BC's bats at extreme risk from the disease. Many of BC's 15 bat species have not yet been exposed to WNS, and it is unknown what the full impact of the disease in BC might be.

Bats are important to our environment and our economy, helping to control forest, agricultural, and urban pests. The endangered Little Brown Myotis can eat 600 mosquitoes per hour (Nagorsen and Brigham 1993) and researchers estimate that bats provide billions of dollars in pest control services annually in the United States (Kunz et al. 2011, Kasso and Balakrishnan 2013). A rapid response to WNS is required to understand and mitigate this significant threat, protect our bat populations, and reduce economic impacts.

One component of WNS response is monitoring the impacts to, and potential recovery of, different species of bats. The ability to reliably detect trends in bat populations through counts depends on a number of factors, including years sampled, number of sites counted, number of bats per site, and annual variation (Walsh et al. 2001). Statistically robust methods for monitoring bat populations have been developed in several European countries in response to long-term population declines and the need to determine if recovery targets are reached (e.g. Walsh et al. 2001, Warren and Witter 2002, Barlow et al. 2015).

The BC Community Bat Program independently conducts the only long-term roost monitoring project in the province. Beginning in 2012 with the Kootenay Community Bat Project, the BC Community Bat Program has expanded remarkably quickly across the province. One facet of the Program is the Annual Bat Count, which involves exit counts conducted at summer day roost sites in anthropogenic structures. Goals of the Annual Bat Count include raising awareness of bats, promoting stewardship of colonies, and ultimately providing information on bat species and numbers.

The Annual Bat Count is coordinated at the provincial level, providing consistent methods and datasheets, plus data management and storage. On the ground, the Annual Bat Count is implemented by regional coordinators. As part of their contribution to the Program, regional coordinators are responsible for ensuring that a number of counts occur in their regions. Coordinators usually do several counts themselves, particularly at strategically important sentinel roost sites. They also recruit, organize, and train volunteers to assist with counts, as is done in the United Kingdom's National Bat Monitoring Program (Barlow et al. 2015).

Volunteer involvement varies by region and depends in part on the direction and goals of the Regional Community Bat Project. Overall, the program has included diverse volunteers including private

landowners, local stewardship groups, interested citizen-scientists, and government staff (e.g. BC Parks, FLNRO Ecosystems, Canadian Wildlife Service).

The Annual Bat Count has a strong potential to provide trend data for those bat species in BC that regularly use anthropogenic structures. The program has expanded greatly in the past four years, but continues to need focus on some aspects of the program to obtain statistically reliable trends, most notably on ensuring retention of sites to get multi-year trends. Specific recommendations to prioritize and improve data collection have been made prior to past field seasons (Kellner 2019). Several of these recommendations have been addressed, while new recommendations have also been added for 2020.

The purposes of this report are to:

1) update the summary of available BC Annual Bat Counts from across the province to include data from 2019,
2) assess the success of the program in meeting the recommendations made prior to the 2019 field season, and
3) continue to provide recommendations to improve the program, to make it an effective tool for monitoring the response of selected bat populations to WNS and other threats from 2017 to 2021.

This report is preliminary in nature and does not include any statistical analyses of the data.

Acknowledgements

The BC Community Bat Program is a joint venture of regional bat projects across the province. It is funded by Habitat Conservation Trust Foundation, Forest Enhancement Society of BC, Habitat Stewardship Program, the Province of BC, and many regional funding partners. Thank you to all the Regional Coordinators who locate roost sites, identify candidate sites for the Annual Bat Count, and engage, organize, and train volunteers. BC Parks has done an exceptional job of ongoing counts at many sites over the years. Orville Dyer (BC MoE) has provided valuable guidance and input to the program, as well as participating in bat counts. We especially thank Juliet Craig and the Kootenay Community Bat Project, who started the Annual Bat Count in BC. Finally, the Annual Bat Count could not occur without our many dedicated volunteers, who collect data for the program.

Methods

Count protocol

The Annual Bat Count is a repeated summer emergence count at day roosts in anthropogenic structures (e.g. houses, barns, bat houses). It also includes count data from one cave used as a maternity roost. These roost sites are usually identified through the work of the BC Community Bat Program. Regional Coordinators conduct, and promote volunteer participation in, bat exit counts at roost sites during

designated sampling periods. The program covers much of BC, although sites tend to be clustered where there is a longer history of the bat program or a larger human population (Figure 1).

Counts are done at day roost sites; there are occasionally several sites at one location, with each site being counted separately and ideally on the same night. For example, a property with an attic roost and two bat boxes in the yard would be one location with three count sites, and multiple counts are done at each site. Data are generally analyzed by site, a structural feature with bats exiting (or not), instead of by location, which is a subjective grouping of known roost sites in an area. Roost sites are classified into nine structure types: barn, unoccupied house, occupied house, church, outbuilding, bridge, tree, bat box/condo, or other.

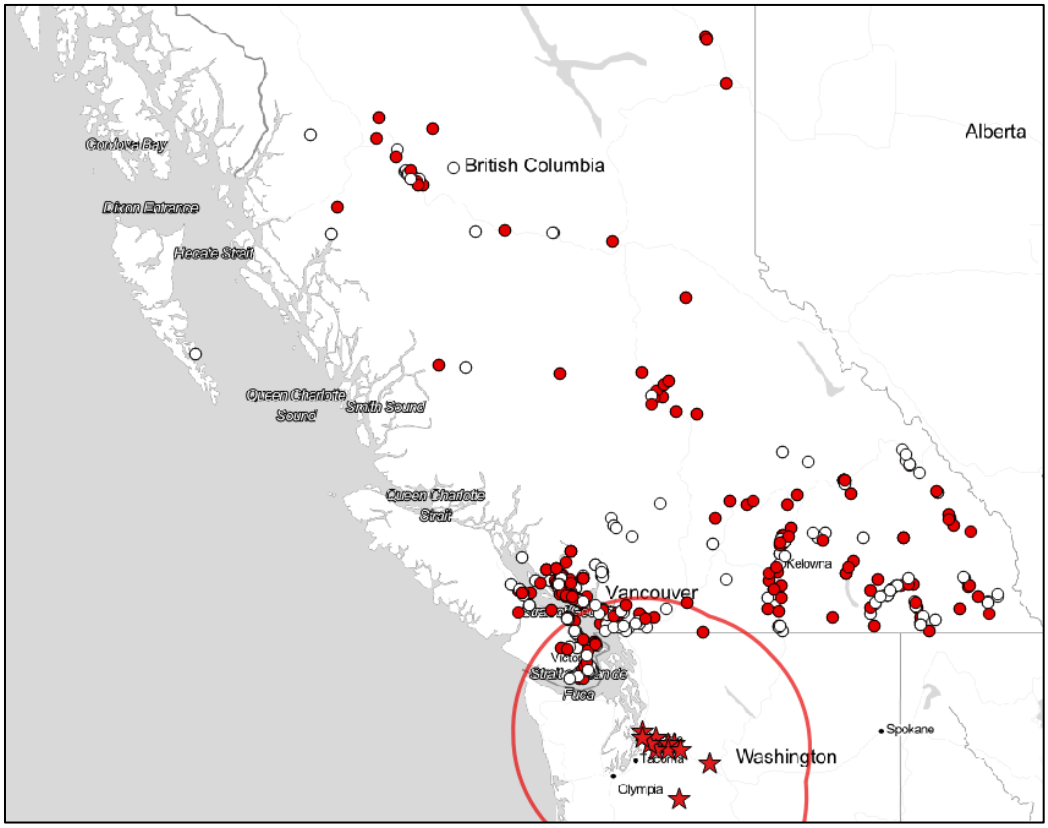

Figure 1. Map of sites sampled in the Annual Bat Count (2012 to 2019). Colour of dot represents the number of years sampled – red dots have two or more years of data and are useful for trend analysis; white dots have one year of data. The WNS detection sites in Washington are indicated by red stars; the red line shows the 200 km buffer around the Washington detections to suggest where WNS might arrive first for count prioritization.

Coordinators and/or volunteers conduct between one and four visual counts of bats exiting roosts at dusk. Ideally, two counts occur between June 1 and 21 (the 'pre-pup period', before pups can fly). These counts are the highest priority, and are consistent with North American Bat Monitoring Program (NABat) protocols (Loeb et al. 2015). Two more counts are recommended once pups are flying (called the 'post-pup period'). In 2018, dates for post-pup counts were switched to July 11 – August 5 (from July 21 – Aug 15 in 2017 and earlier), because of many reports of colonies being vacated by early to mid- August. We hoped that the earlier count window would facilitate counts before colonies began to disperse.

In 2019, we began requesting multiple independent counts on the same night, when possible, given the constraints of volunteer time / availability. This was based on discussion with the NABAT team, and is intended to provide a measure of observer error and assess variability.

The Annual Bat Count is meant to be repeated yearly for as long as possible, but depends on funding, access to count sites, and volunteer availability. Data is recorded for each count and submitted to the regional or provincial coordinator or BC Ministry of Environment and Climate Change Strategy or Ministry of Forests, Lands, Natural Resource Operations and Rural Development staff. Ultimately, count data is entered into the BC Wildlife Species Inventory database[1]. Detailed methods can be found on our website[2] .

Species identification

Verification of the species using a roost site may be done through DNA analysis of guano samples (Wildlife Genetics International, Nelson). Alternatively, some regional coordinators have access to ultrasonic bat detectors (e.g. Echometer Touch (Wildlife Acoustics), Anabat Walkabout (Titley Electronics), RoostLogger (Titley Electronics)), which can provide information on species. Identifications based solely on acoustics are taken as confirmation if the acoustic files are analyzed by a trained bat biologist. Species identification may also be done by qualified biologists through identification of dead bats or live capture by mist-netting. Although these three methods 'confirmed' species identifications for this report, final confirmation of species presence generally requires genetic verification and is the preferred method, if available.

Criteria for identifying maternity roosts

Two methods of identifying maternity roosts were used. Sightings of pups, including mortalities, can be used to confidently confirm a site as a maternity roost. However, confirmed pup sightings are not available for the majority of sites. The second method is to compare the maximum counts from pre-pup and post-pup period. Sites where the maximum count increased between periods were considered maternity colonies. Rationale was explored in previous reports (Kellner 2019). Potential maternity sites were identified using both methods, and sites were manually reviewed to ensure that known maternity colonies were correctly identified.

Sentinel sites

In March 2017, we created a list of priority 'sentinel' sites in BC to prioritize monitoring efforts in June 2017 and to promote long-term monitoring sites (Kellner and Dyer 2017). These sites were chosen to be large, secure colonies with sufficient volunteer or coordinator resources to be counted regularly. To establish the list of sentinel sites, sites were assigned a rank of zero or one for each of the criteria below and all ranks were added to provide a total score. The score was sorted to prioritize sites by high score, within each region. Criteria used for the initial ranking of sites were:

[1] http://a100.gov.bc.ca/pub/siwe/search_reset.do
[2] http://www.bcbats.ca/index.php/get-involved/participate-in-the-bc-bat-count.

- LARGE: colony size greater than 150 bats in at least one count; larger colonies theoretically will have less % variation between counts. Large colonies are also more likely to be maternity colonies,
- ACTIVE: counted in the last two years, indicating recent access to the site and availability of volunteers,
- WITHIN YEAR REPLICATION: multiple counts available within a year,
- BETWEEN YEAR REPLICATION: counts are available from more than one year,
- COSEWIC: are COSEWIC-listed species present (e.g. Little Brown Myotis), and
- KEEN: homeowner/community support (if a landowner is known to be very keen to count and submit data over the long term).

High-ranked sites are then reviewed yearly by provincial and regional coordinators to confirm landowner/volunteer interest and identify other sites that could be prioritized. As of 2019, a pre-populated excel data template was provided to regional coordinators to highlight data collection at sentinel sites.

Trends across years: screening for declines

Maximum pre-pup counts were graphed for each roost site, and the results visually screened for declines. Subjective assessment was used to identify sites that needed further follow-up. These sites were then individually investigated to determine if there were known causes for decline. In 2018, variation within the pre-pup period and post-pup period were assessed. Methods to quantitatively assess yearly variation in relation to this within-year variation have not yet been employed.

Results

Volunteer involvement

Volunteer involvement is essential to the Annual Bat Count, providing many or most of the bat counts in some regions. Volunteers either assist regional coordinators or conducted counts on their own. Volunteers may have assisted at more than one count, and many counts required multiple volunteers to ensure all exits were monitored, so the number of unique volunteers is unknown. Volunteers participated in a minimum of 338/401 counts (84%) in 2016, 418/539 counts (77%) in 2017, 540/795 counts (68%) in 2018, and 612/873 (70 %) counts in 2019 (Figure 2). The number of volunteer-nights was a minimum of 465 in 2016, 430 in 2017, 613 in 2018, and 1308 in 2019, with the very large increase in 2019 likely due to better tracking of volunteer effort.

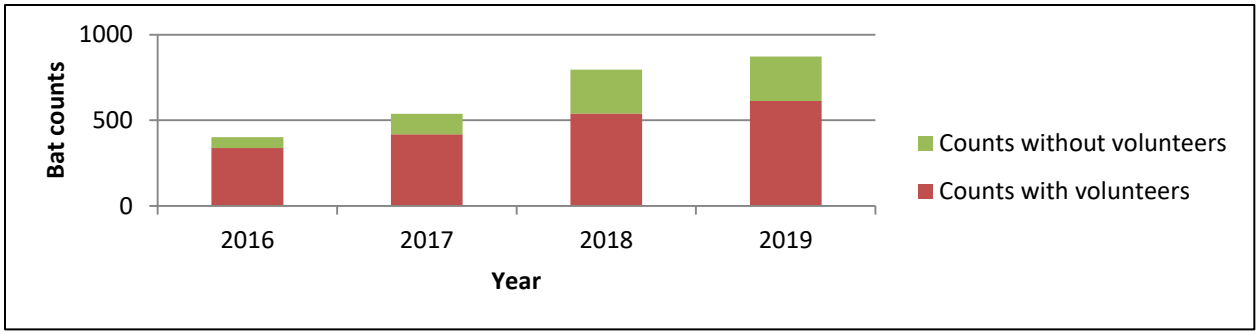

Figure 2. The number of bat counts done with volunteer involvement, from 2016 to 2019. Counts with volunteers include those done entirely by volunteers, such as landowners with a colony, and counts with a CBP coordinator and volunteers.

Number of sites and counts

Three thousand and forty-three (3043) counts were conducted at 580 sites between 2012 and 2019 (Figure 1; Table 1). Each site is usually counted from one to four times per year, although a few sites were counted more frequently. Sites sampled in one year may not have been sampled in subsequent years, and sites counted for multiple years were often but not always counted in consecutive years. The number of sites has increased with the expansion of the Community Bat Program across the province and increased efforts by coordinators to establish count sites and gather baseline pre-WNS data.

In 2019, when we requested multiple counts per site per night when possible, there were 161 counts at 74 sites where observers obtained two or more independent counts on a single night.

Table 1. Number of locations, roost sites, and counts per year. Not all sites from a year were counted in successive years.

Year	Locations	Roost sites	Counts
2012	11	11	27
2013	24	31	82
2014	36	45	113
2015	54	77	204
2016	118	157	401
2017	141	189	539
2018	178	230	795
2019	253	337	873
Unique locations, roost sites and counts, all years	451	580	3034

Monitoring of high-priority sentinel sites

Eighty-three (83) individual sentinel roost sites at 48 locations, with highest priority for ongoing monitoring, were identified (see Methods for sentinel sites) (Appendix 1).

In 2019, 62/83 (75 %) sentinel sites were counted, at 34 locations (34/48 (71 %) locations). An additional two locations are known to have been counted but data was not submitted before reporting. This is

similar to the level of monitoring that was achieved in 2018, when 60 sentinel sites at 37 locations were monitored and data submitted. Sentinel sites NOT monitored in 2019 included one home that was sold (ending five years of monitoring but where the new owners will be approached regarding counts in 2020), one bat exclusion, and several sites where volunteers were expected to count but did not end up participating.

The list of sentinel sites and locations was re-evaluated for 2020. Two locations were dropped, due to change in property ownership (one location) and exclusion of the colony (one location). Three locations were dropped due to lack of lasting landowner interest. One new location was added in the Kootenay Region. There are now 83 priority sites, at 44 locations, for targeting in 2020.

Number of sampling years

Sites have been monitored for between one and eight years (Table 2), leading to the start of a long-term dataset. As of 2019, 344 sites have one year of data, 113 sites have two years of data, 52 sites have three years of data, 33 sites have four years of data, 19 sites have five years of data, 10 sites have six years of data, eight sites have seven years of data, and one of the 580 Annual Bat Count sites currently has eight years of data. A total of 236 sites have two or more years of data that can be used for trend monitoring.

Sites that have been monitored for two or more years can be used in trend analysis using the methods employed in UK's National Bat Monitoring Programme (Bat Conservation Trust 2019). As of 2019 in BC, there are 236/580 locations (41 %) with two or more years of data, for all species combined. This is a slight decline, down from 44 % in 2018, of sites with two or more years of data (Table 2).

There are currently 48 sites within 250 km of the 2016 Washington WNS detection site (23 sites monitored in 2019, and 31 sites with 2+ years of monitoring data). There are 178 sites within 500 km (55 monitored in 2019, and 96 sites with 2+ years of data) (Figure 1).

Table 2. Number of roost locations that have from one to eight years of count data, and the percentage of sites sampled two or more years. Sites with two or more years of data can be used in trend analysis (Bat Conservation Trust 2019).

Number of years counted	Number of sites as of 2016	Number of sites as of 2017	Number of sites as of 2018	Number of sites as of 2019
1	136	156	219	344
2	34	45	93	113
3	12	32	35	52
4	7	9	21	33
5	1	14	9	19
6		1	11	10
7			1	8
8				1
Total	190	257	389	580
Percent with 2+ years	28	39	44	41

Distribution of sites

Roost count sites are distributed throughout B.C. but are focused in areas of higher human habitation and where Community Bat Programs have been established for longer times (Table 3, Figure 1).

Table 3. Distribution of roost sites counted in the Annual Bat Count, by region and year

Region	2012	2013	2014	2015	2016	2017	2018	2019
Sunshine Coast					31	41	49	105
Fraser Valley/Lower Mainland				1	11	21	27	59
Southern Vancouver Island/Gulf Islands[1]		7	7	12	22	35	44	54
Kootenay	10	20	20	31	25	26	21	46
Okanagan	1	3	15	17	31	30	39	27
Cariboo			1	1	9	14	18	18
Skeena				11	13	8	6	12
Columbia Shuswap				1	6	8	4	7
Peace			1		3	3	3	3
Thompson		1	1	2	3	2	3	2
Other[2]				1	3	1	6	4
All sites	11	31	45	77	157	189	230	337

[1]Includes data from bat programs on Salt Spring, Thetis, Mayne, Gabriola, Denman/Hornby, and Texada Islands.
[2] Other includes sites in Northern Vancouver Island, Lillooet, Haida Gwaii and Omineca/Prince George.

Structure type

Most roost sites were located in occupied houses (293 sites; 51%) and bat boxes or bat condos (190 sites; 33%) (Table 4). In 2018, bat boxes made up 33% of all roost sites (127 bat boxes/389 known roost sites); in 2019 bat boxes were still 33 % of all roosts (190/580).

Table 4. Type of structure monitored during the Annual Bat Count, 2012-2019, by region.

Region	Unoccupied house	Occupied house	Outbuilding / barn	Bat box / bat condo	Other[1]	Unk	Total
Sunshine Coast	7	104	20	20	14	3	168
Kootenay	4	40	7	45	0		96
Southern Vancouver Isl./ Gulf Isl.	1	53	5	31	0	2	92
Okanagan	3	20	9	35	1		68
Fraser Valley/ Lower Mainland	2	40	8	16	2		68
Cariboo	1	9	3	15	0		28
Skeena	0	16	1	7	0		24
Columbia Shuswap	0	6	0	8	0		14
Other	0	3	1	6	1		11
Thompson	0	2	1	4	0		7
Peace	0	1	0	3	0		4
Total	**18**	**293**	**55**	**190**	**18**	**5**	**580**
Percent of all roosts	**3**	**51**	**9**	**33**	**3**	**1**	**100**

[1] 'Other' includes 'Umbrella' (n=15), 'Rock/cave' (n=2), and 'Bridge' (n=1).

Bat species

There are seven species of bats recorded roosting in anthropogenic structures in the Annual Bat Count data. These are Little Brown Myotis (*Myotis lucifugus*), Yuma Myotis (*M. yumanensis*), Big Brown Bat (*Eptesicus fuscus*), Californian Myotis (*M. californicus*), Long-legged Myotis (*M. volans*), Long-eared Myotis (*M. evotis*), and Townsend's Big-eared Bat (*Corynorhinus townsendii*) (Table 5). DNA identification from guano, which is used to confirm species, used only one pellet per site so species that rarely use structures or are a small percentage of the bats using the site are likely under-represented in our data, especially at sites with large numbers of bats.

For all sites across years, there are 224/580 (39 %) sites that have a species id, with an additional 17 sites classified as *Myotis* species. There are an additional 35 sites with samples submitted and genetic results pending. If all samples are successful, there will be 259/580 (45 %) sites with species id. Many of the unidentified sites have not been visited for several years and it is unlikely that the bat species using these sites will ever be determined.

Of the 337 roost sites sampled in 2019, thirty-seven (37) sites had a count of 0 bats, so no identification is possible. Of the 300 sites with bats in 2019, 118 (39 %) have a species ID. There are 31 samples from 2019 pending analysis, for a total of 149/300 (50%) sites with ID. As in 2018, in 2019 there were again many new sites were added that did not yet have any information on species.

Little Brown Myotis are more commonly found in artificial structures than any other bat in BC (Table 6) and occur alone or with other species at 126/224 (56%) of sites with confirmed species identification. When multiple species are identified at a roost, Little Brown Myotis are commonly found with Yuma Myotis, and sometimes co-roost with Big Brown Bat, California Myotis, Long-legged Myotis or Long-eared Myotis (Table 6).

Yuma Myotis are the second most common bat in anthropogenic structures and are confirmed at 96/224 (43 %) of sites. They often are found in roosts with Little Brown Myotis and occasionally co-roost with other species including Big Brown Bat, California Myotis and Townsend's Big-eared Bat (Table 6).

Photos: Sunshine Coast Wildlife Project

Table 5. Species, number of roosts monitored for which species has been confirmed, and regions monitored by the Annual Bat Count.

Species	Number of roost sites with confirmed species identification (percent of all roost sites with an ID)[1]	Regions
Little Brown Myotis	126 (56%)	All
Yuma Myotis	96 (43%)	Cariboo, Columbia-Shuswap, Fraser Valley / Lower Mainland, Kootenay, Okanagan, Skeena, Southern Vancouver Island/Gulf Islands, Sunshine Coast, Thompson
Big Brown Bat	23 (10%)	Cariboo, Columbia-Shuswap, Fraser Valley / Lower Mainland, Kootenay, Okanagan, Peace, Skeena, Southern Vancouver Island/Gulf Islands
California Myotis	25 (11%)	Sunshine Coast, Southern Vancouver Island/ Gulf Islands
Townsend 's Big-eared Bat	9 (4%)	Fraser Valley / Lower Mainland, Kootenay, Southern Vancouver Island/ Gulf Islands, Sunshine Coast
Long-eared Myotis	4 (2%)	Haida Gwaii, Southern Vancouver Island/Gulf Islands, Sunshine Coast
Long-legged Myotis	2 (1%)	Cariboo, Southern Vancouver Island/Gulf Islands
Total	224[1]	

[1] Note that more than one species can occupy the same roost site.

There are four sites identified as having Long-eared Myotis. One of the sites is a bat box (Kootenay region), one is a cave, and two are occupied houses. Long-eared Myotis were also confirmed genetically at a bat box roost in the Skeena Region in 2015. However, this site has been conservatively assigned an identification of Little Brown Myotis, as the DNA analysis procedure at the time did not include testing for a gene (muc-11) to positively differentiate Long-eared Myotis from a coastal genotype of Little Brown Myotis. Improved testing from 2016 onwards allowed differentiation of these species. The Kootenay bat box site was confirmed genetically in 2017, after the testing method for MYEV was improved. Confirmation of species in the other three cases involved in-hand identification and acoustics. A maternity colony in a cave in Haida Gwaii was identified through capture as a mixed colony of Long-eared Myotis and Little Brown Myotis. A dead bat on-site, paired with acoustics, identified Long-eared Myotis in a mixed colony in a house on the Sunshine Coast. Acoustic identification was used in 2017 to identify Long-eared Myotis in a mixed colony at a house on Southern Vancouver Island.

California Myotis was identified in occupied houses, barns, and bat boxes. Long-legged Myotis was genetically confirmed at two building roosts, one in the Gulf Islands (cedar siding on an occupied house), and one site in the Cariboo (a barn).

Table 6. Species assemblages and the number of roosts found for each species and species group, at 580 anthropogenic roosts in BC.

Species in roost	Number of roost sites	% of all roost sites	% of roost sites with known species ID (n=224)
Little Brown Myotis	79	18	35
Little Brown Myotis / Yuma Myotis	32	7	14
Little Brown Myotis / Yuma Myotis / Big Brown Bat	2	< 1	1
Little Brown Myotis / Yuma Myotis / California Myotis	8	2	4
Little Brown Myotis / Big Brown Bat	1	< 1	< 1
Little Brown Myotis / Long-legged Myotis	1	< 1	< 1
Little Brown Myotis /Long-eared Myotis	2	< 1	1
Little Brown Myotis /Long-eared Myotis / Big Brown Bat	1	< 1	< 1
Yuma Myotis	52	11	23
Yuma Myotis/ California Myotis / Long-eared Myotis	1	< 1	< 1
Long-legged Myotis	1	< 1	< 1
California Myotis	14	2.5	6
Townsend's Big-eared Bat	8	2	4
Townsend's Big-eared Bat / Big Brown Bat	1	< 1	< 1
Big Brown Bat	18	4	8
Myotis spp.	17	2	8
No ID	304	42	
TBD	36	6	
Total	580		

Species at sentinel sites

Six species of bat were confirmed at 67/83 (81 %) of the sentinel sites (Table 7), while 17 sites have no ID at present. Little Brown Myotis were confirmed at 45 sentinel roosts. Yuma Myotis were confirmed at 38 sentinel roosts.

Table 7. Number of sentinel roost sites by species.

Species in roost	Sentinel roost sites
Little Brown Myotis	23
Little Brown / Yuma Myotis	20
Little Brown / Long-legged Myotis	1
Little Brown / Yuma / Big Brown Bat	1
Yuma Myotis	17
Big Brown Bat	2
Townsend ’s Big-eared Bat	1
California Myotis	1
Long-legged Myotis	1
NoID – no testing has occurred	16
Total	83

Identification of maternity colonies

Approximately 2/3 of all sites monitored are maternity colonies. Counts increased from pre-pup to post-pup count periods at 64% 204/320 roost sites (64%).

Maternity colonies were found in all types of structures used as roost sites (Figure 3). The majority of maternity colonies were found in occupied houses (160/320 maternity colonies, 50 %) and bat boxes / bat condos (116/320, 36 %) (Table 8). These results are very similar to those for all roost sites monitored (including the sites not flagged as possible maternity roosts (e.g. 51% in occupied houses, 33 % in bat boxes; see Structure type above).

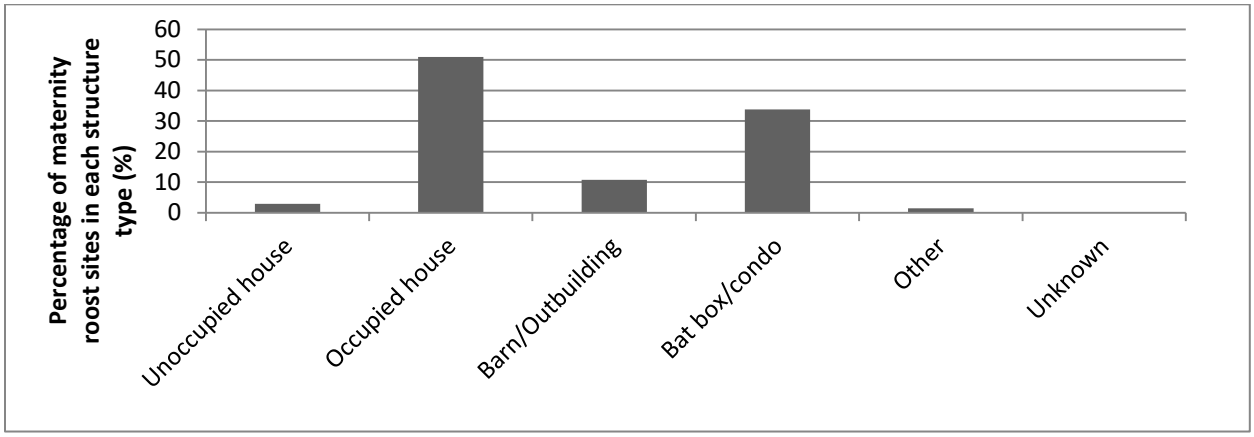

Figure 3. The distribution of 320 maternity roosts by structure type. Maternity roosts were identified through an increase in counts from pre- to post-pup periods.

Table 8. Summary of roost sites by structure type and colony type for 320 sites with pre-pup and post-pup counts in the same year. Maternity colonies were identified based on an increase in numbers from pre-pup to post-pup counts.

Structure type	Maternity sites	Total sites	% of structure type housing a maternity colony	% of all maternity roosts in a given structure type
Unoccupied house	6	9	67	3
Occupied house	104	160	65	51
Outbuilding /barn	22	30	73	11
Bat box/ bat condo[1]	69	116	59[1]	34[1]
Other[2]	3	5	60	1
Total	204	320	64	100

[1] Monitoring at bat boxes includes both occupied and unoccupied bat boxes. The % structure housing a colony is therefore an underestimate for this structure type.

[2] 'Other' includes 'Umbrella', 'Rock/cave', and 'Other' categories.

Eighty (80/204, 39%) of these maternity colonies sites were confirmed as Little Brown Myotis, either alone or with other species (Table 9). Little Brown Myotis maternity roosts were mainly in occupied houses (41/80, 51%) but also in bat boxes/ bat condos (27/80, 34%) (Table 9).

Table 9. Number of maternity colonies by species and structure type. Maternity colonies were identified based on an increase in numbers from pre-pup to post-pup counts.

Species	**Little Brown**	**Little Brown mix**	Yuma	Myotis mix, no Little Brown	Long-legged	California	Townsend's	Townsend's / Big Brown	Big Brown	TBD	Myotis spp.	NoID	Sum	**% of total with Little Brown**
Unoccupied house	**0**	**3**	0	0	0	0	0	1	0	1	0	1	6	**50**
Occupied house	**23**	**18**	10	2	1	8	1	0	2	7	2	30	104	**40**
Outbuilding/barn	**5**	**4**	3	0	0	0	3	0	0	1	0	6	22	**41**
Bat box/ bat condo	**14**	**13**	13	0	0	0	0	0	4	4	1	21	69	**39**
Other[1]	**0**	**0**	0	0	0	0	0	0	0	1	0	1	3	**0**
Total	**42**	**38**	26	2	1	8	4	1	6	14	3	59	204	**39**

[1] 'Other' includes 'Umbrella', 'Rock/cave', and 'Other' categories.

Variability within count periods

There is large variation in count results within a site and within designated count periods. There is also variation between years in the timing of when colonies reach maximum size and then begin to decline (Figure 4). The observed variability emphasizes the importance of doing at least two counts, to better estimate maximum number of bats in the roost and to be able to estimate variability for that site.

Photo: J. Saremba

Annual Bat Count 2012-2019

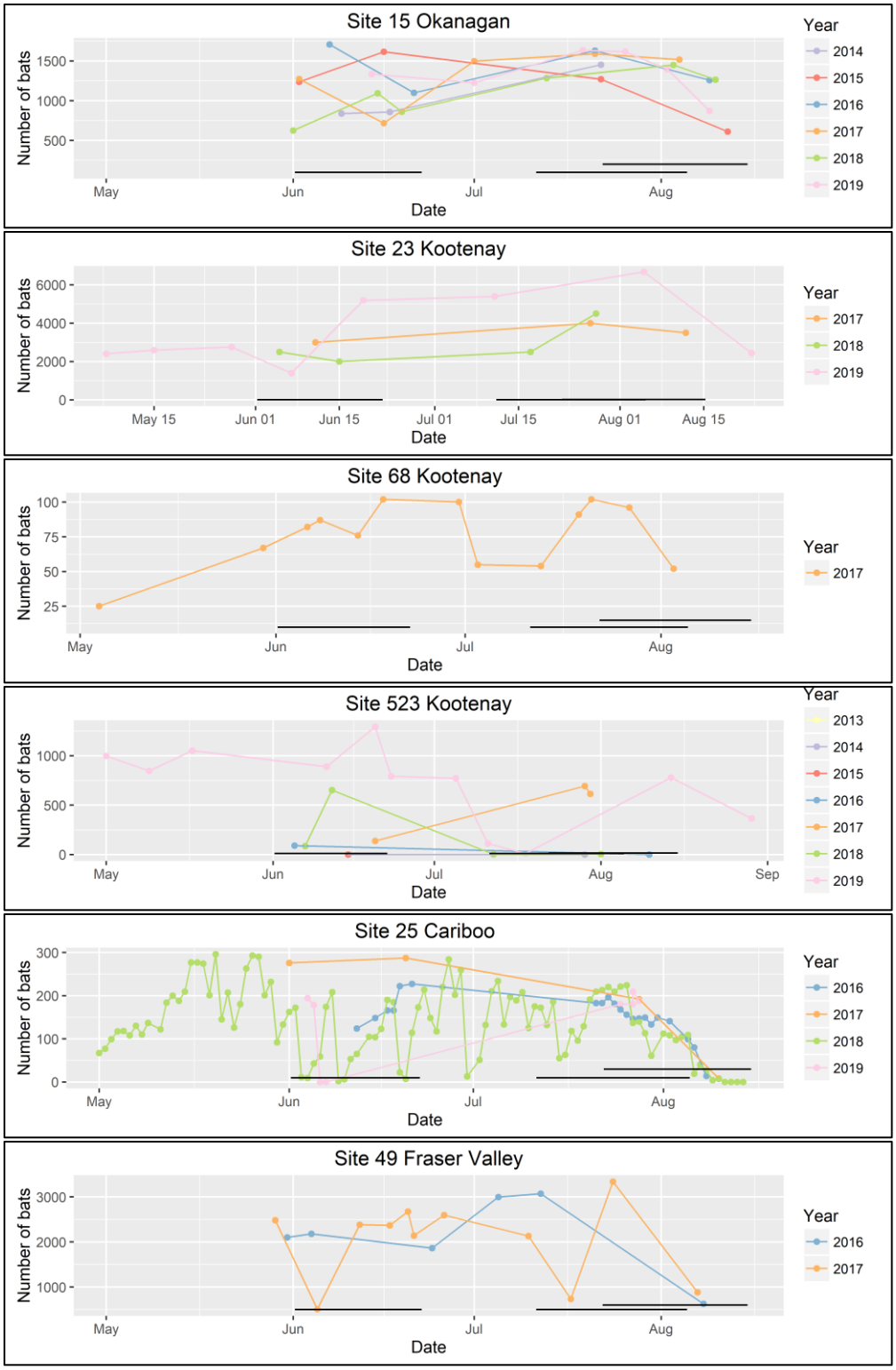

Figure 4. Counts for six sites with more than four counts in a year, showing nightly and yearly variation in count numbers. Horizontal lines indicate Bat Count periods in the pre-pup (Jun 1-22) and post-pup (Jul 22- Aug 15 (pre-2018) / Jul 11- Aug 5 (2018 onwards) count periods.

Dates of first pups

Observations of first pups of the year were obtained from several roost sites (Table 10). These observations show yearly variability in the start of parturition. These dates also suggest that any counts prior to ~ July 9 would not include volant pups (assuming around three weeks until pups begin flying). The current pre-pup count period is June 1 – 22 and therefore prior to volancy of pups. The current post-pup count period is July 11 – August 4.

Table 10. Dates of first pup (or lactating female) observed, by Region.

Region	Species	Year	Date
Vancouver Island/Gulf Islands	MYLU/MYYU	2019	Jun 16
Sunshine Coast (Clowhom)	MYLU/MYYU/MYCA	2019	Jun 17
Sunshine Coast (Jervis Inlet)	MYLU/MYYU/MYCA	2019	Jul 19
Okanagan	MYLU/MYYU	2017	Jun 26
Okanagan	MYLU/MYYU	2018	Jun 21
Okanagan	MYLU/MYYU	2019	Jun 16
Okanagan	COTO	2019	Jun 18
Kootenay	MYLU	2016	Jun 16
Kootenay	MYYU	2019	Jun 14
Peace	MYLU	2017	Jun 30
Peace	MYLU	2018	Jun 21
Cariboo	MYLU	2018	Jun 18

Trends across years

Two hundred and thirty-six (236) sites have two or more years of count data. One hundred and seventy-five (175) of these sites have multiple years of pre-pup count data and were screened for declines (Appendix 2).

Visual inspection subjectively identified twenty (20/175; 11%) of these sites as having a 'large' decline in maximum pre-pup counts. These twenty sites were investigated individually to determine if there were obvious causes for declines (excessive heat, bat exclusion, new roost sites nearby, large amount of variation normally at the site, etc.) (Appendix 2, Table 13). Changes in maximum pre-pup counts between years must be considered in context of the large variation within count periods in a year (see Variability within count periods, above) and the observed variability between years.

Nine of the twenty sites with potentially large declines had normal or increasing post-pup counts later in the summer. This suggests that these sites did not have a real decline. The timing may have been off for the pre-pup counts at these sites, with bats perhaps not at summer roosts yet, or few bats emerging on the count nights due to cool temperatures, high wind or other factors.

Four other sites were also considered to not reflect potential declines due to WNS. Two sites with declines were in location with multiple roost sites nearby (i.e, likely roost complexes). The other roost sites showed no declines, and roost switching and/or timing of counts may have contributed to low counts at the sites with observed declines. One site was a colony of Townsend's Big-eared Bats, with no

within-year repetition of counts and only two years of monitoring. This species has not been shown to decline from WNS, so if the decline is real it is due to other causes. One site was a partial exclusion.

There were seven sites where declines were not explained (Table 11). Two sites were small colonies with no repetition in June counts, and one was a site was a roost were the landowner reported that they only counted one exit, so it was a poor sample. Details on these sites are in Table 11. Declines at these small sites are likely not biologically significant – see Discussion. The remaining four sites were larger colonies that only had one count each in June, and no post-pup counts. They occurred at two locations (two sites per location); one of the locations had a third site that did not decline. Without more counts, it is unknown if declines are within normal variation or not; these sites are flagged for more monitoring in 2020, including ensuring multiple June counts (all sites) and spring guano collection (two sites at one location in the Lower Mainland).

Discussion

Participation and support

Interest in the Annual Bat Count has been increasing, with more sites monitored and increasing volunteer participation each year. The number of counts done by volunteers has increased each year.

There are huge benefits of volunteer involvement, including increasing the number of counts done, increasing the geographic scope of the project, and (we believe) increased local awareness and stewardship. However, this dramatically increases the number of hours, and associated cost, invested by regional coordinators to train, coordinate, and follow-up with volunteers.

Continued financial support for Annual Bat Count provincial and regional coordinators is also necessary to ensure that sentinel roost sites are counted yearly. Coordination is required at the provincial level to set program priorities and goals, monitor progress, analyze results and ensure that the results are available to guide species monitoring and recovery actions. Regional coordinators need to have time to review data, contribute to or modify the priority site list generated at the provincial-level, organize volunteers and landowners, assist in conducting counts, and enter data. Without adequate time for planning and coordinating the many volunteers, sampling is left in the hands of volunteers who may or may not participate in the program, and it is unlikely that all targeted sites will be counted.

Success of this broad-scale monitoring program depends on recruiting and retaining volunteers. The program currently recruits new colonies and volunteer counters through community presentations, press releases, and our website.

Program evaluation should be done to identify if volunteers are retained and for how long, what proportion of volunteers are new recruits, and if conducting a bat count on your own or other property leads to increased conservation actions such as increased interested in colony protection.

The primary sources of funding to-date for the Annual Bat Count at the provincial level have been from Habitat Conservation Trust Foundation / Forest Enhancement Society of BC, the BC Ministry of Environment and Climate Change Strategy, and the Habitat Stewardship Program for Species at Risk. Regional bat projects are encouraged to apply for and access other funds to support additional counts. As the program has expanded across the province and new sites are sought out and added to the long-term monitoring program, funding levels for this aspect of the Community Bat Program have not increased accordingly. Future growth of the program will likely be hampered by available funding. We need to secure alternate funds at the provincial level, plus encourage and support regions to apply for regionally-specific grants. One promising avenue is increasing partnerships with BC Parks across the province.

Species identification

One ongoing recommendation to improve the Bat Count data has been to increase the number of sites with species identification. While the percentage of all sites with species ID has crept up to 50 % (260/580 sites from 2012-2019), success at getting ID at sentinel sites has been higher, with 81 % (67/83) of these now identified.

Species identification is necessary to understand the implications of any changes in colony size. Species identification in 2020 should target:

1. species at all sentinel sites, and
2. sites with 2+ years of monitoring data.

At other roosts, species identification should occur as budget allows. To encourage species identification at sentinel sites, data gaps will be highlighted with regional coordinators. Coordinators will be responsible for ensuring sample collection for these sites, or for remote sites, obtaining mailing addresses to which we can send a DNA collection kit.

Providing identification of the species in a roost also serves to engage landowners and encourage stewardship. However, many new roost sites are now reported to the CBP yearly. Although the costs and effort to collect samples are low and volunteers/landowners can easily accomplish collection, DNA analysis of guano from all sites each year is not financially realistic. Increased reliance on acoustic monitoring may help identify species at non-sentinel sites. The CBP has bat detectors available for use, but capturing useful calls for ID usually requires a user with some knowledge of acoustic equipment and sampling. Acoustic monitoring may be useful when trained regional coordinators can be on-site, but is not applicable for many volunteers/landowners.

Potential for monitoring population trends

Number of sites and duration of monitoring

Population trend data is important for monitoring population changes that are expected from white-nose syndrome. Catastrophic declines are expected for species that are susceptible to WNS – for example, bat counts at hibernacula of some species in eastern North America declined by 30 – 99 %

yearly after WNS arrived (Frick et al. 2010). Detection of such large declines is easily done and does not require statistical analyses.

However, the different winter and summer roosting ecology of western bats compared to bats east of the Rockies may result in a different, perhaps slower, response, which would require more sites and longer sampling duration to detect. Recovery rates will also obviously be slow, and will definitely require many sites and a long sampling duration to detect trends with high confidence.

Detection of statistically reliable trends depends on a number of factors including time frame, sample size, annual replicates, annual variation, etc. (Walsh et al. 2001). Variation within and between years depends in part on the degree of roost fidelity/switching by that species, with more roost switching leading to more variable data and a larger number of sites required. In the UK, knowledge of the ecology of a species is used to identify which of several survey techniques will produce the most reliable trend (Bat Conservation Trust 2019). Research is underway in BC to investigate roost switching by species in anthropogenic structures, and in the future will contribute to our understanding of the effectiveness of bat counts for population monitoring.

Walsh et al. (2001) recommended a minimum of five years of monitoring for trend information for United Kingdom bats due to annual variations in counts. Two years of monitoring is the minimum for using sites in trend monitoring analyses (Bat Conservation Trust 2019). Most United Kingdom (UK) bat species required between five and nine years of counts at 100 sites to detect population changes of 5% per year (26.2% change over 5 years).

Currently, we have 236 sites with two or more years of monitoring. This suggests there may be enough sites to select a suitable sample size for providing reliable long-term trend data for some bat species. However, also of concern is replication within a sampling year. The number of sites required for detecting a trend increases substantially when there is no replication and only one count is done per year at a site. For example, *Pipistrellus* species in the United Kingdom required an additional 72 sites sample size, if only one count per year was done, compared to two counts per year, to have the same statistical power to detect change (Walsh et al. 2001). Many BC sites continue to have only one count per year; replication should continue to be emphasized in 2020.

Species monitored

Bats appear to have different vulnerabilities to WNS, based on patterns of mortality in affected species (WNS.org 2020) so species-specific trends are needed to monitor impacts and recovery. The Annual Bat Count focusses on anthropogenic structures so will only be useful for monitoring BC species that regularly use these structures. The Annual Bat Count has good potential to monitor population trends for Little Brown Myotis and Yuma Myotis, which both suffer high mortality rates from WNS in eastern North America (Environment Canada 2015). The Little Brown Myotis has now been detected at 91 Annual Bat Count sites; and Yuma Myotis at 65 sites. The Big Brown Bat, which is also susceptible to WNS but does show catastrophic declines in eastern North America (e.g., Moosman et al. 2013) has been detected at 22 sites. More sites are likely needed to monitor this species. There are too few roost

sites for other species for them to be effectively monitored at a provincial level using the Annual Bat Count.

Sentinel sites

Forty-four (44) locations (encompassing 83 roost count sites) currently meet most of the criteria for establishing reliable trends and are identified as 'sentinel sites.' This total number of sentinel sites may not provide enough samples for determining a provincial trend, as it does not reach the recommended targets of 30-50 sites monitored per year per species (Walsh et al 2001). Additional sentinel sites (tentatively estimated at 25 to 50 sites, based on Walsh *et al.* 2001) need to be established in addition to the 44 existing sentinel sites to establish trends - perhaps not to detect the large declines expected from WNS, but certainly to monitor recovery. Specific recommendations to increase monitoring and identification of species at sentinel sites are presented below and these tasks will be a target in 2020.

Methods for detecting declines

In 2019, yearly variation in pre-pup counts was assessed visually to identify sites of potential concern. Sites with subjectively "large" declines were flagged. Four of the twenty sites had small sample size and only one count per session. This process underscored the importance of focussing on larger roost sites to ensure that declines are biologically relevant.

In future, declines in sites should be quantitatively assessed. One option is to compare the percent decrease in pre-pup count to the variation observed in pre-pup counts in previous years. Reviewing site-specific variation over previous years should assist in determining a realistic value for concern (e.g., 20 % decline). In 2018, the average percent difference in first and second pre-pup counts was assessed as 146 % across all counts (Kellner 2019); this reflects the large range in colony sizes and the need to use site-specific variation to assess changes at each site.

Additionally, methods to analyze repeated count data should be investigated (e.g. program TRIM - Trends and Indices for Monitoring data (van Strien et al 2004), Generalized Additive Models (Bat Conservation Trust 2019), and power analyses should be run to determine if counts have power to detect a pre-determined level of change. Again, this level of change should be determined in consultation with provincial biologists and after considering the normal variation seen in counts pre-WNS.

Bat boxes and the Annual Bat Count

The large number of bat boxes deployed through the Community Bat Program over time has potential to increase our knowledge about the effectiveness of bat boxes as habitat enhancement and mitigation. Data on bat box installation and use by bats can be captured through the Annual Bat Count or through visual inspection and/or guano catchers. There are currently 190 bat boxes in the Annual Bat Count database; however, many are lacking data on box and installation. To increase the value of monitoring these boxes, data gaps should be filled when possible. To ensure installed bat boxes contribute to population monitoring goals, it is necessary to continue to:

- promote registration of installed bat boxes with the Community Bat Program,

- promote yearly monitoring for occupancy by using a guano catcher or looking into the box, and
- promote monitoring during the Annual Bat Count.

These additional priorities need to be communicated to regional coordinators and volunteers, and data submitted online through our "Register Your Bat Box" link.

Summary of recommendations and priorities for 2020

1) Establish a 5-year strategic monitoring program for 2017 to 2022 to track select bat populations in relation to the expected arrival of WNS in BC.

    a) Research statistical methods for trend analysis, analyse the variation within a count period and between years, and conduct a power analysis to clearly identify sample sizes, duration of counts, etc. needed to monitor bat species in BC. This is required to achieve an estimated minimum sampling duration (# years) and sample size (# sites) needed to develop statistically-useful trends by species.
        - Power analysis discussions initiated by BC government early 2018; ongoing discussion with BC and US FWS / NABat.
        - In 2020, focus on furthering statistical analyses (upload data to USGS, investigate BC partnerships).
        - Establish long-term acoustic monitoring at a sub-set of sentinel sites. This will increase our understanding of colony composition for mixed colonies and provide information on timing of arrival and departure of bats to guide recommendations on exclusions or renovations for other homeowners in BC. However this will require funding and partners to develop an effective program, and is currently low-priority.

    b) Identify methods (e.g. % decrease in yearly prep-pup counts) that can be used to flag sites with declining counts
        - Visual screening of graphs has been used to-date; develop standard, simple, and rapid R-scripted methods in 2020. Methods should be site-specific and consider within-year and between-year variation.

    c) Modify Annual Bat Count protocols if needed to ensure counts and replicates occur in the ideal time periods
        - Modifications have included: 2017 - prioritize obtaining two counts in the pre-pup period in June; 2018 – advance timing of post-pup counts to July 11 – Aug 5.
        - The utility of continuing post-pup counts was discussed provincially and all counts will be retained for the present, with an emphasis on pre-pup counts.

2) Ensure that sentinel sites are monitored for a minimum 5-year period, with 2 or more annual replicates, to assess population trends.

a) Sentinel sites have high numbers of bats (e.g. >150) and/or contain maternity roosts, have a high probability of long term presence (i.e. aren't likely to be destroyed) and contribute to species-specific population monitoring on a regional basis.
   - Sentinel sites were identified and re-assessed yearly; monitoring of these sites will be promoted to regional coordinators and to roost stewards. Efforts must be made to ensure volunteers are available to count sites,
   - Confirmation of a roost as a maternity roost is difficult; continue to seek out information on presence of pups but consider colony size as adequate surrogate,
   - Retain the check-box for 'pups seen' and date on the 2020 data sheet.

b) At these sentinel sites, species ID is confirmed at 81 % of sites. Efforts will be made to ensure:
   - species are confirmed through genetics and/or acoustic means in 2020 by specifically approaching regional coordinators/ roost stewards.

c) Sentinel sites must be counted yearly, with counts replicated two or more times annually. In 2019, only 71 % of sentinel sites were monitored. Monitoring of priority sites will be promoted by:
   - reviewing the Bat Count goals and identified sentinel sites with regional coordinators,
   - ensuring volunteers are contacted and engaged,
     - Summary data on counts on each region should be prepared and provided to regional coordinators and volunteers
   - providing coordinators with a pre-filled datasheet clearly identifying priority sites,
   - reminding coordinators to contact landowners individually to provide feedback on past counts and encourage participation to ensure counts happen at these locations, and
   - checking in with roost stewards/volunteer counters in early June to allow arrangement for alternate counters if needed.
     - Sites identified as lower priority/not sentinel sites will continue to be monitored for community engagement and stewardship promotion.

3) Increase the number of sites monitored in the Fraser Valley/ Lower Mainland (Vancouver to Hope), Sunshine Coast, and Southern Vancouver Island/ Gulf Islands regions (ideally to 30 to 40 sites per region year, if possible). These are the first areas in BC that are likely to be impacted by WNS. In 2019, 218 sites were monitored in these regions, an increase from 120 in 2018. Efforts will be made to increase the number of sites by:
   a) ongoing outreach by regional coordinators to increase the number of known large roosts and promote counting,
   b) following up with known recipients of bat boxes and with online bat box registrants to promote counting at these sites, and
   c) promoting multi-year monitoring at these new sites.

4) Promote continuing roost counts at sites with strong volunteer support, to encourage stewardship, increase the number of multi-year samples to support detection of statistical trends, and scan for significant colonies. At all sites, it will be important to:
   a) continue monitoring of previously-counted sites, to increase the number of sites with 2+ years of data,
   b) obtain two or more counts in the pre-pup period, and
   c) when possible, obtain independent counts on the same night, and
   d) make efforts to encourage continuing participation, retaining interested homeowners and trained volunteers, to obtain multi-year samples. We will emphasize re-contact with an info summary, public celebration of volunteers, email reminders to counters before and in early June, and tokens of gratitude (pencils, stickers).

5) Coordinate with broader-scale bat monitoring programs, including data submission to NABAT.

6) Develop and distribute questions to bat count participants to determine the effect of participation in bat counts on their intent and actions to protect roost habitat for bats. Questions can be easily incorporated as part of the data form used for monitoring.

7) Prepare outreach-quality, simple regional summaries about the topics presented here at the provincial level, for use by regional coordinators and distribution to volunteers and landowners. These may already be available for the Kootenay and Okanagan regions. Topics should include:
   a) level of volunteer involvement,
   b) number of counts and for which species, to identify regions that require more roost counts for effective species monitoring,
   c) # of sampling years per site, level of recruitment of sites into a multi-year monitoring program, and
   d) multi-year trends by species to identify sites where data has not been continuously collected and may require extra attention (e.g. landowner follow-up, recruitment or organization of volunteers).

8) Seek out new funding sources to support the growing Annual Bat Count.
   - Regional programs are encouraged to source regional funding.
   - Partnerships with BC Parks has ensured Bat Counts are done in Okanagan and Skagit Parks.
   - Develop relationships with other Parks to encourage stewardship and Bat Counts.

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Appendix 1. Sentinel sites for ongoing monitoring

See Methods for criteria for listing as a Sentinel Site. Sites in bold font are within 250 km of the 2016 and 2017 WNS detection sites.

Sentinel Site ID	Targetted for 2020	Monitored in 2019	Comments 2019	Region	Species	Maximum count
1			Dropped – not monitored since 2016, no landowner interest	BC – other	MYLU	57
67	**Yes**	**Yes**	**New in 2018**	**BC – other**		**2474**
3	Yes	Yes		Cariboo	MYLU/MYVO	651
4	Yes	no	Bella Coola – contact by phone	Cariboo	MYYU	213
25	Yes	Yes		Cariboo	MYLU	293
26	Yes	Yes		Cariboo	MYLU	301
27		No	Dropped – not monitored since 2016, no landowner interest	Cariboo	MYLU	298
28	Yes	Yes		Cariboo	MYLU	114
29	Yes	Yes		Columbia Shuswap	EPFU	27
49	Yes	Yes	**No data submitted as of Dec 2019**	**Fraser Valley / Lower Mainland**	**MYLU/MYYU**	**3340**
53	Yes	Yes		**Fraser Valley / Lower Mainland**	**MYLU/MYYU**	**820**
54	Yes	Yes		**Fraser Valley / Lower Mainland**	**COTO**	**414**
64	Yes	**Yes**		**Fraser Valley / Lower Mainland**	**MYLU**	**273**
65	Yes	**Yes**		**Fraser Valley / Lower Mainland**	**MYLU**	**160**
66	Yes	**Yes**		**Fraser Valley / Lower Mainland**		**1006**
9	Yes	Yes	Population boom 2018	Kootenay	MYYU	5878
10			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYLU	1050
11	Yes	Yes		Kootenay	MYLU/MYYU	2113
12			Dropped – not monitored since 2015, no landowner interest	Kootenay	EPFU	36
13	Yes	Yes		Kootenay	MYLU/MYYU	1345
32			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYLU	157
33	Yes	Yes		Kootenay	MYLU	357
34			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYYU	279
36			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYLU	251
37			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYLU	217
38	Yes	Yes		Kootenay	MYLU	199
39		No	Dropped - Not monitored since 2017	Kootenay	MYLU	170
40	Yes	Yes		Kootenay	MYYU	282
41	Yes	Yes		Kootenay	MYLU	191
42	Yes	Yes		Kootenay	MYYU	213
43			Dropped – not monitored since 2015, no landowner interest	Kootenay	MYYU	295
44			Dropped – not monitored since 2013, no landowner interest	Kootenay	MYYU	270
45			Dropped – combined with 41	Kootenay	MYLU	131

47	Yes			Kootenay	MYLU	170
55	Yes	Yes		Kootenay	MYLU	4500
58	Yes	Yes		Kootenay	MYLU/MYYU	351
69	Yes	Yes	New site in 2018. Added to Priority list 2019.	Kootenay	MYLU/MYYU	804
15	Yes	Yes		Okanagan	MYLU/MYYU	1708
16	Yes	Yes		Okanagan	MYLU/MYYU	1396
17			Dropped - Sold in 2019 – new owners did not count	Okanagan	MYLU	103
57	Yes	Yes		Okanagan	MYLU/MYYU	343
61	Yes	Yes		Okanagan	MYLU	832
62	Yes	Yes		Okanagan	MYLU/MYYU	423
63		No	Dropped - Bats evicted in 2019.	Okanagan	MYLU/MYYU	532
48	Yes	Yes		Peace	MYLU	150
22	Yes	Yes		Skeena	MYLU	146
23			Dropped - Original building demolished, condo not counted according to protocols	Skeena	MYYU	1020
24	Yes	No		Skeena	MYLU	283
52	Yes	No		Skeena	MYLU	267
51	Yes	No		Sunshine Coast	MYCA	170
8	Yes	Yes		Thompson	MYLU/MYYU	382
2			Dropped – Courtenay, not monitored since 2016	Vancouver Island / Gulf Islands		198
6	Yes	Yes		**Vancouver Island / Gulf Islands**	**MYLU/MYYU**	**581**
7	Yes	Yes		**Vancouver Island / Gulf Islands**	**MYLU/MYYU**	**1195**
14	Yes	Yes		**Vancouver Island / Gulf Islands**	**MYVO**	**115**
30	Yes	Yes		**Vancouver Island / Gulf Islands**	**MYYU**	**62**
31	Yes	Yes		**Vancouver Island / Gulf Islands**	**MYLU/MYYU**	**1120**
46			**Dropped – at Spider Lake, outside of HAT's area, not monitored since 2016**	**Vancouver Island / Gulf Islands**		**573**
50	Yes	**Yes**		**Vancouver Island / Gulf Islands**	**MYLU/MYYU**	**1117**
56	Yes	**Yes**		**Vancouver Island / Gulf Islands**	**MYLU/MYYU /EPFU**	**731**
59	Yes	Yes	Nanaimo	Vancouver Island / Gulf Islands	MYLU/MYYU	356
60		**No**	**Not monitored in 2018 either**	**Vancouver Island / Gulf Islands**	**MYYU**	**541**

Appendix 2. Yearly trends

Maximum bat counts in the pre-pup period, by year, region, and species. Colours represent different roost sites; dots are counts and lines connect counts across years. 'Other' includes counts from Northern Vancouver Island, Skagit, and Prince George.

Species categories are: MYLU (colonies with Little Brown Myotis), MYLU+ (colonies with Little Brown Myotis and other species, usually Yuma Myotis), MYYU/MYYU+ (colonies with Yuma Myotis or Yuma Myotis and other species but NOT Little Brown Myotis), and Other (colonies with other species, other mixed species, and where species is unknown).

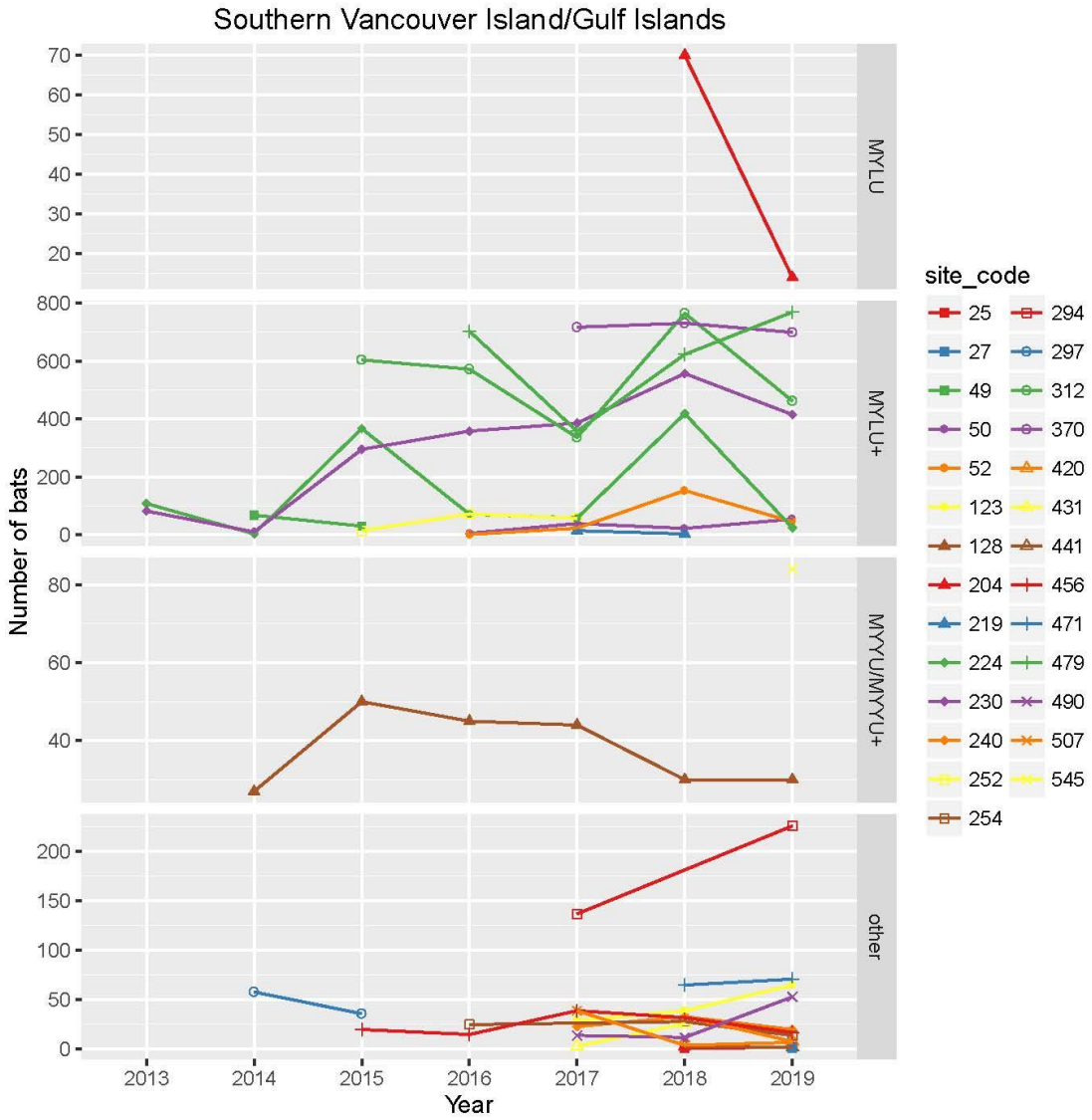


Figure 5. Vancouver Island Region yearly maximum pre-pup counts.

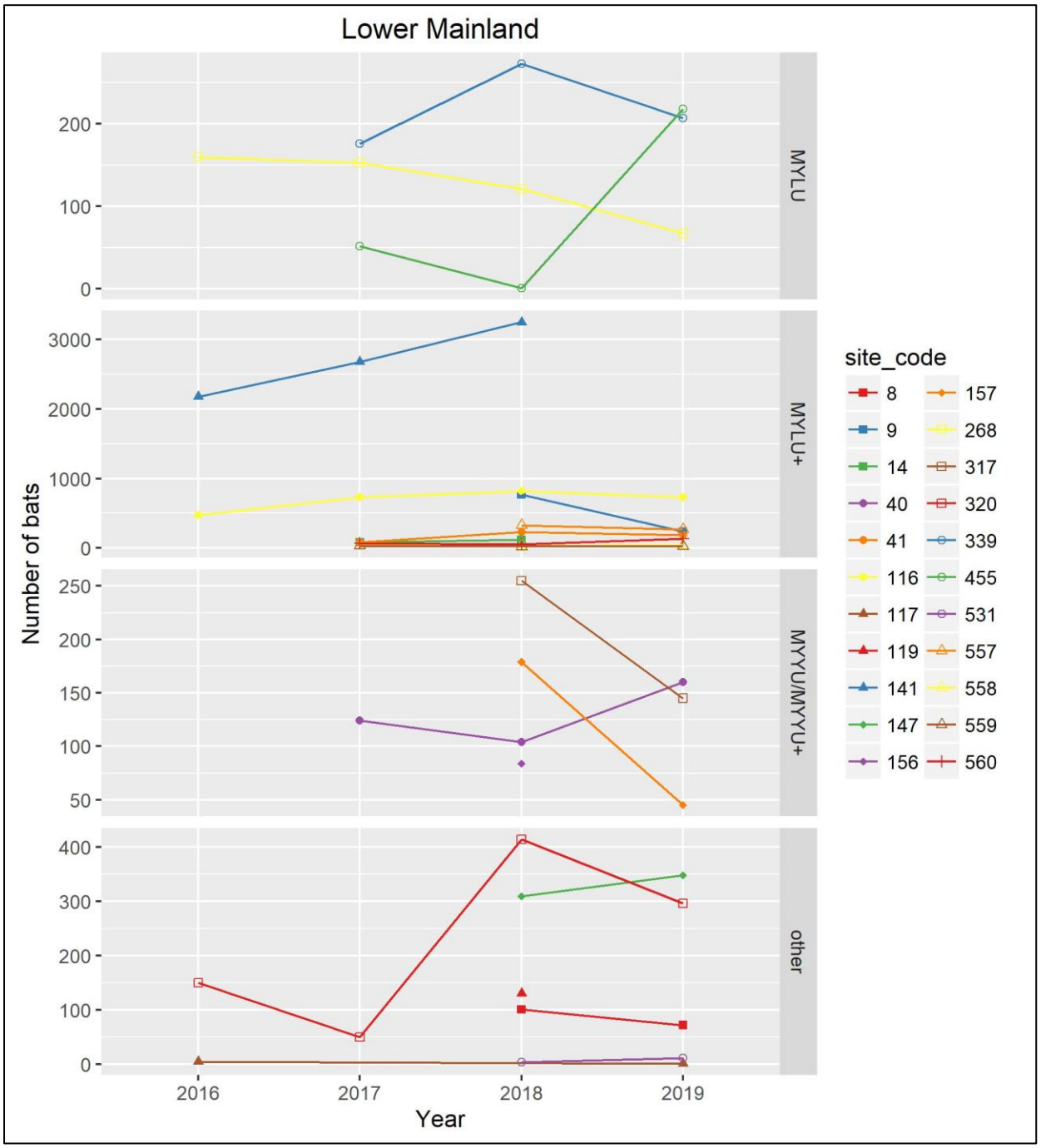


Figure 6. Fraser Valley/Vancouver Region yearly maximum pre-pup counts.

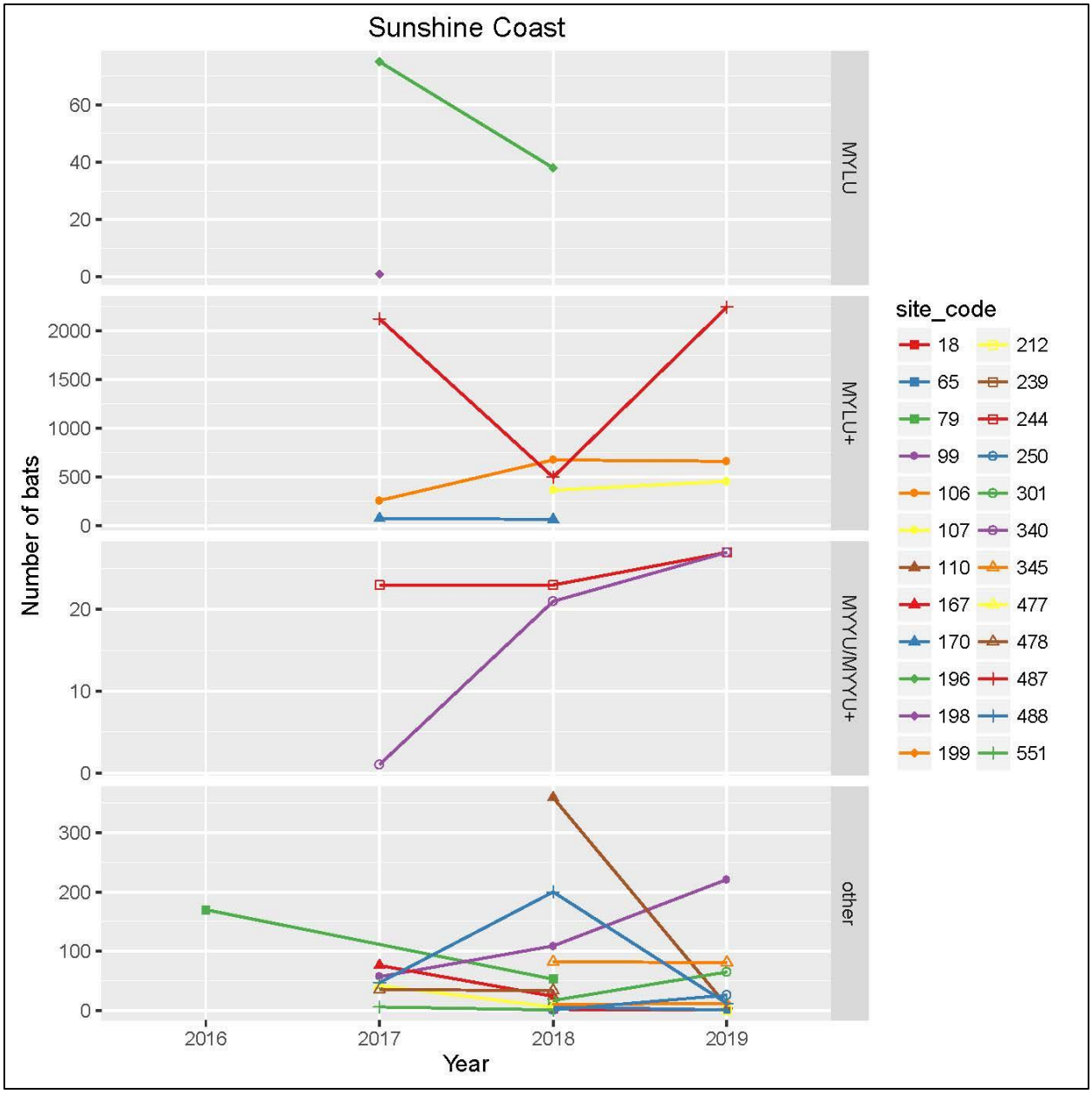


Figure 7. Sunshine Coast Region yearly maximum pre-pup counts.

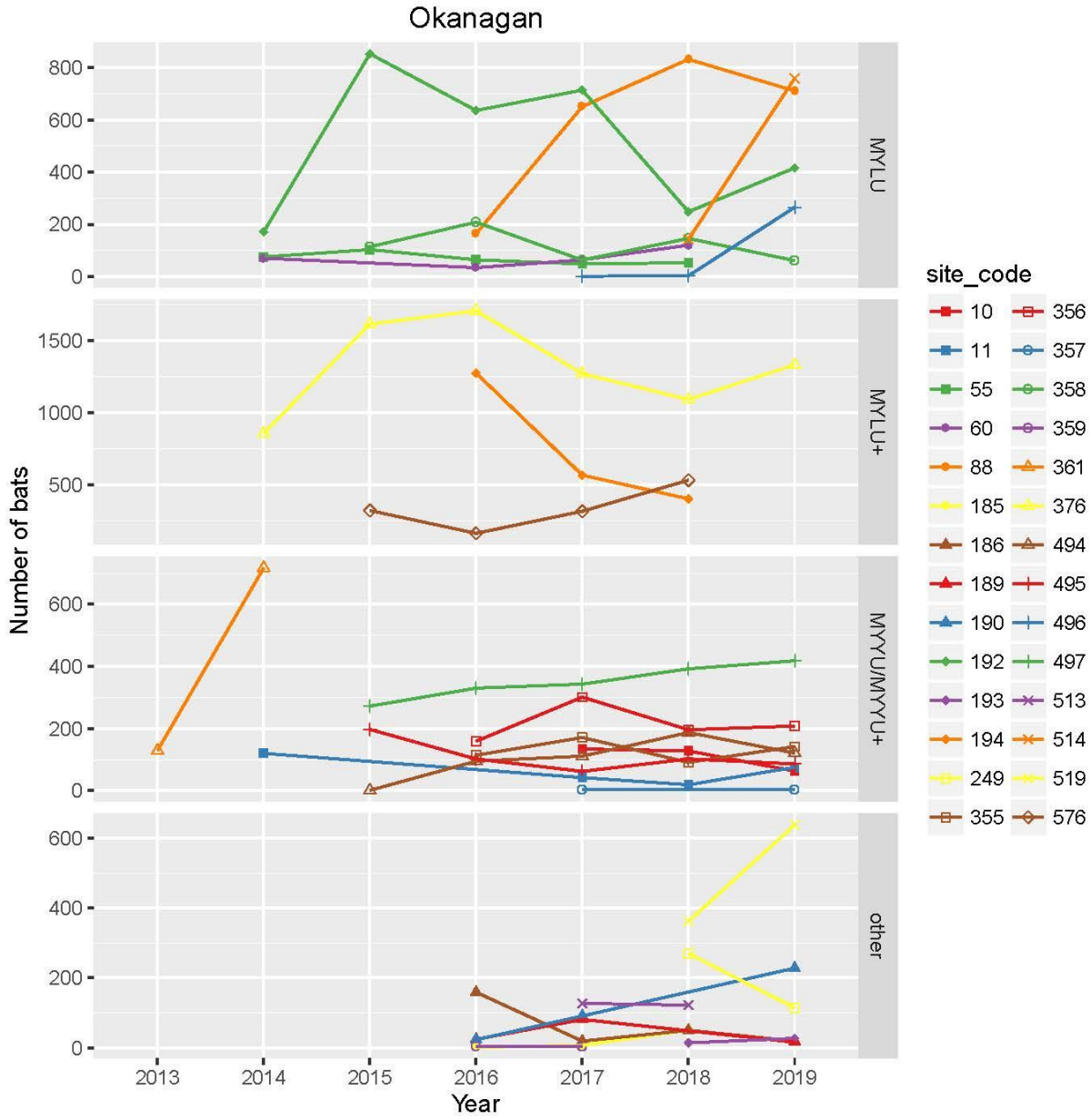


Figure 8. Okanagan Region yearly maximum pre-pup counts.

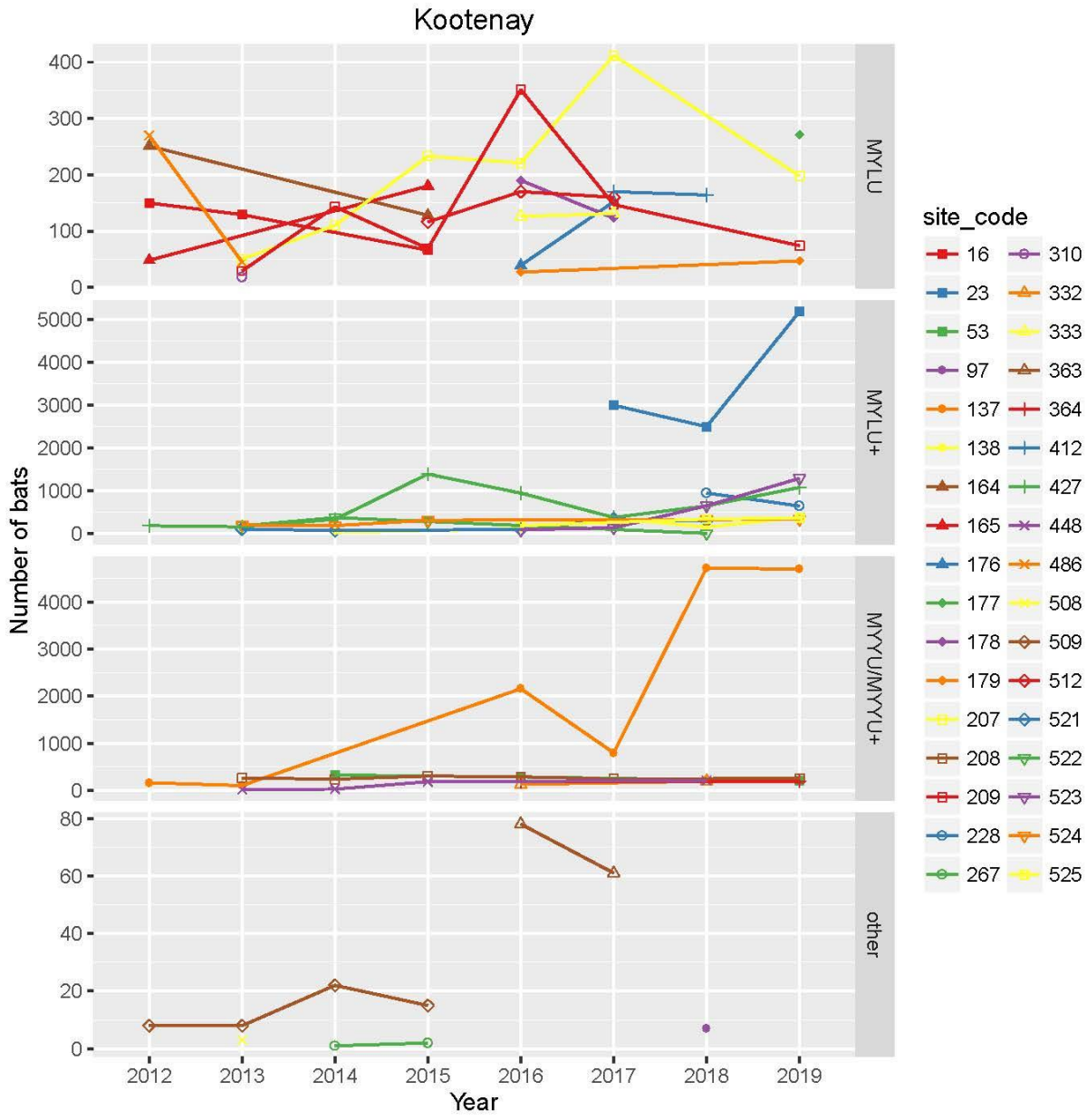


Figure 9. Kootenay Region yearly maximum pre-pup counts.

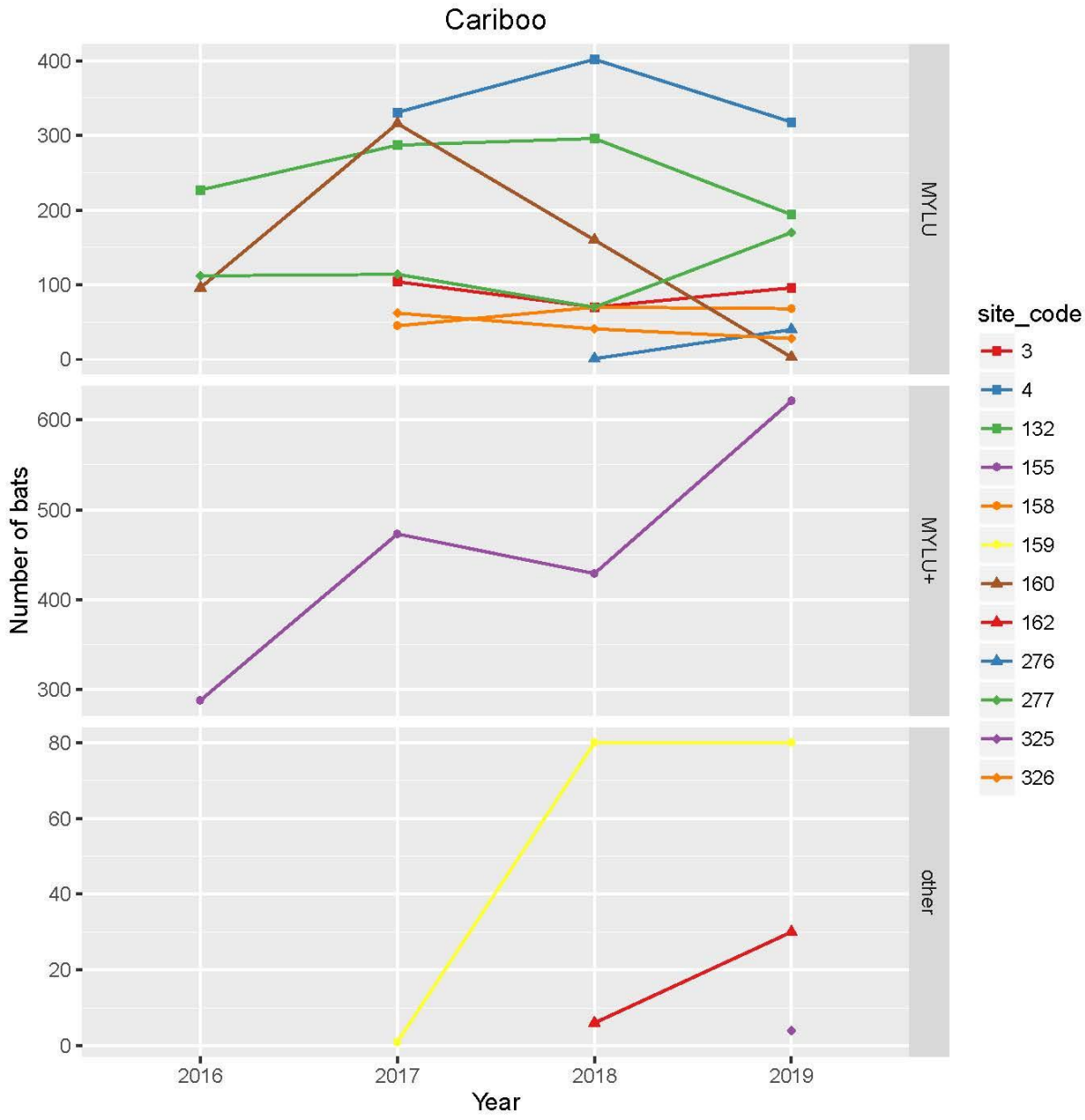


Figure 10. Cariboo Region yearly maximum pre-pup counts.

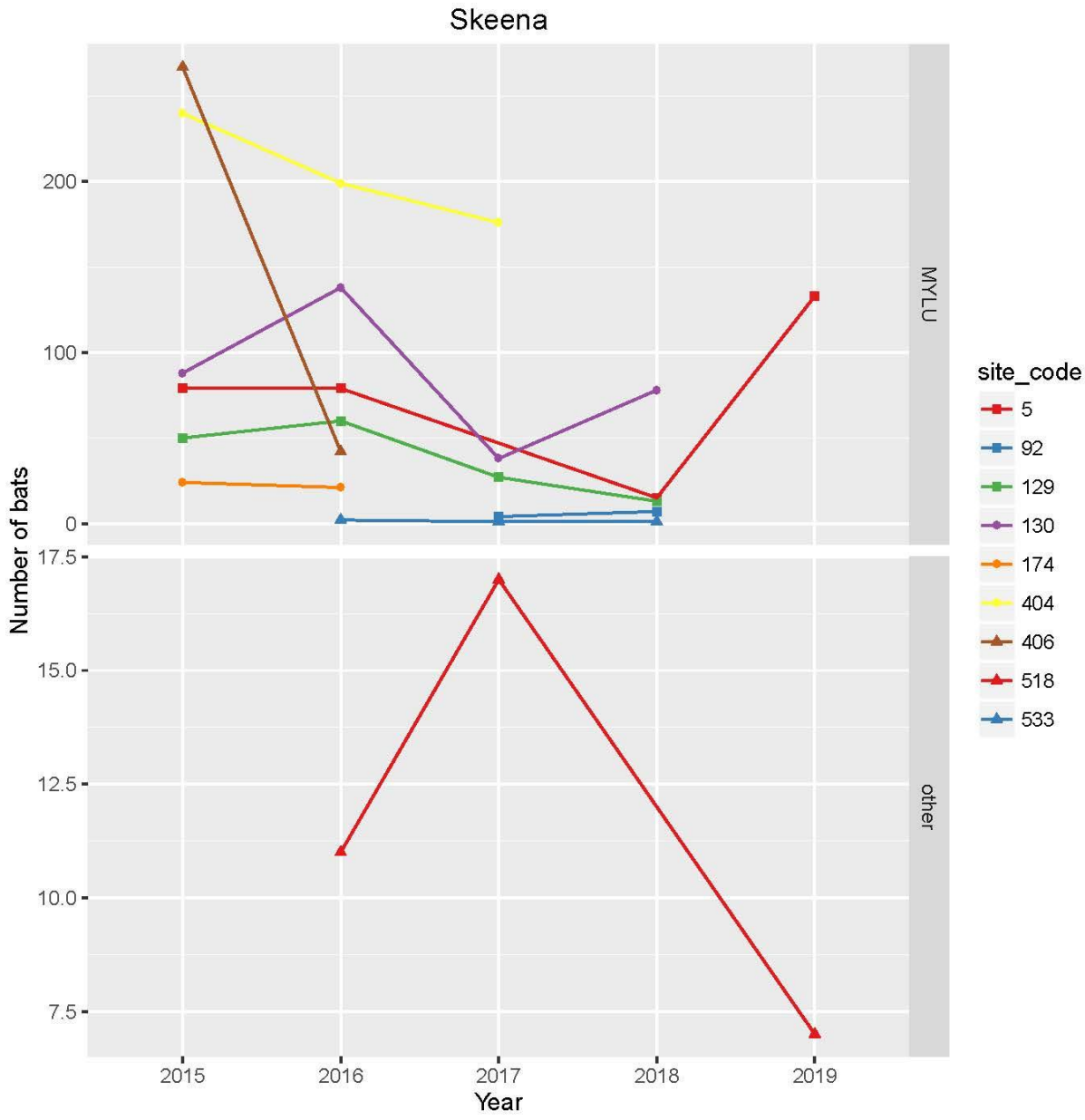


Figure 11. Skeena Region yearly maximum pre-pup counts.

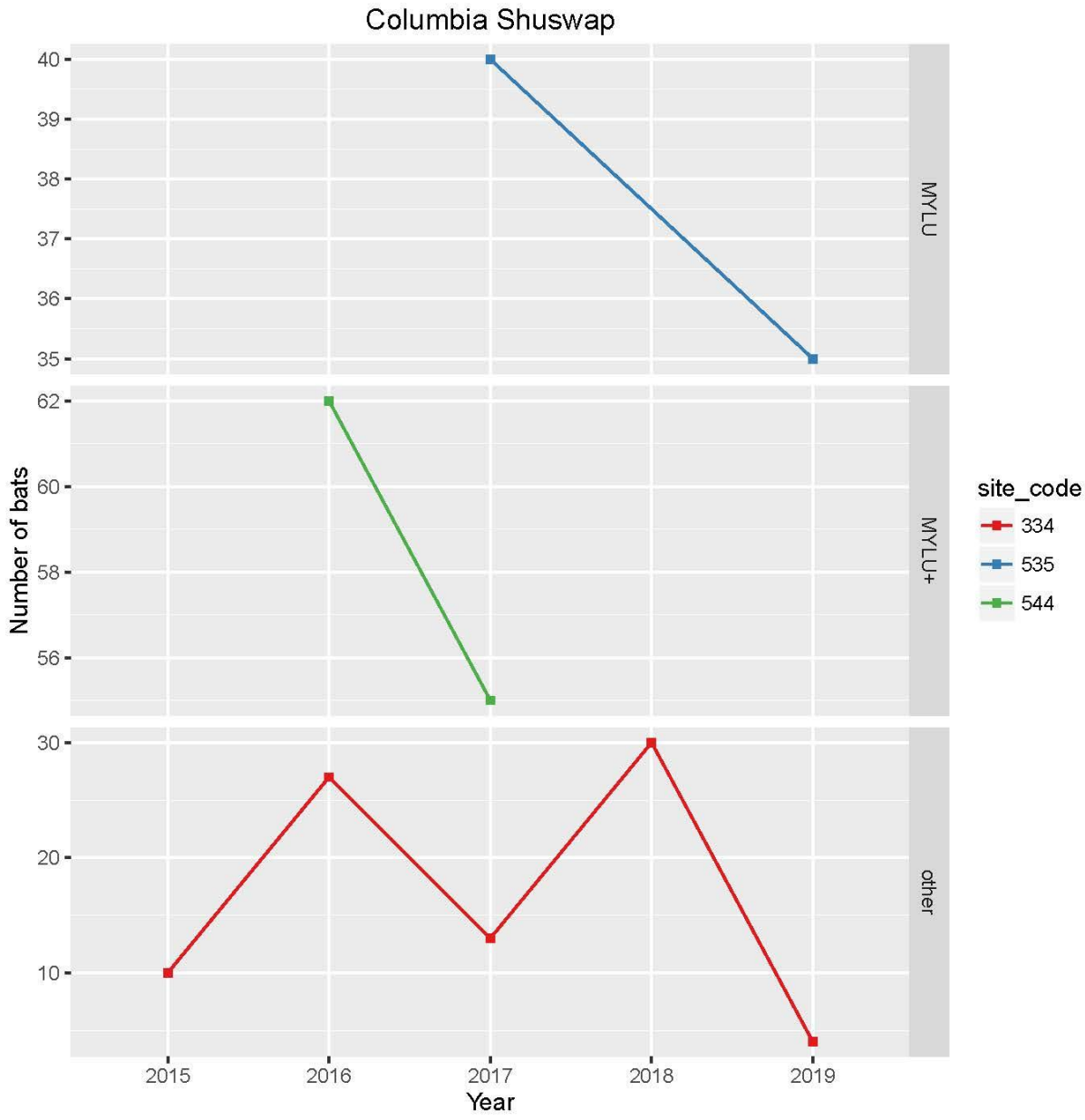


Figure 12. Shuswap Region yearly maximum pre-pup counts.

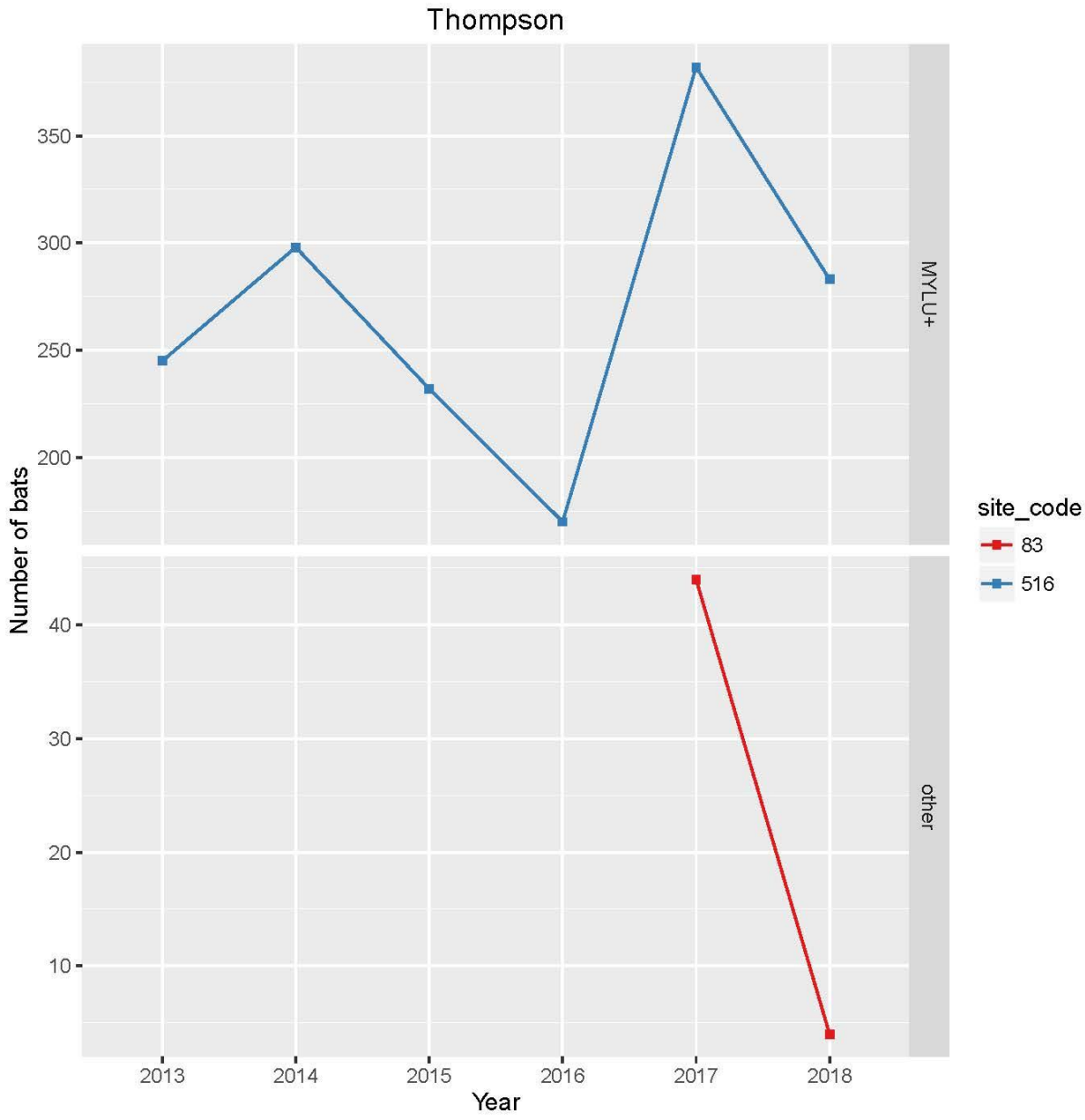


Figure 13. Thompson Region yearly maximum pre-pup counts.

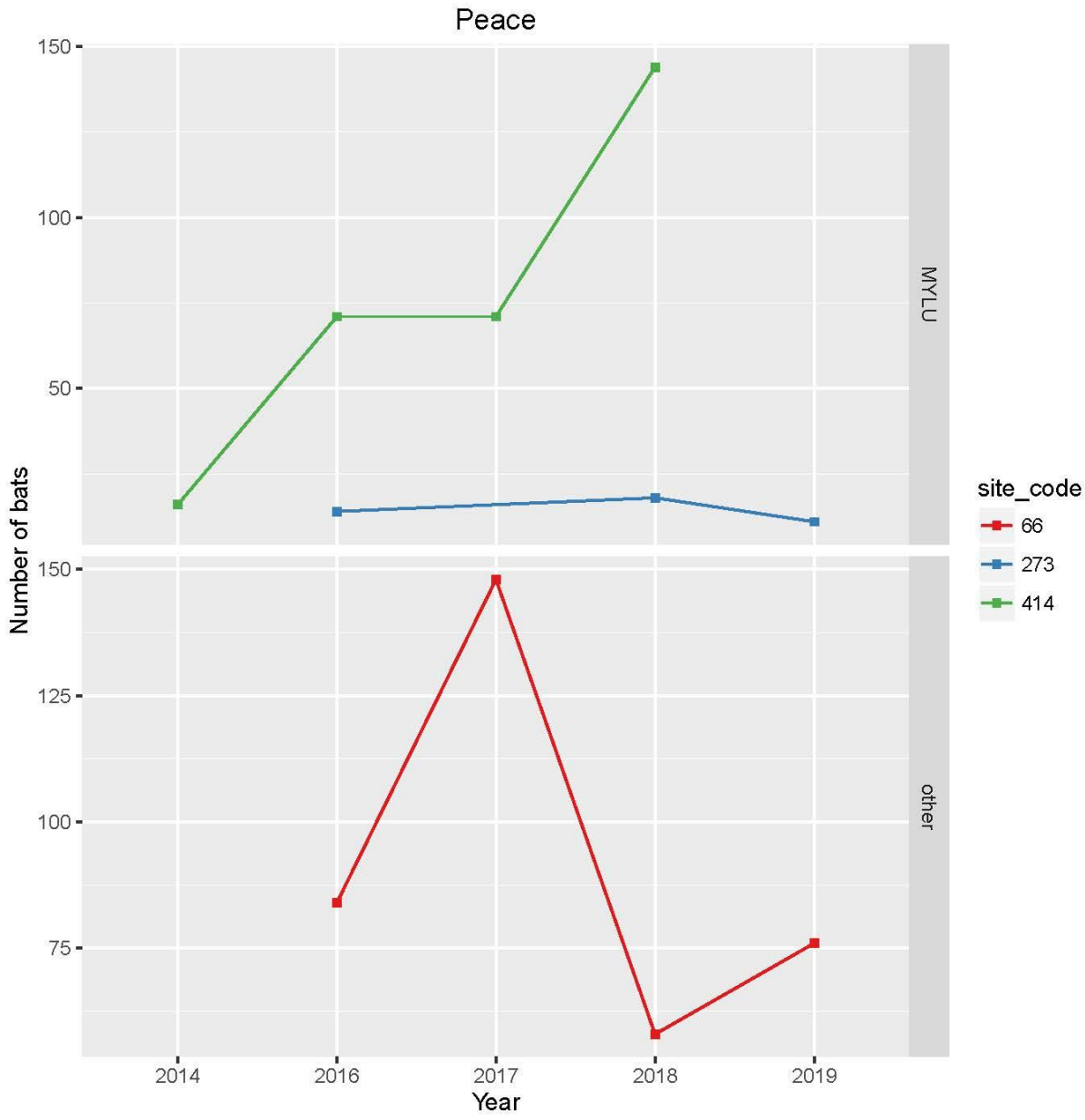


Figure 14. Peace Region yearly maximum pre-pup counts.

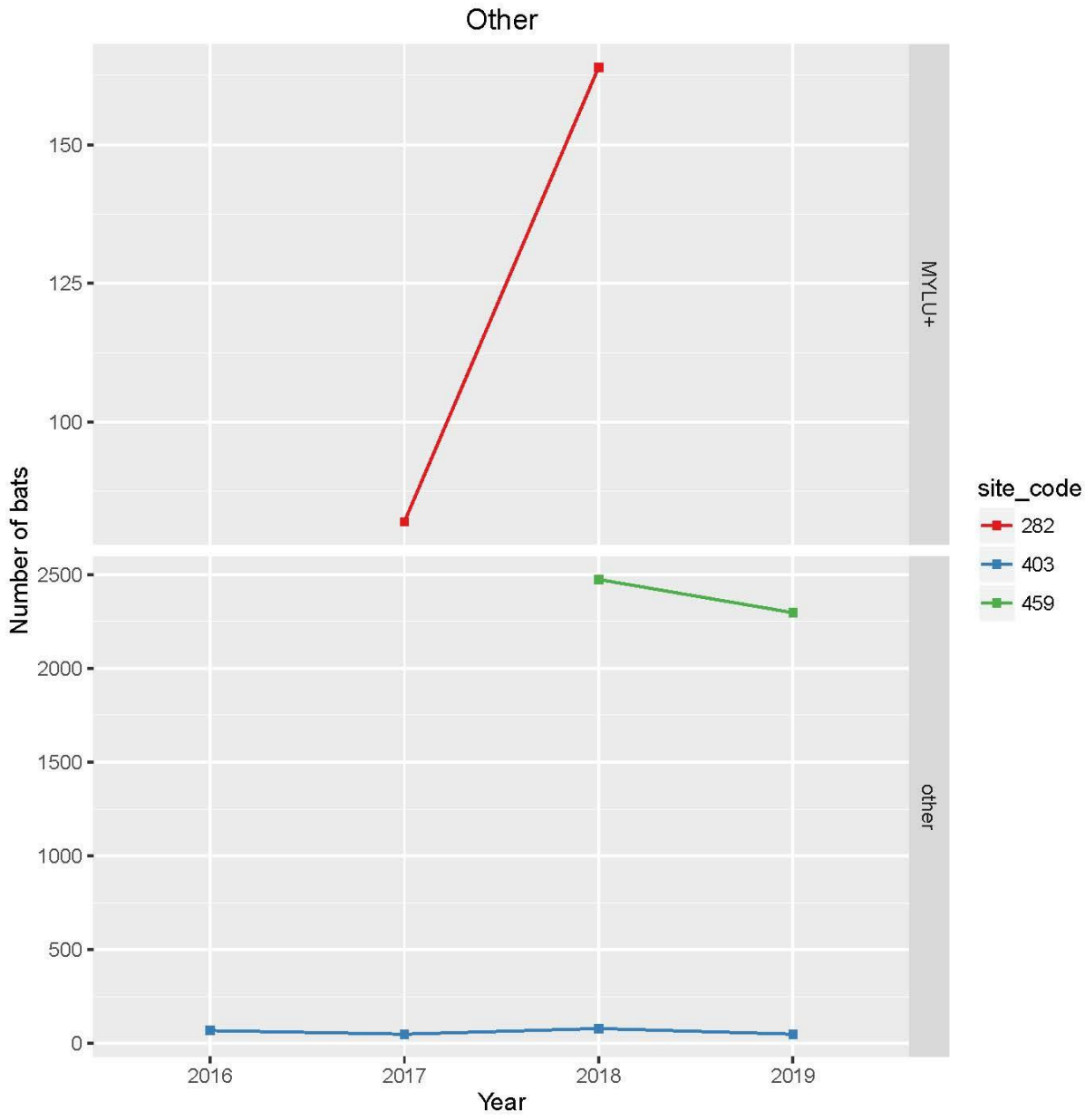


Figure 15. Other Region yearly maximum pre-pup counts.

Table 11. Detail on 20 sites with obvious declines in pre-pup maximum counts in 2019, by region. Grey bands indicate sites with unexplained decreases.

Region	Site code	Comment	Summary
Southern Vancouver Island/ Gulf Islands	204	Drop in 2019 in pre-pup max count, but #s recover in post-pup (max post-pup counts are 150 in 2018, 192 in 2019).	Post-pup recovery
Southern Vancouver Island/ Gulf Islands	128	Drop in 2019 in pre-pup max count, but #s recover in post-pup. Post-pup #s are stable or increasing over the years.	Post-pup recovery
Fraser Valley/ Lower Mainland	8	Large decline in June but maybe timing off. Only single prepup count per year. Try and get more counts.	No repetition
Fraser Valley/ Lower Mainland	9	Large decline in June but maybe timing off. Only single prepup count per year. Try and get more counts.	No repetition
Fraser Valley/ Lower Mainland	157	Drop in 2019 in pre-pup max count, but #s recover in post-pup	Post-pup recovery
Fraser Valley/ Lower Mainland	268	Drop in 2019 in pre-pup max count, but #s recover in post-pup	Post-pup recovery
Fraser Valley/ Lower Mainland	317	Drop in 2019 in pre-pup max count, but #s recover in post-pup	Post-pup recovery
Sunshine Coast	110	Large decline at this roost site in June but maybe timing off? Remote location so more counts not possible. Six other sites in < 1 km (five bat boxes and one cabin) did not drop.	No repetition; roost complex
Sunshine Coast	196	Drop in 2019 in pre-pup max count, but #s recover in post-pup	Post-pup recovery
Sunshine Coast	488	Large decline in June 2018 to 2019 but maybe timing off in 2019? but #s recover in post-pup	Post-pup recovery
Okanagan	358	Okanagan Lake Provincial Park. Many bat boxes close together – others do not decline. Should look at grouped #s.	Roost complex
Okanagan	249	Decline, but only 1 count per year for two years. COTO; if decline, likely not WNS.	COTO
Kootenay	207	Decline, but only 1 count in 2019. Same location as 209. Site 208 at this location did not decline.	No repetition; change in counting team; roost complex
Kootenay	209	Decline, but only 1 count in 2019. Same location as 207. Site 208 at this location did not decline.	No repetition; change in counting team; roost complex
Cariboo	160	Exclusion. Bat boxes at this location are doing well = sites 158,159,161,162	Exclusion
Skeena	518	Small colony. Drop in 2019 in pre-pup max count, but #s recover in post-pup	Post-pup recovery
Columbia-Shuswap	535	Small colony (30 - 50 bats). Only 1 count in 2019 (35), landowner reports not counting all sites where bat roosts.	Small roost, poor count (range = 31 - 40,

			mean = 35 ± 4)
Columbia-Shuswap	544	Small colony. Few counts. Not monitored since 2017 due to restricted access on BCH land.	Small roost, no repetition (range = 49 - 62, mean = 55 ± 6)
Columbia-Shuswap	344	Small colony. Post-pup counts were in normal range.	Post-pup recovery
Thompson	83	Decline. Site not monitored in 2019. Small colony, few counts.	Small roost, few counts, high variation (range =0 - 44, mean = 12 ± 21)

Appendix 3. Summary for volunteers

BC COMMUNITY BAT PROGRAM
BC Annual Bat Count Summary 2019

Why counting bats is important

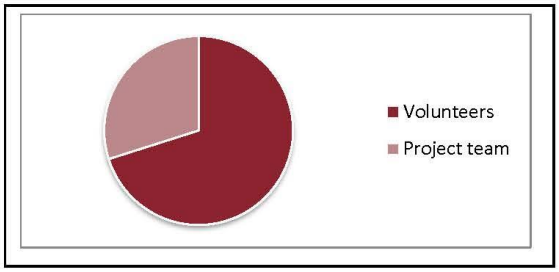
The BC Annual Bat Count is a summer emergence count of bats at day roosts in human-made structures (e.g. houses, barns, bat houses). Begun in 2012, we now have data on seven bat species from 3034 counts done at 580 sites around the province.

Bats are an essential part of our BC ecology and are of huge economic importance, consuming large quantities of insects each night. Bats face a wide variety of threats, including habitat loss, increasing severity of fires, and wide-scale mortality from White-nose Syndrome (WNS).

The Annual Bat Count dataset is a key part of our provincial bat monitoring program, helping to monitor trends in bat populations and detect declines from WNS. Monitoring will also inform our policies and management actions to protect and conserve our bats. No private landowner information is passed along when the count results are shared.

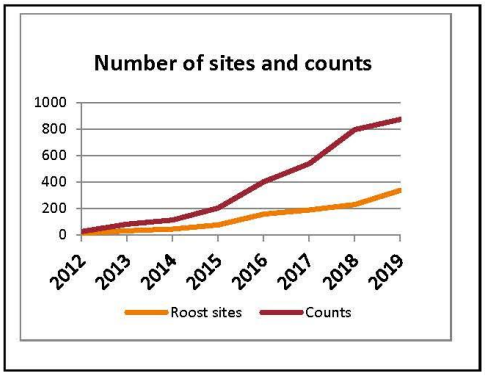
Number of volunteers

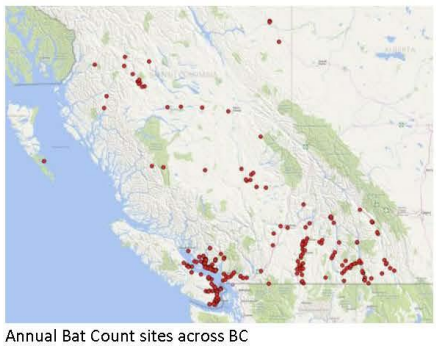
The BC Annual Bat Count continues to grow, thanks to our volunteers. In 2019, volunteers donated **1308 volunteer-nights**, participating in **612 bat counts** (up from 540 in 2018).



Number of sites

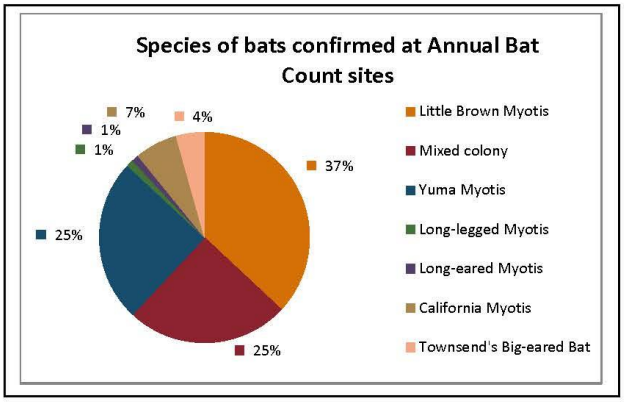
In 2019, there were a total of **873 counts** done at **337 roost sites**.




Annual Bat Count sites across BC

Species of bats

Seven species have been identified at sites counted in the Annual Bat Count. Most common are the Little Brown Myotis and Yuma Myotis. There are also Big Brown Bats, California Myotis, Townsend's Big-eared Bats, Long-legged Myotis, and Long-eared Myotis. Mixed colonies, with more than one species present, are common. More information about these species can be found on our website or in the Bat-friendly Communities Guide.

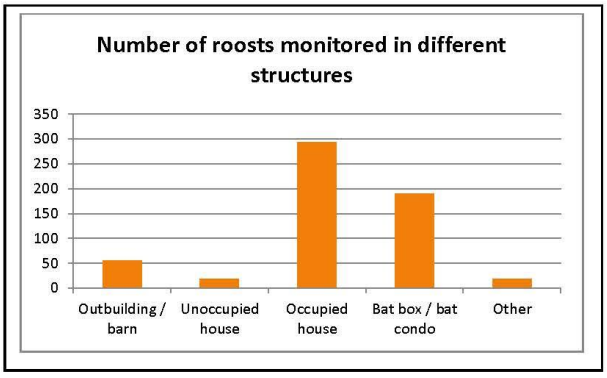


There are now **224 sites** where we know the species of bat living there. If you have a roost and do not know what species of bat lives there, you can submit a guano sample following the directions on our Bat Count page, or contact the BC Community Bat Program Coordinator.

Structures used by bats

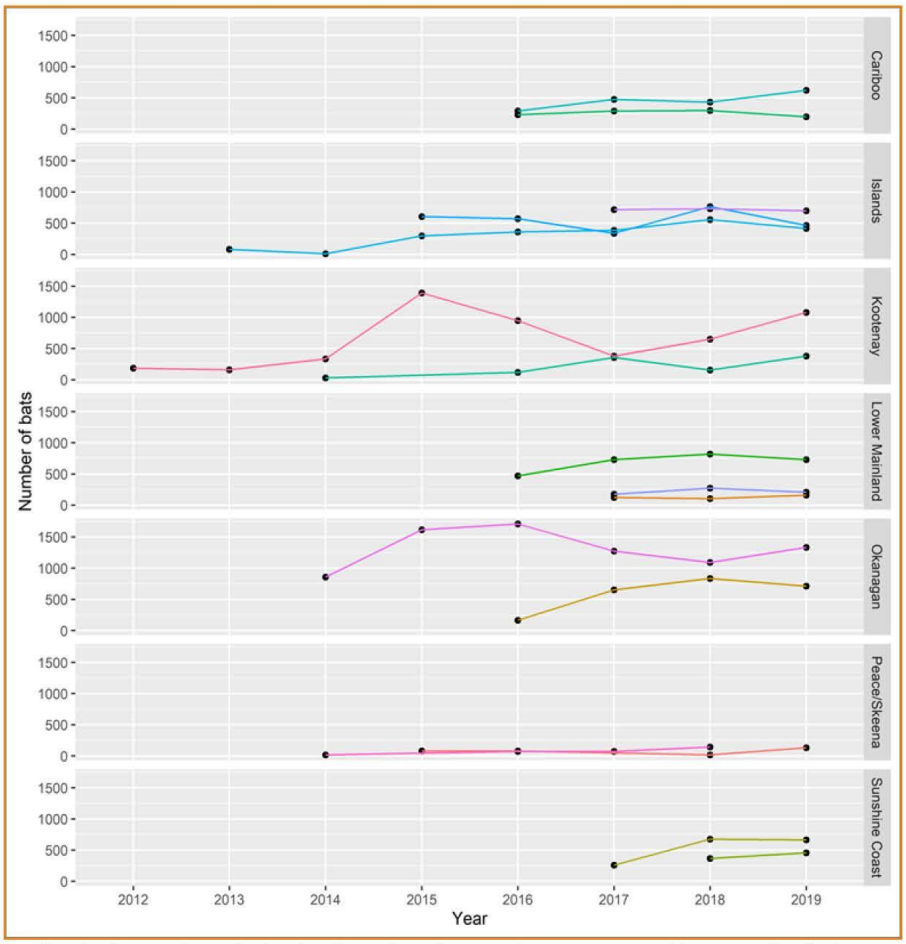
Bats roost in many structures, including rocky outcrops and trees with loose bark, cracks, or cavities. The BC Annual Bat Count focuses on bats in human-made structures.

Most monitored roost sites are located in occupied houses (293 sites; 51%) and bat boxes or bat condos (190 sites; 33%). Bat colonies are also monitored in outbuildings/barns, unoccupied houses, and other structures (umbrellas, caves, and bridges).



Trends at count sites

The Annual Bat Count data set can illustrate trends in populations. Count data from key sites are graphed by region and species group to screen for sites with large declines, identify areas to focus on to improve sample sizes, and to provide feedback to coordinators and local volunteers.



Results from select priority sites in each region are above - stay tuned for more detailed information on how bat colonies in your region are doing. You can request data for your own count site from bcbats@gmail.com.

Thank-you for counting! We look forwards to your 2020 results!
Visit: www.bcbats.ca Annual Bat Count

HABITAT CONSERVATION TRUST FOUNDATION
FESBC Forest Enhancement Society of British Columbia
Environment and Climate Change Canada
Environnement et Changement climatique Canada
BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

Annual Bat Count 2012-2019