Coastal Western Screech-Owl Studies and Nocturnal Wildlife Inventory within Old Growth Ecosystems of Southwest BC

Photo Credits: Felix Martinez-Nunez (left – old Western Redcedar), C. Toby St. Clair (right – ARU check by Felix M.)

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EXECUTIVE SUMMARY

This Habitat Stewardship Program (HSP) Species at Risk Stream project, initially proposed as a 2-year project and funded for the first year, was conducted to address gaps in actions identified within recovery plans for the Threatened coastal subspecies of Western Screech-Owl (*Megascops kennicottii kennicottii* – WESOke) and for the Endangered Little Brown Myotis (*Myotis lucifugus* - MYLU). Key gaps that this project has endeavoured to address include identification of critical habitat for Western Screech-Owl and the establishment of a monitoring plan to collect information necessary to monitor population trends and assess threats of invasive species to this threatened subspecies. Field studies for the project were conducted within 10 study areas on Vancouver Island (7 study areas) and the South Coast region (3 study areas) of British Columbia, primarily within ancient forest habitats with a focus on forests dominated by cypress species such as Western Redcedar (*Thuja plicata*) and Yellow Cedar (*Cupressus nootkatensis*). These habitats have not historically been recognized as important for Western Screech-Owl and, as such, have seldom been surveyed for this species; however, recent and historic records of Western Screech-Owls in ancient Western Redcedar forests and other habitats with similar characteristics indicate that this has been an oversight. Field studies, including passive acoustic monitoring with multi-day deployments of bioacoustics monitoring equipment and active monitoring with call playback surveys and handheld bioacoustics monitoring equipment, were conducted during spring and winter months between April 2021 and March 2022. Other project activities included gathering and vetting historical survey data, refining and disseminating standardized survey protocols, developing a publicly accessible database into which all suitable historical data can be compiled, and conducting outreach and education to involve indigenous, academic, government, citizen science, and other groups in the project during this past year's work and in the future. This project and the activities carried out this past year will ultimately help to inform designations of critical habitat for Western Screech-Owl and contribute to a monitoring plan and publicly accessible database that is necessary to assess threats of invasive species and habitat loss/change and monitor population trends for this owl. In addition, survey data collected on bats provide important information on understudied winter and spring emergence habitat use within ancient forests for species threatened by the fungus causing white-nose syndrome. Results from this past year of project work suggest that ancient forest ecosystems do provide habitat for Western Screech-Owl; however, more in depth analyses are required to account for variation in detection rates to accurately assess the importance of these habitats relative to others that have been surveyed more regularly over the past few decades.

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
ARU	autonomous recording unit
BADO	barred owl (*strix varia*) species code
BC	British Columbia
cm	centimeter
CPB	call-playback (survey type)
COSEWIC	committee on the status of endangered wildlife in canada
dB	decibel
ECCC	environment and climate change canada
EMT	echometer touch (bat acoustic monitoring device)
FLNRORD	ministry of forests, lands, natural resource operations and rural development
FOCI	friends of cortes island
GPS	global positioning system
HSP	habitat stewardship program
kHz	kilohertz
km	kilometres
km/h	kilometres per hour
m	metre
MYLU	little brown bat (*myotis lucifugus*) species code
NGO	non-government organization
NABat	North American bat monitoring program
PMRA	Pacific megascops research alliance (pacificmegascops.org)
QA	quality assurance
QC	quality control
RIC	resource inventory standards committee
S-ARU	sonic autonomous recording unit – for bird monitoring
SC	special concern
SARA	species at risk act
sec	second
U-ARU	ultrasonic automonous recording unit – for bat monitoring
UTM	universal transverse mercator
WESOke	western screech-owl (*megascops kennicottii, kennicottii* sub-species) species code
%	percent
<	lesser than
>	greater than

1.0 INTRODUCTION

This report describes objectives and summarizes the results of activities carried out for the Coastal Western Screech-Owl Studies and Nocturnal Wildlife Inventory project during April 2021 through March 2022. As the project title suggests, activities focused on coastal Western Screech-Owl (*Megascops kennicottii kennicottii* - WESOke), listed as Threatened under the federal Species At Risk Act (SARA), as well as other owl and bat species, including Little Brown Myotis (*Myotis lucifugus* - MYLU), listed as Endangered under SARA. Project activities were conducted, in part, by Hemmera staff with funding provided through Environment and Climate Change Canada's (ECCC) Habitat Stewardship Program (HSP) for Species at Risk but were also supported by volunteer efforts and in-kind support from collaborating partners with the project who are acknowledged at the end of this report.

1.1 Project Objectives

The overall objective of this project was to address gaps in actions identified within species recovery plans for WESOke (Government of BC 2013) and MYLU (Government of Canada 2015).

The broad objectives of the project for WESOke were as follows:

- Gather and compile historical survey data
- Identify critical habitat
- Establish monitoring plan to collect the information necessary to assess threats of invasive species and monitor population trends.

Project activities carried out to accomplish these objectives were as follows:

- Development of safe working procedures
- Obtaining permissions in consultation with landowners/managers and indigenous groups
- Outreach and education
- Survey protocol refinement and development
- Development and testing of efficient passive acoustic monitoring data processing methods
- Surveys and monitoring during spring 2021, winter 2021/2022, and spring 2022
- Processing and summarization of survey data
- Management and compilation of current and historic survey data
- Reporting.

1.2 Monitoring Locations and Survey Timing

Though research involving WESOke in British Columbia (BC) dates back at least 25 years (Deal and Lamont 1996), there are still some major uncertainties as to which habitat types and landscape features are important to this subspecies. Recent observations of high densities of WESOke in some ancient forest[1] ecosystems has emphasized how little is known about owls in these systems in coastal BC (Kennedy 2016; Hemmera 2020). Mid to high productivity ancient forests are almost completely missing from this dataset. Understanding how WESOke and Barred Owl (*Strix varia* - BADO), a predator thought to be a driver of detectability and abundance of WESOke, use these and other habitats is essential for defining critical habitat and determining what actions should be taken for the conservation of this threatened subspecies.

[1] For this report, ancient forests are defined as any primary growth forest that has not been clearcut or had more than 50% of the dominant canopy trees removed, within the last 200 years.

Using expert opinion, preliminary results from a handful of locations, and looking at the similarities within, and differences between, different ancient forest landscapes, we hypothesized that WESOke are using some types of ancient forest more than others. For example, Sitka Spruce (*Picea sitchensis*) and Douglas Fir (*Pseudotsuga menziesii*) dominated floodplains have lower and more open undergrowth, dominated by forbs and trailing shrubs. Forests dominated by cypresses like Western Redcedar (*Thuja plicata*) and Yellow Cedar (*Cupressus nootkatensis*) provide far more light gaps allowing the undergrowth to grow more tall and dense. These understory features are similar to the patches of higher productivity forests within low productivity bog matrices on Northern Vancouver Island (e.g., Nahwitti Bog) that support the highest known densities of WESOke. Dense and tall undergrowth forests dominated by cypress may also exclude BADO, as BADO may have more difficulty hunting their main prey sources (squirrels and other similarly sized rodents) using perch-hunting methods in habitats with dense understory. Additionally, mid-high productivity ancient forests such as those dominated by cypress contain woodpecker-excavated nest cavities that WESOke use for nesting. These dead-standing trees and the diversity of vegetation structure in most coastal ancient forest types may also allow for more consistent foraging opportunities for WESOke.

Because of the structural differences between different types of ancient forest and between ancient and second growth forest, we selected a diversity of forest age and structure for surveys. Concurrent monitoring of WESOke within second growth forests and traditionally surveyed habitats provide the context necessary to interpret survey results from ancient forests.

We defined the following 3 spatial components for the project:

- Study areas - Areas which encompass one or more target habitat type for the project potentially including forests of varying age or structure which are accessible either by road or within walking distance from a road. Typically including 1 to 3 transects.
- Transects - A series of stations within a study area that is representative of the study area or a single targeted forest age and structure within the study area. Typically including 10 to 12 stations.
- Stations - Locations where surveys are conducted, spaced evenly along each transect. Typically spaced 800 meters (m) apart with 2 to 3 visits per year at each station for call playback surveys.

Study areas selected for this project, and the habitat types targeted within those areas, are specified below in **Table 1**. Ancient forests match all 4 of the following criteria, whereas second growth areas match only criteria 3 and 4:

1. Mid-high productivity ancient forest (representing various dominant tree species)
2. Continuous patches of ancient forest of various sizes
3. Easily accessible during the early spring via car or truck
4. Easily traversable paths by foot or vehicle for playback transects to be completed

Table 1 Study Areas Selected for Coastal Western Screech-Owl and Other Nocturnal Wildlife Inventory and Habitat Type Descriptions in Each Including Originally Proposed Study Areas and Additional Study Areas

Proposed or Additional	Study Area Name	Habitat Type
Proposed	Carmanah Walbran	Ancient Forest - high productivity. Western Redcedar dominated slopes and Sitka Spruce valleys as well as second growth forest along access roads.
Proposed	Strathcona Provincial Park & Puntledge Watershed[1]	Ancient Forest - high productivity. Douglas-fir and Western Hemlock forest with Western Redcedar and Yellow Cedar in the higher intermontane valleys.
Proposed	Golden Ears Provincial Park[1]	Ancient Forest - mid and high productivity. Series of open and dense undergrowth forests composed of Douglas-fir dominated river valleys and Western Redcedar dominated slopes.
Proposed	Clayoquot Sound & Kennedy Lake	Ancient Forest - mid to low productivity. Ancient Western Redcedar, Hemlock and Pine slopes with predominantly second growth riparian areas.
Proposed	Port Renfrew & San Juan Valley	Ancient and Second Growth Forests - high productivity. Sitka Spruce and western redcedar in a larger matrix of second growth Western Hemlock.
Proposed	Schoen Lake	Ancient Forest - mid productivity Amabilis Fir and Western Hemlock at low elevation with mixed cypress habitats at higher elevations.
Additional	Squamish River Watershed[1]	Second Growth Forest - high productivity. Riparian and dominated by Big Leaf Maple, Hemlock and Red Alder.
Additional	Tsitika River Watershed	Ancient Forest - mid to high productivity. Steep Western Redcedar slopes and Amabilis Fir, Sitka Spruce flood plains. A matrix of unlogged and logged with more unlogged areas than otherwise accessible in other river valleys
Additional	Coquitlam River Watershed[1]	Ancient Forest - high productivity. Western Redcedar and Western Hemlock slopes directly to lake edge. Minimal second growth riparian deciduous
Additional	Ballenas Island[1]	Ancient Forest - low productivity. Coastal Douglas Fir, Arbutus forest with extensive undergrowth and little canopy closure. A large amount of exposed rock, moss and lichen.

Notes: [1]Includes transects within Federal Provincial Territorial Priority Places (https://www.canada.ca/en/services/environment/wildlife-plants-species/species-risk/pan-canadian-approach.html#toc3)

Specific survey locations for monitoring of nocturnal wildlife within each study area and transects surveyed within study areas are illustrated in **Figure 1** for 2021 field studies and in **Figure 2** and **Figure 3** for 2022 field studies in the Vancouver Island and South Coast regions, respectively (see **Section 3**).

Survey timing for Western Screech-Owls has historically been based on provincial standards (Hausleitner 2006) which specify that they are best conducted between February and April. This is the timeframe in which individuals are thought to advertise and defend nests and is therefore considered an appropriate time to assess occupancy of breeding territories. Surveys for bats were conducted during this time and also during winter months since little data is currently available regarding winter bat activity in BC.

2.0 METHODS

Methods applied and steps taken to carry out activities to meet project objectives listed in **Section 1.1** are detailed below.

2.1 Development of Safe Working Procedures

The project developed a health and safety plan for safe execution of surveys in consultation with BC Parks and Metro Vancouver which was used to inform safe work practices for volunteers in addition to Hemmera and other project staff.

2.2 Permissions and Consultation with Land Managers and Indigenous Groups

We carried out consultation with indigenous groups with overlapping traditional territory, relevant BC parks staff, and other land managers and owners to discuss and coordinate access to transect routes for surveys.

2.2.1 Indigenous Consultation

We reached out to indigenous groups whose traditional territories overlapped with the project's study areas and solicited input regarding any additional areas of interest to these groups with respect to inventory of nocturnal wildlife. In the case that we were unable to establish a line of communication, we completed surveys and continued to reach out both directly (email) and indirectly (mutual acquaintances). We requested access to territories and permission to study our focal species in their territory. Indigenous groups and group members were also welcomed and encouraged to participate in any of the research.

2.2.2 BC Parks and Metro Vancouver Permissions

As some of the study areas are located within BC Provincial Parks in the South Coast and West Coast BC Parks regions, we applied for 2 Letters of Authorization (LoA), one for working in each of these 2 regions. Permission from BC Parks to complete this work was obtained prior to accessing the research locations either in LoA format or in the form of written consent. Correspondence with Metro Vancouver staff along with orientations for working within the Coquitlam Lake watershed were also required to gain permissions to access the Coquitlam River Watershed study area.

2.3 Outreach and Education

Collaboration, outreach, and education was managed through Pacific Megascops Research Alliance (PMRA). An email account and website were setup to communicate with and reach out to collaborators and to the general public (pacificmegascops.org). PMRA used social media, word of mouth and emails to invite volunteers and potential collaborators to become involved.

PMRA created and planned presentations for different age groups and interests and reached out to indigenous groups, local non-government organizations (NGO) universities, and nature clubs, to offer free presentations focused on WESOke conservation and research.

2.4 Call Playback Protocol and Passive Acoustic Data Processing Method Refinement

The project proposed development of new survey methods consistent with historical standards (Hausleitner 2006; RIC 2001). Protocols for ARU siting and deployment were refined, formalized, and posted publicly to the PMRA website. A method for rapid scanning and processing of ARU data was developed to provide standardized and more efficient processing of passive acoustic owl data. See **Section 2.6** for the details of the rapid scanning ARU data processing method.

2.5 Surveys and Monitoring

Monitoring methods included active surveys for owls (call playback surveys (CPB)) and bats (Echo Meter Touch 2 Pro (EMT)) as well as passive acoustic monitoring with autonomous recording units (ARU), passively recording sonic frequencies (frequencies that humans can hear) for birds and ultrasonic frequencies (frequencies higher than what humans can hear) for bats. Active surveys involve a person present at the time of surveying (CPB and EMT) and passive surveys involve ARUs recording predefined times and frequencies of sound that are later reviewed for species identification (**2.5.1**, **2.5.2**, **2.5.3** and **2.5.4**).

Survey methods applied to meet the project objectives for owl monitoring were developed by PMRA (see **Appendix A**) using guidance from Resource Inventory Standards Committee (RIC) protocols from the province of BC (Hausleitner 2006; RIC 2001), from Nocturnal Owl Survey protocols from Birds Canada (Birds Canada 2020), and based on the results of analyses conducted by Hemmera (Hemmera 2017) and information regarding territory size and detection distance from other studies (Turgeon et al. 2017; Davis and Weir 2010; Deal and Lamont 1996).

Surveys for bats using EMTs were paired with owl surveys at a sub-set of transects and at a sub-set of stations using ultrasonic ARUs where resources and accessibility permitted. Ultrasonic acoustic monitoring for bats followed standardized recording schedules for passive acoustic monitoring for North American bat surveys (Lausen et al. 2020) and the same schedule as call playback surveys for active EMT monitoring.

2.5.1 Call Playback Surveys for Owl Monitoring

Surveys of owls using CPB methods were conducted in accordance with methods developed by PMRA (**Appendix A**). The survey methods detailed in **Appendix A** were developed for this research and to be compatible with a broad variety of owl survey objectives. They have been hosted at pacificmegascops.org and are available for general use with associated training information.

2.5.2 EMT Surveys for Bat Monitoring

Active acoustic monitoring using handheld EMT bat detectors (Wildlife Acoustics Inc.) with Kaleidoscope Pro Auto-ID classifiers, were conducted at the same time and location as call playback surveys for owls along some transects. An experienced bat biologists manually vetted the species ID recorded during the surveys when possible. When it was not possible to identify the species on site, the calls from the active acoustic monitoring were manually vetted by an experienced bat biologist using AnalookW (Titley Electronics, Ballina, NSW, Australia).

2.5.3 Sonic ARU Surveys for Owl Monitoring

Passive acoustic monitoring can be effectively used to study animals that produce discernable sounds. It is particularly powerful as a tool for studying low detectability (e.g., slow to respond, infrequent vocalizations, large home ranges), nocturnal species, in regions with limited access and unpredictable weather (Shonfield and Bayne 2017)**.** Because this study encountered all of these obstacles, we deployed ARUs to both support and expand on CPB surveys.

Sonic ARUs were programmed to record in sessions of 3 minutes every 15 minutes, from 1.5 hours before sunset until 1.5 hours after sunrise for a minimum of one week (i.e., 7 nights). Beyond being predominantly nocturnal, the nightly vocal activity of WESOke, and most other owls in coastal BC, has not been well documented. We recorded throughout the night to both account for this, and to fill this data gap in vocal behaviour. We paused recordings for 12 minutes between each session to save on battery and memory space and because sufficient data could be obtained with this schedule to meet study objectives. We recorded into the diurnal portions of the day to ensure the data obtained could also be used by researchers studying diurnal species.

ARUs were fixed to trees of less than 10 cm in diameter (to reduce sound masking) at 1.5 meters (m) from the ground. Microphone gain was set to 12.5 decibels (dB) and preamp to 26 dB. The sampling rate was set at 24 kilohertz (kHz). The high-pass filter was turned off and recordings were not compressed. Microphones were tested with an audio meter (Extech model 407744) before field deployment to ensure sensitivity was within the optimal range.

2.5.4 Ultrasonic ARU Surveys for Bat Monitoring

Bioacoustics technology is an efficient, non-invasive tool for examining bat activity patterns and species diversity over long durations and provides a metric of bat activity based on the number of bat calls recorded within approximately 50 m of the detectors (Fraser et al. 2020; Lausen 2016). Acoustic data can confirm the presence of individual species and document any changes in bat species diversity between years. Acoustic data can also provide information to infer bats' habitat use.

Ultrasonic ARUs were deployed and recorded data for a minimum of one week. Nightly acoustic sampling was scheduled from dusk to dawn, starting 30 minutes before sunset and finishing 30 minutes after sunrise as per North American Bat Monitoring Program (NABat) standard protocols. The bat detectors were programed to record acoustic calls in full spectrum format with a high-pass filter of >16 kHz, gain of 12 dB and a sample rate of 256 kHz. All ARUs were fitted with omnidirectional SMM-A1 microphones recording at a sample rate of 16 kHz and gain of 0 dB. The microphones were installed approximately 2 m above ground and were set up to record acoustic data from 30 minutes before dusk to 30 minutes after dawn. Microphones were deployed and directed away from features that introduce clutter to avoid any noise or reflection from understory vegetation or ground and rocks. As done for sonic ARUs, microphones were tested with an audio meter for ultrasonic microphones before field deployment to ensure sensitivity was within the optimal range.

One of the limitations of bioacoustics for bat species is that their echolocation calls, especially those from Myotis species, can be difficult to precisely identify to species due to high variability within species (Obrist et al. 2004) and the overlap in call characteristics among species. MYLU, Western Long-eared Myotis (*Myotis evotis*) and Long-legged Myotis (*M. volans*) must in some circumstances be treated as a group because of the overlap in call characteristics. The same can be true for Big Brown Bat (*Eptesicus fuscus)* and Silver-haired Bat (*Lasionycteris noctivagans*).

2.6 Processing and Summarization of Survey Data

In accordance with the year one schedule approved for this HSP project, only sonic ARU bioacoustics data from 2021 were processed and summarized for this project. The 2021 sonic ARU data were first processed using long duration false-colour spectrograms (Towsey et al. 2021) to select 3 to 5 nights dispersed evenly throughout the deployment period where low background noise (e.g., wind, rain, construction) allowed for effective visual scanning for target species. Spectrogram visualization images of one minute in length and between zero and 6000 kHz in frequency range, were then created using Sound eXchange (SoX; http://sox.sourceforge.net/). These images were then visually scanned for all owls present in coastal BC, with a focus on those found in **Table 2**. Both the scanning and background noise assessment were completed using Timelapse (https://saul.cpsc.ucalgary.ca/timelapse/) image processing software for camera traps. This process involves only free, opensource software and code. Though it is not currently available as a single set of code online, it is available upon request (pacificmegascops@gmail.com) and will soon be available on github (https://github.com/jjkenned).

The number of nights ARUs were deployed was recorded at each station and the results of acoustic data analyses were assessed as present or not detected for owl and bat species. This type of passive acoustic monitoring data cannot consistently distinguish between individual birds or bats to provide estimates of density at ARU monitoring stations.

2.7 Management and Compilation of Current and Historic Survey Data

Records from 2021 CPB and ARU surveys, as well as CPB and EMT records from 2022 surveys, were screened and vetted for accuracy. Any outlying records (e.g., high counts, rare species) were verified by confirming with field staff and, where possible, by reviewing data sources such as hardcopy data forms, survey notes, and ARU recordings. Once these quality assurance (QA) measures were applied to identify anomalous species or counts, data from the current year were entered into a relational database management system (Microsoft Access). These data have been stored on local hard drives and converted to Bird Monitoring Data Exchange (BMDE) format compatible with Birds Canada's NatureCounts database (https://www.birdscanada.org/naturecounts/default/main.jsp) where it will be managed and made accessible to the public indefinitely. Transferring and recording schedules were validated using custom R script (R Core Team 2021). All audio data have been archived for any more detailed or alternative analyses desired or requested at a later.

Table 2 Species and Subspecies Targeted in Surveys and Federal Species at Risk Status

Taxa	English Name	Latin Name	Species Code	Federal SARA[1] Status
Bats	Townsend's Big-eared Bat	*Corynorhinus townsendii*	COTO	Not Listed[2]
	Hoary Bat	*Lasiurus cinereus*	LACI	Not Listed
	Silver-haired Bat	*Lasionycteris noctivagans*	LANO	Not Listed
	Big Brown Bat	*Eptesicus fuscus*	EPFU	Not Listed
	Yuma Myotis	*Myotis yumanensis*	MYYU	Not Listed
	Californian Myotis	*Myotis californicus*	MYCA	Not Listed
	Long-legged Myotis	*Myotis volans*	MYVO	Not Listed
	Little Brown Myotis	*Myotis lucifugus*	MYLU	Endangered
	Long-eared Myotis	*Myotis evotis*	MYEV	Not Listed
	Mexican Free-tailed Bat	*Tadarida brasiliensis*	TABR	Not Listed
	Keen's Myotis	*Myotis Keenii*	MYKE	Data Deficient
Owls	Coastal Western Screech-Owl	*Megascops kennicottii kennicottii*	WESOke	Threatened
	Barred Owl	*Strix varia*	BADO	Not Listed
	Great Horned Owl	*Bubo virginianus*	GHOW	Not Listed
	Northern Pygmy-Owl	*Glaucidium gnoma*	NOPO	Not Listed
	Vancouver Island Pygmy-Owl	*Glaucidium gnoma swarthi*	NOPOsw	Not Listed[2]
	Northern Saw-whet Owl	*Aegolius acadicus*	NSWO	Not Listed

Note: [1]Species at Risk (SARA) - Species identified under Schedule 1 of the Species At Risk Act. [2]Provincially Blue listed in British Columbia.

3.0 RESULTS

3.1 Development of Safe Working Procedures

The Health and Safety Plan used in conducting this research can be found in **Appendix B**. This plan was developed from a remote research Hemmera Health and Safety Plan template and provided to Metro Vancouver and BC Parks for review and modifications. Essential aspects include first aid equipment, check-in protocols, inReach (Garmin) messaging devices and personal protective equipment that is appropriate for remote forest researcher.

For collaborators and volunteers who were not directly involved with HSP funded aspects of this research we provided field work safety recommendations. This included many of the same aspects as the project Health and Safety Plan in **Appendix B**, including bringing an inReach and setting up a check-in schedule where available, using reflective equipment if on a road with any traffic, bringing a first aid kit and going in groups when conducting surveys. Wildlife deterrents (e.g., bear spray) were also recommended when volunteers were planning on leaving the road for prolonged periods. No incidents were reported during the research activities for this project.

3.2 Permissions and Consultation with Land Managers and Indigenous Groups

Verbal, and later written, approval of the surveys was provided by Erica McClaren for work conducted within BC Provincial Parks on Vancouver Island, and a Letter of Authorization was provided by Joanna Hirner for surveys conducted within BC Provincial Parks in the South Coast region (**Appendix C**) (e.g., deployment of ARUs within Golden Ears Provincial Park). Following orientations and consultations with Metro Vancouver to obtain permissions and meet safety criteria required to work in the Coquitlam River Watershed, written approval was also provided by Metro Vancouver to conduct surveys in this area and gate passes were activated to provide access.

A presentation was done for the Maa-nulth Wildlife Council to request collaboration and permission for land access from nations within the Maa-nulth First Nations Final Agreement. This was successful in presenting proposed work and establishing communication with some nations along Western Vancouver Island. For nations where we were unable to make contact, we are continuing to reach out and establish collaborative and reciprocal relationships. Following up from this meeting, at least one site of interest (Henderson/Hucuktlis Lake) was identified by Ryan Anaka, Director of Lands and Resources of the Uchucklesaht Tribe Government, as a site of interest to that nation. Efforts will be made to include this as a new study area in subsequent years.

Results are not presented in this report for the Wolf Lake transect near Comox and within the Strathcona Provincial Park & Puntledge Watershed study area (49.76, -125.17). This land is privately owned by Mosaic Forest Management (https://www.mosaicforests.com/) and we are in communication with Mosaic to come to an agreement regarding use of the data to inform habitat associations and population trends of WESOke while maintaining the privacy of this proprietary information. All other surveys were completed in Provincial Parks or on crown land.

3.3 Outreach and Education

PMRA is actively involved in several WESOke research collaborations and has hosted and participated in presentations, workshops, and conferences since the end of the HSP granting cycle. **Table 3** provides an overview of outreach and collaboration associated with this project. All outreach and education activities were conducted with a focus on learning about WESOke their habitat and conservation concerns.

Workshops were designed to teach basic owl and bat survey methods. This involved an overview of WESOke and bat ecology, how to conduct playback surveys, how to use and interpret EMTs, how to program and deploy/retrieve an ARU and the basics of interpreting sonic and ultrasonic ARU recording data. Working with the Friends of Cortes Island (FOCI) we were able to train 10 people in the use of ARUs and how to conduct the standard WESOke surveys designed by PMRA. This direct engagement led to engagement of others across the Discovery Islands, BC and several other surveys were conducted as a result.

Presentations, though audience specific, generally involved some basic information on WESOke ecology and behaviour, our current understanding of WESOke ecology and plans for future research. Some of these presentations have involved emphasis on how WESOke relate to, and may respond to, climate change and how passive acoustic monitoring can be used to facilitate collaboration between species at risk researchers.

Collaborations have generally involved assistance with deploying ARUs or filling geographic data gaps that, without help, this study would not be able to fill on its own. The exception to this is the collaboration with Birds Canada, who is working with us on developing and managing a database for WESOke and provided 20 ARUs to study WESOke and assisted in surveys by retrieving ARUs and completing survey transects.

Table 3 Outreach and Education Completed between April 2021 and March 2022

Type of Outreach	Organization (Individuals)	Date	Topic	Number of People Engaged
Meeting – Propose future collaboration	Maa-nulth Wildlife Council	7-Apr-21	Presenting proposed WESOke surveys with hopes of collaboration and territory research permissions	15
Collaboration – Meetings and consultation	UBC Okanagan MSc Student (Megan Buers)	Sept 2021-Present	Provide input on research being conducted on WESOke in Okanagan (ARUs, playback surveys, behaviour etc.)	1
Collaboration – Data management	Birds Canada (Catherine Jardine)	Sept 2021-April 2022	Building a database for keeping WESOke survey data and a direct data entry system	1
Collaboration – Coquitlam River Watershed Surveys	Metro Vancouver	Nov 2021 - Mar, 2022	Facilitating access and collaborating with Metro Vancouver Staff (Austin Bauer) on completing surveys	4
Workshop – Owl and bat survey methods	WildResearch	19-Jun-21	How to conduct surveys in person and with ARUs	4
Collaboration – Borrowing ARUs and volunteering for surveys	Birds Canada (Remi Torrenta)	Jan 2022-Present	Surveys planned and completed in the Tsitika River Watershed with Birds Canada ARUs and with help from Remi Torrenta	2
Blog posts – History of PMRA and current research	General public – pacificmegascops.org	Jan 2022 – present	Updates on research being conducted by PMRA and outreach to engage and encourage other researchers and the general public	749
Collaboration – Making better ARUs	Vancouver Island University (Michael Lester, Pablo Jost)	Jan 2022 - Present	Creating a more consumer friendly research product based on the AudioMoth and test with WESOke	2
Collaboration – Assisting Prov and Federal government biologists	ECCC, Madrone, FLNRORD	Dec 2021 - Feb, 2022	Assisting in survey design to fill data gaps in southern Vancouver Island old growth	4

Type of Outreach	Organization (Individuals)	Date	Topic	Number of People Engaged
Collaboration – Assisting Prov government biologists	FLNRORD (Jenna Cragg)	Feb – Mar 2021	Assisting in site selection, survey design and survey methods	3
Workshop – How to conduct owl surveys	University of Victoria Birding Club	31-Mar-22	Owl survey methods training session for students interested in doing owl surveys	3
Collaboration – ARUs in Golden Ears Provincial Park	BC Parks Staff (Riley Kennedy)	3-Mar-22	Teaching use of ARUs and help with deployments	1
Workshop – Owl and bat survey methods	WildResearch	24-Feb-22	How to conduct surveys in person and with ARUs	10
Presentation – PMRA research	Edmonton Nature Club	24-Feb-22	WESOke research being conducted by PMRA	30
Meeting - plan future collaboration	Uchucklesaht Tribe (Ryan Anaka, Wilfred Cootes)	11-Feb-22	ARU based Wildlife Surveys with PMRA and Uchucklesaht	2
Workshop – How to do Owl surveys	Friends of Cortes Island	9-Feb-22	Training on owl survey methods for FOCI and other collaborators across the discovery islands. Meetings and collaborations are continuing	10
Meeting – Permission to conduct surveys	BC Parks, Kwantlen Nation	7-Feb-22	Meeting with BC Parks & Kwantlen First Nation to discuss study objectives, knowledge sharing, and opportunities for participation in Golden Ears Prov Park surveys	6
Meeting – Planning collaboration	BC Parks Foundation (Kate Le Souef)	26-Jan-22	Planning collaboration between PMRA and BC Parks Foundation for future surveys on their land	1
Meeting – PMRA research	Mosaic Forest Products (Sue McDonald)	26-Jan-22	Progress of forestry WESO research and communication regarding possible sharing of data and collaboration down the road	4
Presentation – PMRA research	Simon Fraser University, Les Ecologistes Seminar	20-Jan-22	WESO conservation and research across BC	20

3.4 Call Playback Protocol and Passive Acoustic Data Processing Method Refinement

The call playback protocol developed and used for this project can be found in **Appendix A** and at pacificmegascops.org, where it is publicly available.

The rapid visual scanning process, detailed in **Section 2.6**, was successfully refined and tested for use in this project and for easy adaptability to other target species. This method was used to scan for all owl species. Other species frequently observed on these recordings were Ruffed Grouse (*Bonasa umbellus*), Sooty Grouse (*Dendragapus fuliginosus*) and Pacific Chorus Frog (*Pseudacris regilia*). As stated in **Section 3.5.2**, Band-tailed Pigeon was also recorded. The method was also effective in identifying and removing recordings of inclement weather and other sources of background noise.

3.5 Surveys and Monitoring

Monitoring results from the spring of 2021 and early spring 2022, including survey efforts and summaries of detection data, are provided below. Results are summarized for ARU survey data from 2021, as well as CPB and EMT survey data from both years and presented within the context of the level of effort for each survey transect and the proportion of survey stations, within each transect, at which the target species were observed (i.e., naïve occupancy). Analyses required to account for incomplete detection, which would allow for comparisons across study areas and habitat types, have not yet been conducted and are pending subsequent funding and/or volunteer efforts. Similarly, results from ARU data collected in 2022 are pending funding for data processing.

3.5.1 Survey Effort and Timing

During the spring of 2021 (April and early May), the winter of 2020/2021 (December, January, and early February), and the spring of 2022 (late February and March), surveys were conducted along 15 transects and within 5 of the 6 study areas initially proposed for the research (**Table 1**, **Table 4**). The only study area proposed for the project that was not surveyed in 2021 or 2022 was Schoen Lake, which could not be accessed in March 2022 due to tree fall and lack of road maintenance. A CPB survey was completed here by collaborators in April 2022 and further surveys are planned for this location in subsequent years pending further funding.

The study areas listed in **Table 1** in the Vancouver Island and South Coast regions of BC are illustrated in **Figure 1** for surveys conducted in 2021, and in **Figure 2** and **Figure 3** for surveys conducted in 2022 in the Vancouver Island and the South Coast regions, respectively. Of the 10 total study areas, 5 are within Federal Provincial Territorial Priority Places[2]. Photos of habitat within the study areas are included in **Appendix D**.

Not including the passive acoustic monitoring locations from Wolf Lake, ARUs were deployed at 8 locations and recorded a total of 155 nights and 1,374 3-minute recording sessions in 2021. These data were processed as part of a collaboration between PMRA, Madrone Environmental Services (https://www.madrone.ca/), the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD) and ECCC. These recordings were processed by Tania Tripp with Madrone Environmental Services under a contract from ECCC. In 2022, ARUs were deployed at 68 locations and recorded for more than 1,800 nights. In accordance with the project schedule, these data have yet to be processed.

A total of 9 call playback transect visits were completed during the spring of both 2021 and 2022 (through March 31, 2022) from 4 transects in 2021 and from 5 transects in 2022 (**Table 4**). Additional visits conducted at these and other transects in April of 2022 are reported in **Appendix E**.

[2] See https://www.canada.ca/en/services/environment/wildlife-plants-species/species-risk/pan-canadian-approach.html#toc3.

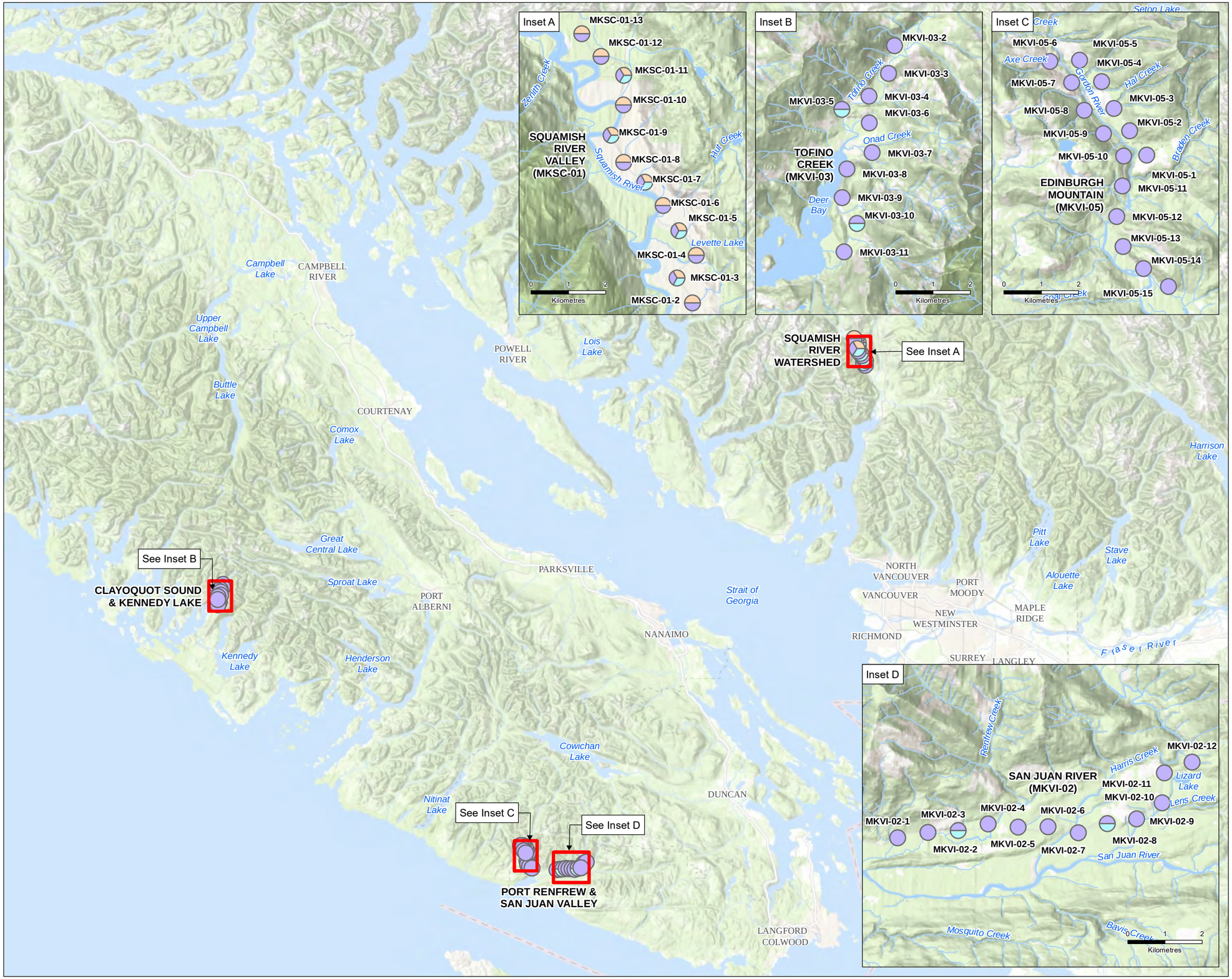
Table 4 Number of Call Playback (CPB) Survey Visits, Echo Meter Touch (EMT) Bat Survey Visits and Number of Ultrasonic and Sonic Autonomous Recording Units (ARU) Deployed at Each Transect between April 2021 and March 2022

Study Area Name	Transect Name	CPB		S-ARU		EMT		U-ARU	
		2021	2022	2021	2022[2]	2021	2022	2021	2022[2]
Carmanah Walbran	Carmanah Walbran - Roadside		2		7		2		4
	Carmanah Walbran - Remote				14				
Ballenas Island	Ballenas Island				4				
Strathcona Provincial Park	Strathcona – Buttle Lake		2		3		2		4
Puntledge River Watershed	Wolf Lake[1]	3[1]		6[1]					
Golden Ears Provincial Park	Gold Creek to Fergusson Lake				8				
Clayoquot Sound & Kennedy Lake	Tofino Creek	2		2					
Port Renfrew & San Juan Valley	San Juan River	2		1					
	Edinburgh Mountain	2							
Schoen Lake[1]	Schoen Lake - Roadside[1]								
Coquitlam River Watershed	Coquitlam Lake - East		3		8		3		4
Squamish River Watershed	Squamish River Valley	3	1	5	4	2	1		
Tsitika River Watershed	Tsitika River - Main				8				
	Tsitika River - Lower		1		4				
	Tsitika River - Upper				8				
Total ARU Locations and CPB Visits		**9 (3[1])**	**9**	**8 (6[1])**	**68**	**2**	**8**	**0**	**12**

Note: [1]Data unavailable due to data privacy or access constraints. WESOke – Coastal Western Screech-Owl (*Megascops kennicottii kennicottii*).[2]Includes deployments in December 2021 in addition to 2022 data.

Coastal Western Screech-Owl Studies and Nocturnal Wildlife Inventory within Old Growth Ecosystems of Southwest BC

Spring 2021 Nocturnal Wildlife Inventory Study Areas, Transects, Stations, and Survey Types



Legend

- Nocturnal Wildlife Survey Station
- EchoMeter Touch (Active Bat Survey)
- Call Playback (Active Owl Survey)
- Sonic ARU (Passive Owl Survey)
- Watercourse
- Waterbody

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.
3. Study Area names are labeled in the main figure and Transect names are labelled within insets.
4. Survey station nomenclature defined as XXYY-##-##, where XX = Project ID (MK - Megascops kennicottii); YY-## = Transect ID including a Region Code (YY = SC - South Coast or VI - Vancouver Island) followed by a two digit number unique to each region; second set of numbers (##) = Station ID uniquely numbered for each transect.

Sources

- Contains information licensed under the Open Government Licence(s) - British Columbia
- Basemap: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

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Coastal Western Screech-Owl Studies
and Nocturnal Wildlife Inventory
within Old Growth Ecosystems of Southwest BC

Winter and Spring 2022 Nocturnal Wildlife Inventory Study Areas, Transects, Stations, and Survey Types - Vancouver Island

Inset A

Inset B

Inset C

Inset D

Inset E

See Inset A

See Inset B

See Inset C

See Inset D

See Inset E

TSITIKA RIVER WATERSHED

TSITIKA RIVER - LOWER (MKVI-24)

TSITIKA RIVER - MAIN (MKVI-23)

TSITIKA RIVER - UPPER (MKVI-22)

STRATHCONA - BUTTLE LAKE (MKVI-08)

STRATHCONA PROVINCIAL PARK

SQUAMISH RIVER WATERSHED

COQUITLAM RIVER WATERSHED

GOLDEN EARS PROVINCIAL PARK

BALLENAS ISLAND

BALLENAS ISLAND (MKBI-01)

CARMANAH WALBRAN - ROADSIDE (MKVI-06)

CARMANAH WALBRAN - REMOTE (MKVI-04)

CARMANAH WALBRAN

MKVI-24-4
MKVI-24-5
MKVI-24-6
MKVI-24-7
MKVI-24-8
MKVI-24-9
MKVI-24-10
MKVI-24-11
MKVI-24-12

MKVI-23-9
MKVI-23-8
MKVI-23-10
MKVI-23-7
MKVI-23-5
MKVI-23-6
MKVI-23-4
MKVI-23-3
MKVI-23-2
MKVI-23-1
MKVI-22-8
MKVI-22-7
MKVI-22-6
MKVI-22-5
MKVI-22-4
MKVI-22-3
MKVI-22-2
MKVI-22-1

MKVI-08-10
MKVI-08-9
MKVI-08-8
MKVI-08-7
MKVI-08-6
MKVI-08-5
MKVI-08-4
MKVI-08-3
MKVI-08-2
MKVI-08-1

MKBI-01-1
MKBI-01-2
MKBI-01-3
MKBI-01-4

MKVI-04-8
MKVI-04-7
MKVI-04-6
MKVI-04-15
MKVI-04-14
MKVI-04-13
MKVI-04-5
MKVI-04-12
MKVI-04-4
MKVI-04-10
MKVI-04-3
MKVI-04-9
MKVI-04-2
MKVI-04-1
MKVI-06-12
MKVI-06-11
MKVI-06-10
MKVI-06-9
MKVI-06-6
MKVI-06-8
MKVI-06-7
MKVI-06-4
MKVI-06-3
MKVI-06-2
MKVI-06-1

Catherine Creek
Tsitika River
Tsitika Lake
Russell Creek
Aldworth Creek
Cox Creek
Downton Lake
Buttle Lake
Karst Creek
Campbell River
Ralph River
Shepherd Creek
Cribs Creek
Coal Creek
Carmanah Creek

Woss Lake
Vernon Lake
Campbell Lake
CAMPBELL RIVER
Upper Campbell Lake
POWELL RIVER
Lois Lake
Buttle Lake
COURTENAY
Comox Lake
Great Central Lake
Sproat Lake
PORT ALBERNI
Kennedy Lake
Henderson Lake
Strait of Georgia
NORTH VANCOUVER
VANCOUVER
PORT MOODY
Pitt Lake
Alouette Lake
Stave Lake
Nitinat Lake

0 1 2 Kilometres

0 0.2 0.4 Kilometres

Legend

- Nocturnal Wildlife Survey Station
- EchoMeter Touch (Active Bat Survey)
- Call Playback (Active Owl Survey)
- Sonic ARU (Passive Owl Survey)
- Ultrasonic ARU (Passive Bat Survey)
- Watercourse
- Waterbody

Notes

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5. Survey station nomenclature defined as XXYY-##-##, where XX = Project ID (MK - Megascops kennicottii); YY-## = Transect ID including a Region Code (YY = SC - South Coast or VI - Vancouver Island) followed by a two digit number unique to each region; second set of numbers (##) = Station ID uniquely numbered for each transect.
6. Survey data from stations where U-ARUs were deployed include U-ARU and S-ARU data from December 2021 in addition to data from 2022

Sources

- Basemap: ESRI World Topographic Map
- Inset Basemap: ESRI World Topographic Map

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Page Size: 11" x 17"

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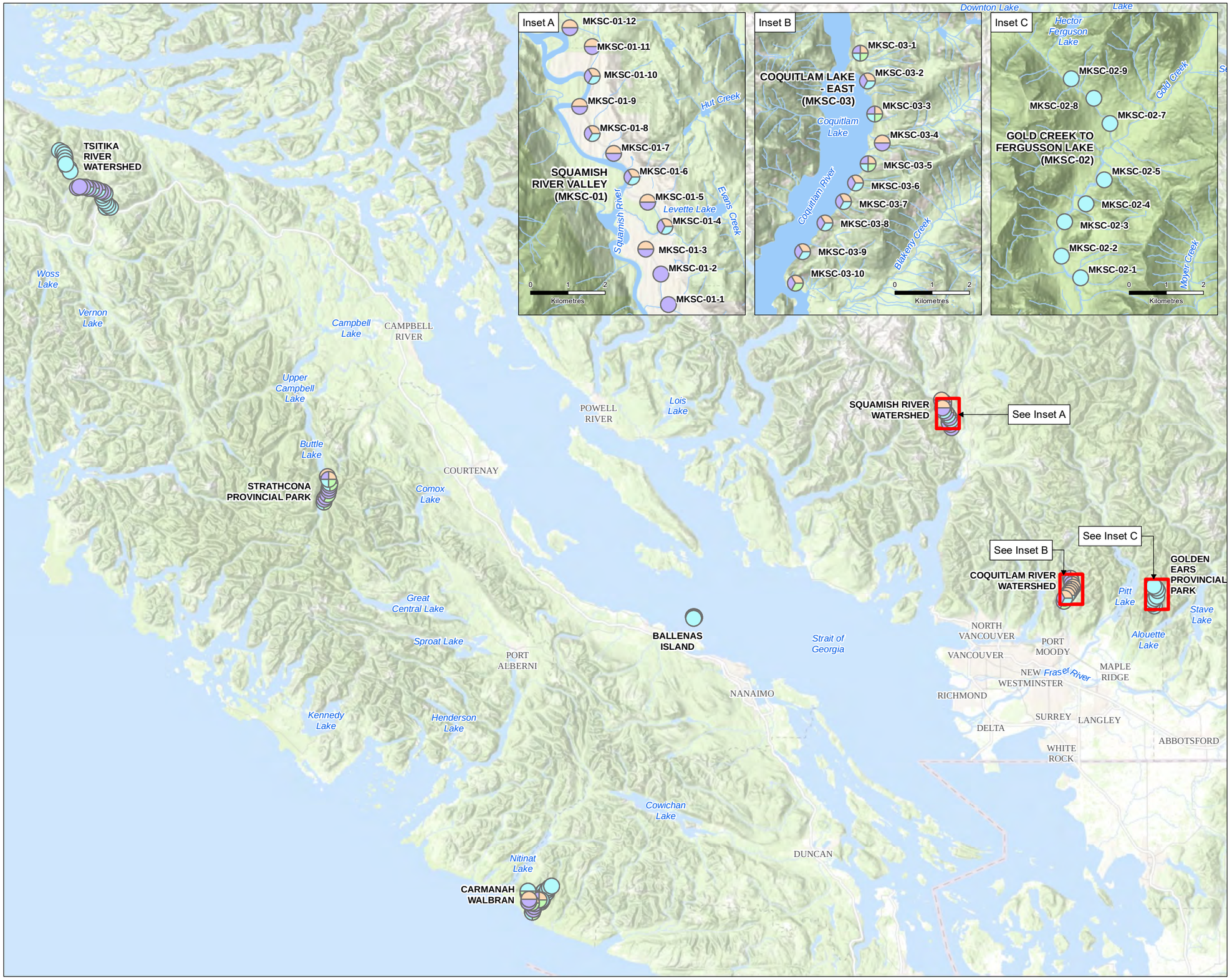
Coastal Western Screech-Owl Studies and Nocturnal Wildlife Inventory within Old Growth Ecosystems of Southwest BC

Winter and Spring 2022 Nocturnal Wildlife Inventory Study Areas, Transects, Stations, and Survey Types - South Coast



Legend

- Nocturnal Wildlife Survey Station
- EchoMeter Touch (Active Bat Survey)
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- Sonic ARU (Passive Owl Survey)
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- Watercourse
- Waterbody

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6. Survey data from stations where U-ARUs were deployed include U-ARU and S-ARU data from December 2021 in addition to data from 2022

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106381-01	Production Date: Nov 9, 2022	Figure 3

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3.5.2 Species at Risk

The following species at risk, as per *Species at Risk Act* (SARA) or Committee on the Status of Endangered Wildlife in Canada (COSEWIC) rankings, were observed during surveys, along with their at risk status and number of individuals observed:

- Coastal Western Screech-Owl – Threatened – 15 confirmed detections
- Little Brown Myotis – Endangered – 1 potential detection
- Band-tailed Pigeon (*Patagioenas fasciata*) – Special Concern – 2 incidental detections

3.5.3 Naïve Occupancy Rates for Owls

Naïve occupancy for a species is the proportion of potential territories in which the species is detected. For example, in this study, naïve occupancy is the proportion of stations on a transect in which WESOke was detected at least once across all visits during a single breeding season[3]. Naïve occupancy is typically lower than true occupancy because there are usually some owls present that are not detected during surveys. Naïve occupancy results also limit one's ability to compare across time and locations because it does not account for sources of variability in detection probability such as temperature, habitat type, or the presence of other owl species.

Naïve occupancy statistics were calculated for WESOke and 4 other owl species at 4 transects in 2021 and at 5 transects in 2022 (**Table 5**), and results are presented separately for data collected from call playback surveys and from ARU deployments. WESOke were detected during CPB surveys and/or ARU deployments at 4 of the 8 transects surveyed across 2021 and 2022. Naïve occupancy statistics are not available from passive acoustic surveys conducted in 2022 (data processing contingent on further funding and/or volunteer effort).

Table 5 Naïve Occupancy of Owls Recorded Using Call Playback (CPB) Surveys and Sonic Autonomous Recording Units (S-ARUs) Between April 2021 and March 2022

Transect Name	Species Code	Naïve Occupancy			
		2021		2022	
		CPB	S-ARU	CPB	S-ARU
Squamish River Valley	WESOke	0	0	0	Pending
	BADO	0.08	0.80	0	Pending
	NOPO	0	0.20	0	Pending
	GHOW	0	0	0	Pending
	NSWO	0.08	0.40	0	Pending
Coquitlam Lake - East	WESOke			0	Pending
	BADO			0.30	Pending
	NOPO			0	Pending
	GHOW			0	Pending
	NSWO			0	Pending

[3] Note that this assumes that (is only true if) station spacing is equal to or greater than territory sizes or the average distance between nests such that there is no more than one station per territory on average.

Transect Name	Species Code	Naïve Occupancy			
		2021		2022	
		CPB	S-ARU	CPB	S-ARU
San Juan River	WESOke	0.08	0		
	BADO	0.08	0		
	NOPO	0	0		
	GHOW	0	0		
	NSWO	0	0		
Tofino Creek	WESOke	0.50	1.00		
	BADO	0	0		
	NOPO	0	0		
	GHOW	0	0		
	NSWO	0	0		
Carmanah Walbran - Roadside	WESOke			0.20	Pending
	BADO			0	Pending
	NOPO			0	Pending
	GHOW			0	Pending
	NSWO			0	Pending
Edinburgh Mountain	WESOke	0			
	BADO	0			
	NOPO	0			
	GHOW	0			
	NSWO	0			
Strathcona – Buttle Lake	WESOke			0	Pending
	BADO			0.20	Pending
	NOPO			0	Pending
	GHOW			0	Pending
	NSWO			0	Pending
Tsitika River - Main	WESOke			0.10	Pending
	BADO			0.30	Pending
	NOPO			0	Pending
	GHOW			0	Pending
	NSWO			0	Pending

Note: Naïve occupancy – proportion of stations in transect where species were detected during at least one visit in the listed year. Naïve occupancy does not account for variation in detection rate, effort or landscape variables, and since visit effort was inconsistent across transects and years, these values are only meant to be used to track research progress. Naïve occupancy statistics may not be representative of the true occupancy values. Grey cells indicate no data collected or (for 2022 S-ARU data) not processed yet. Species codes found in **Table 2**. WESOke – Coastal Western Screech-Owl (*Megascops kennicottii kennicottii*), BADO – Barred Owl (*Strix varia*), NOPO - Northern Pygmy-Owl (*Glaucidium californicum*), GHOW – Great Horned Owl (*Bubo virginianus*), NSWO – Northern Saw-whet Owl (*Aegolius acadicus*). Pending – ARU data gathered and to be processed pending further funding.

3.5.4 EMT Bat Detections during Call Playback Surveys

While 3 surveys were planned for each transect where EMT surveys were conducted simultaneously alongside WESOke call playback surveys, only 2 such surveys were successfully completed at most sites due to technical issues and weather. The greatest number of bat call detections from EMT surveys conducted during call playback surveys for owls were from a Squamish River Valley 2021 survey conducted on April 17 and a Coquitlam Lake – East 2022 transect. Surveys from 2022 were all conducted prior to the end of March and resulted in fewer bat call detections along all transects except Coquitlam Lake - East. The most common bat detected was Hoary Bat (LACI - *Lasiurus cinereus*) with 11 total detections. There were only two potential Little Brown Bat detections (calls of 40k Myotis) from in the Squamish River Valley. All but one bat detection was recorded prior to midnight.

Table 6 Bat Call Detections by Species from Echo Meter Touch Surveys during Spring of 2021 and 2022

Transect Name (Year)	Visits	EPFU	LANO	EPFU/ LANO	LACI	MYCA	MYYU	40k[2]	Total
Squamish River Valley (2021)	n=2	1	5	0	0	2[1]	1[1]	1	11
Squamish River Valley (2022)	n=2	0	0	0	0	0	1	0	1
Carmanah Walbran – Roadside (2022)	n=2	1	0	2	0	0	0	0	3
Strathcona – Buttle Lake (2022)	n=2	0	0	0	0	3	0	0	3
Coquitlam Lake – East (2022)	n=3	0	2	5	11	1	0	0	22

Note: [1]One record is either MYCA or MYYU. [2]40k Myotis are either MYLU or MYVO. See **Table 2** for English and Latin names corresponding to species codes. Bat detections from stationary surveys may include multiple calls from the same individual. Total bat detections sum to more than individual species counts due to some records of *Myotis* sp. bats which could not confidently be assigned a species identification with the call signature recorded.

3.6 Processing and Summarization of Survey Data

As stated in **Section 3.5.1**, a total of 1,374 records of results from 3-minute-long ARU recordings were processed from bioacoustics data collected in 2021 from which survey results are reported in **Table 5**.

3.7 Management and Compilation of Current and Historic Survey Data

Management and compilation of current survey data was effectively accomplished, as described in **Section 3.5**. Recent and historic survey data have been gathered from 23 studies across coastal BC, 3 of which are either being collected or have already been formatted in a manner compatible with data collected for this project which are set-up for conversion to NatureCounts format through which they can be made publicly accessible indefinitely by Birds Canada.

Publicly available datasets were obtained from the provincial SPI database, additional datasets and spatial data describing survey efforts and locations were obtained from members of the Western Screech-Owl working group and previously existing NatureCounts datasets. Additionally, we met with owners of the largest proprietary data set for coastal screech-owls in BC (MOSAIC forest management) and started negotiations regarding data sharing. We also obtained a data sharing agreement with ECCC and have coordinated with Friends of Cortes Island (FOCI) and ECCC such that surveys carried out by these organizations or their contractors are conducted in accordance with PMRA protocols and the data obtained are directly compatible with the data collected for this HSP project. An interim database was developed to manage ARU and CPB data collected in 2021 and 2022 in Microsoft Access with referential integrity enforced. This database has been set up for queries that provide data in the Bird Monitoring Data Exchange (BMDE) format required for NatureCounts database and queries have also been established to provide data formatted for submission to provincial databases (i.e., wildlife species inventory (SPI) database). The existing Nocturnal Owl Survey (NOS) database managed by Birds Canada is already available through NatureCounts and data obtained from this project will be made available through the same data portal. Finally, a list of all bat and owl occurrences recorded during this project, including dates, times, and geographic coordinates, has been submitted to SPI.

4.0 DISCUSSION AND RECOMMENDATIONS

The overall objective of this project was to address gaps in actions identified within species recovery plans for WESOke and MYLU. The specific objectives of the project for WESOke were as follows:

- Gather and compile historical survey data
- Identify critical habitat
- Establish monitoring plan to collect the information necessary to assess threats of invasive species and monitor population trends.

The results obtained are discussed below within the context of these monitoring objectives and prior understanding regarding owl occupancy rates and habitat associations. As per the objectives described in **Section 1.1**, the project has taken important steps in improving our understanding of WESOke distribution and habitat associations in BC. By gathering and compiling all available survey data, we will also be able to bring these data into a location and format to facilitate easy access and interpretation by researchers exploring distribution, population, trend and habitat association questions relating to WESOke. Because so many different methods have been used in historical WESOke surveys, formatting these data has taken longer than expected and the formatting process is on-going. However, reviewing these data has allowed us to explore and find solutions to issues and inconsistencies with survey methods used for this species and to design and communicate the new set of protocols (**Appendix A**) that resolve some of these historical inadequacies and will allow this study's dataset to be analyzed in conjunction with the maximal number of historical datasets.

4.1 Development of Safe Working Procedures

The Health and Safety Plan worked well for all participants. Volunteers, Hemmera employees and collaborators all remained safe during the field work. Not taking this safe season for granted, PMRA will be adapting the health and safety plan developed for this project and will require volunteers and collaborators to review the document and have it with them in the field when conducting surveys. Due to the remote nature of the work, we have decided to build on the safety protocols we have now to make sure that future research minimizes the potential for health and safety incidents.

4.2 Permissions and Consultation with Land Managers and Indigenous Groups

We were successful in meeting and engaging with several indigenous groups during this project (**Table 3**) and are continuing to work on establishing long term collaborative relationships with indigenous groups including some we were unable to engage with this year.

Engaging with the Kwantlen First Nation in discussions regarding survey area permission and access was very successful in accomplishing both our indigenous engagement and consultation goals. Interest in exploring the results of this work was expressed by Kwantlen Nation representatives. Now that the 2022 spring data has been collected, we will be able to engage further with these individuals and provide collaborative opportunities for those interested in taking part. We will also be able to present results to those interested.

4.3 Outreach and Education

Collaborations have been essential in making this project successful and setting it up for success in the future. Without the numerous willing collaborators (**Table 3**) this project would have been much more restricted in scope. Birds Canada has been instrumental in helping us build a database for WESOke surveys completed across BC. This will mean that future collaborators and other interested parties will be able to easily access, collect and share WESOke survey data across BC. In addition to this, Birds Canada provided 20 ARUs for passive bioacoustics surveys within the Tsitika River Watershed study area.

We were also able to help the Friends of Cortez Island (FOCI) in learning how to conduct passive acoustic monitoring and playback surveys. Starting in the winter of 2022, our continued support of their work has meant that we can help them collect the highest quality ARU and call playback data possible in order to better understand owl distributions in the Discovery Islands. The surveys conducted in the February and March 2022 field season have filled a large data gap in that region of BC.

Presentations, workshops and conferences have made up most of the outreach and education for this project. This outreach was successful in engaging a number of collaborators involved in different interest groups. Researchers and students were particularly interested in taking part in this initiative.

4.4 Call Playback Protocol and Passive Acoustic Data Processing Method Refinement

The call playback survey methods developed by PMRA were repeatedly trialed and refined over the past year of this project (**Appendix A**). Feedback from volunteers and researchers with varying experience in bird surveys was instrumental in designing and refining a user-friendly method that is both easy to learn and gathers the data required to meet various study objectives, including our own.

Much like the call playback methods, the rapid visual scanning protocol (**Section 4.2**) was tested repeatedly on several species, including owls, grouse, amphibians, and songbirds. One particularly good way to engage volunteers and provide valuable training to biologists, is to train volunteers to use this method. Multiple observers used this method to process the ARU data from 2021. This allowed for effective comparison between multiple observers and provided further feedback on process development. This work is continuing as it will be used by both paid and volunteer researchers to process large volumes of nocturnal wildlife data over the summer of 2022.

4.5 Surveys and Monitoring

In order to compare passive acoustic and call playback monitoring methods, and to increase the amount of quality passive acoustic data available for WESOke and other species at risk, we increased the number of ARUs deployed across coastal BC in 2022.

- **2021** – 8 ARU locations and 155 recording nights
- **2022** – 68 ARU locations and more than 1,800 recording nights.

This increase in survey effort was made possible through collaboration, volunteer efforts and HSP funding. The data obtained from 2021 ARU surveys and from all call playback surveys will be made available for use by researchers across coastal BC through the on-going collaborative efforts of PMRA and Birds Canada; however, processing of ARU data collected in 2022 and further summarization and analysis of these data are contingent on future funding and/or collaborations.

Regarding species at risk detections, WESOke was by far the most well documented species of conservation concern detected during field studies. The single potential observation of MYLU could have been a Western Long-eared or Long-legged Myotis. It is important to note that the value of the data collected through the standardized protocols applied for WESOke surveys is far greater than the 15 occurrence records reported here. Every station where WESOke were not detected and the extent to which they were re-detected provide essential information for understanding the factors influencing their occupancy rates and detection probabilities.

4.5.1 Preliminary Results from WESOke Surveys

Preliminary results suggest that continuing this research will provide answers to pressing conservation questions and lead to separate ecological and behavioral observations to further our understanding of this species. The following are a select set of examples:

WESOke was absent from all call playback surveys in the south coast region, however one individual was observed foraging on the side of the road within the Coquitlam Lake - East transect multiple times on one night. This individual was between stations, so was not detected on the survey. Several WESOke were observed foraging along the side of the road in the Tsitika River Watershed and in Carmanah Walbran study areas during CPB surveys in 2022 and 2021 respectively. WESOke have been observed hunting Pacific Chorus Frogs along the side of roads in BC before (G. Monty, Pers. Comm.; https://ebird.org/checklist/S70232516). These observations may shed some light on some of the factors involved in the relatively high roadkill mortality rate in places like Pacific Rim National Park (I. Cruickshank, Pers. Comm.) and emphasizes the importance of individual movement tracking in exploring sources of mortality in areas adjacent to human activity.

WESOke and BADO were detected on several of the same transects (**Table 5; Appendix E**). Notably, the Tsitika River Watershed appeared to have relatively high occupancy rates of both species, which were even encountered at the same time on the same points. This is inconsistent with our hypothesis that BADO exclude WESOke from certain old growth habitats with comparatively low and sparse undergrowth, and instead suggests that there are some ancient forest habitats where these 2 species can coexist, at least temporarily. It would be interesting to investigate if both species persist in these areas in the future.

When interpreting naïve occupancy summary statistics, it is important to understand that variation in these values is influenced by survey method, effort, and conditions. Naïve occupancy statistics also do not account for differences in detectability across habitats, years, the presence of predators, or other factors. Thus, these statistics do not allow for like-to-like comparisons of occupancy across study areas, habitat types or years.

Additionally, for a number of logistical reasons not all surveys were conducted prior to the end of March for each transect. For the sake of comparison, naïve occupancy results including newly available data from April 2022 surveys are provided in **Appendix E**. As an example of how additional effort can influence estimates of naïve occupancy, occupancy in the Tsitika River Watershed increases 3-fold for WESOke when data from April 2022 surveys are included in the calculation (**Appendix E**).

Though the results presented in this report are preliminary, they are mostly consistent with our hypotheses involving the association of WESOke with ancient forest ecosystems. When the data from April 2022 and all incidental observations are considered, WESOke were detected at all ancient forest study areas from which data have been processed (**Table 1**). The one transect surrounded entirely by second growth forest (Squamish River Valley) is the only transect where WESOke was not detected either incidentally, on ARU recordings, or during call playback surveys.

We have also increasingly observed an association between WESOke and Cypress forests. As Western Redcedar and Yellow Cedar dominated ecosystems tend to have both plentiful nesting cavities, diverse foraging opportunities and high, dense undergrowth, that has been hypothesized to exclude predatory BADO, these ecosystems meet a lot of the requirements for WESOke. Depending on future funding, the ARU recording data collected in a variety of old growth forest types in 2022, in collaboration with a number of other ARU datasets, can be used to address the question of whether BC Cypress forests, and Western Redcedar in particular, should be considered critical habitat for WESOke.

While total surveys conducted met our sampling objectives, unpredictable weather often reduced the number of CPB visits at transects to less than 3. The lessons learned from dealing with poor and unpredictable weather are 2-fold: 1. Budget more resources for unpredictable weather events such that we do not assume 100% success for data collection during field visits; 2. Use ARUs rather than CPB surveys for remote sites or sites without local volunteers to allow for greater flexibility around weather constraints.

4.5.2 Preliminary Results from Bat Surveys

Few, if any, MYLU were documented during these surveys and most bat detections, were recorded in either late March or April and prior to midnight. It is therefore recommended that subsequent surveys of spring emergence are conducted during the latter half of March, or better still, in April and that surveys are conducted as early as possible during the night while still adhering to survey protocols (e.g., beginning no earlier than 30 minutes after sunset).

4.6 Processing and Summarization of Survey Data

Processing and analysis of these data is ongoing. The methods established in this research will help to make this work far more efficient in the future.

4.7 Management and Compilation of Current and Historic Survey Data

Management and compilation of historic survey data is part way through completion. All data is present, but in the process of being moved into a single format and single database. The diversity of this data was a major challenge, but also informative in understanding what needs to be done to make sure that analyses incorporate all such data.

All available reports from historic surveys were reviewed to assess the survey methods applied to determine each study's suitability for inclusion in a compiled dataset. For database compilation, suitable datasets are those with sufficient data for determination of detection probabilities (e.g., ARU data, repeated call playback surveys) which allow analyses to distinguish between differences in occupancy from differences in the rate at which owls are detected during surveys. Historic datasets determined to be suitable for inclusion in the compiled dataset will be re-formatted to conform to the NOS BMDE standard and provided to Birds Canada for inclusion in the Nature Counts dataset, but the effort required to accomplish this task ultimately exceeded the funding and volunteer resources available to complete this compilation task within the 2021 fiscal year. We have worked with Catherine Jardine at Birds Canada and have developed and tested an app-based data entry form on the NatureCounts app which is now complete and will be available for use by surveyors in 2023 to enter their data directly into the NatureCounts database. Volunteer efforts by PMRA will follow through on re-formatting the historical datasets obtained into BMDE format with continued support from Birds Canada. Both PMRA and Birds Canada are committed to completing this activity in fiscal 2022 regardless of additional funding.

5.0 ACKNOWLEDGEMENTS

We would like to thank the following indigenous nations and groups for allowing this project to be carried out on their traditional territories and for allowing us to ask the research questions of populations they have studied since time immemorial: Kwikwetlem Nation, Kwantlen Nation, Squamish Nation, and Katzie Nation from the south coast; K'ómoks Nation, Pacheedaht Nation, Ditidaht Nation, the Maa-nulth Wildlife Council and all participating nations, and Uchucklesaht Tribe. We would also like to thank the many volunteers who generously provided their time and resources to accomplish these surveys. These surveys were often remote and difficult to get to, either requiring long hikes through occasionally challenging terrain, long drives or both. Thank you to AJ Fedoruk, Annick Antaya, Austin T. Bauer, Becki LaForge, Braden Judson, Bruce Patrick Carron, Chris Bindernagel, Chris Currie, Courtney Lahue, Dana Gullison, Dave West, Don Kennedy, Emily Upham-Mills, Ian Cruickshank, Ian Thomas, Jack Bindernagel, Jason Straka, Kaiden Bosch, Liam Ragan, Pablo Jost, Quinn Klassen, Rease Larson, Riley Kennedy, Samuelle Simard-Provencal, Tanya Seebacher, Thor Veen, and, in particular, Tim Ennis for substantial contributions on behalf of the Comox Valley Land Trust. We would additionally like to thank Hemmera employees who went above and beyond to assist in this research. Jay Brogan, Felix Martinez-Nunez, Shae Turner volunteered their personal time to this research to make sure that it was done well. Much of this work would not have been possible without their help. Assistance from HSP funding has meant that this work could be done. Without this funding this study would have been very different and much less informative. We would also like to thank Birds Canada, in particular Catherine Jardine and Remi Torrenta for their continued support and collaboration. MFLNRORD biologists Jenna Cragg and Joël Gillis and ECCC biologist Megan Harrison have helped to provided ARUs and support that made many surveys possible and assistance from Tania Tripp and Madrone Environmental Services continue to help with WESOke research across Coastal BC. Saul Greenberg from the University of Calgary has helped make the data processing far more feasible. Thanks to the Ministry of Environment and NABat for providing ARUs and EMTs and making the bat work possible. In particular, we would like to thank Mandy Kellner for making this happen. Thanks (again) to both Felix Martinez-Nunez and Tim Ennis for providing bat survey equipment. Thanks also to John Reynolds and Jane Pendray, WildResearch and Hemmera for providing ARUs to help support this research.

6.0 CLOSING AND STATEMENT OF LIMITATIONS

This work was performed in accordance with Contract No. 106381-01 between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Environment and Climate Change Canada (ECCC), dated September 28, 2021 (Contract). In performing this Work, Hemmera has relied in good faith on information provided by others, and has assumed that the information provided by those individuals is both complete and accurate. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced.

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We sincerely appreciate the opportunity to have assisted Environment and Climate Change Canada with this project and if there are any questions, please do not hesitate to contact the undersigned by phone or email.

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APPENDIX A

Call Playback Protocol and Datasheet Used for Surveys and Designed by Pacific Megascops Research Alliance

Western Screech-Owl Surveys

Pacific Megascops Research Alliance

Date _____ Region/Transect _____Visit_____

Protocol and Project _____

Station	Time Start *(24hr)*	Temp *(°C)*	Wind *(beaufort)*	Precip *(0-5)*	Cloud Cover *(%)*	Moon Vis *(circle)*	Moon Light *(0-5)*	Other Light *(0-5)*	Noise *(1-4)*	Car Count	Visual Scan	Observers *(3 letter codes)*
						Yes / No					Yes / No	

Species	Sex	First detection		Distance Bin (1-5) for Each Time Frame							Vocal Act. *(H, S, C)*	Minute playback stopped	Observation Notes
		Direction *(NNW,SE)*	Minute *(0-17)*	0-2 min *Silent*	2-3 min *Playback*	3-7 min *Silent*	7-8 min *Playback*	8-12 min *Silent*	12-13 min *Playback*	13-17 min *Silent*			

Station Notes:

Station	Time Start *(24hr)*	Temp *(°C)*	Wind *(beaufort)*	Precip *(0-5)*	Cloud Cover *(%)*	Moon Vis *(circle)*	Moon Light *(0-5)*	Other Light *(0-5)*	Noise *(1-4)*	Car Count	Visual Scan	Observers *(3 letter codes)*
						Yes / No					Yes / No	

Species	Sex	First detection		Distance Bin (1-5) for Each Time Frame							Vocal Act. *(H, S, C)*	Minute playback stopped	Observation Notes
		Direction *(NNW,SE)*	Minute *(0-17)*	0-2 min *Silent*	2-3 min *Playback*	3-7 min *Silent*	7-8 min *Playback*	8-12 min *Silent*	12-13 min *Playback*	13-17 min *Silent*			

Station Notes:

Datasheet Entered By: _____ Full names of Observers (sheet 1): _____

Western Screech-Owl Survey Reminder Sheet

Version III – Jan 2022

Contact pacificmegascops@gmail.com for modifications

Pacific Megascops Research Alliance

Species and vocalizations

Add others if needed

WESO - Western Screech-Owl
BADO - Barred Owl
NSWO Northern Saw-whet Owl
GHOW - Great Horned Owl
NOPO - Northern Pygmy-Owl
SEOW Short-eared Owl
BANO - Barn Owl

Sex (*M, F, U, J)*

Direction of first detection (*e.g. NW or SSW)*

Minute of first detection (*e.g. 13 at 13:15)*

Distance bins

Distance to owl within time section of survey, represented in bins
1 = 0-50 m
2 = 50-100 m
3 = 100-200 m
4 = 200 – 400 m
5 = 400+ *(rare for WESO)*

Breeding Evidence

Vocal breeding evidence during survey
H = Heard vocalizing
S = Seen only and silent
C = Courtship (counter calling or mating)

Weather conditions

Wind - *Beaufort scale*

Beaufort #	Speed in km/h	Description	Wind effects
0	<1	Calm	Smoke rises vertically
1	1-5	Light air	Wind motion visible in smoke
2	6-11	Light Breeze	Leaves rustle. Wind felt on skin
3	12-19	Gentle Breeze	Leaves and small twigs in motion
4	20-28	Moderate Breeze	Dust and paper raised. Small branches move
5	29-38	Fresh Breeze	Small trees begin to sway
6	39-49	Strong Breeze	Large branches in motion, whistling is heard in wires

Precip - Precipitation level during survey
0 - No precipitation
1 - Very light, and intermittent
2 - Consistent, very light precipitation *sprinkling or misting*
3 - Consistent, moderate precipitation throughout survey (*quiet, no sound masking*)
4 - Consistent, heavy precipitation (*some sound masking*)
5 - Torrential downpour (*complete sound masking*)

Cloud cover - Percentage of sky covered with clouds

Light and Sound Conditions

Moon vis - Is the moon above the horizon and visible through clouds

Light Level Measures
0 - Pitch black, cannot see anything around you
1 - Dark, Can't see without light under cover of canopy
2- Limited visibility, can't move around without light
3 - Fairly good visibility, can move around without light, but need light to see details in forest
4 - Great visibility, can do most things without light, except see colours and read
5 - Bright enough to see colours and read writing

Moon Light - Light level being produced by the moon, estimated outside of forest cover

Other light - Light from anthropogenic sources except for cars (street lights, building lights, distant industrial light etc)

Noise - Background noise during survey, that could hinder hearing distance
1 - Quiet
2 - Some noise, but not getting in the way of detectability
3 - Significant noise reducing detectability
4 - Constant and significant noise (roaring creek or constant heavy traffic)

Car Count – Number of cars passed during survey

Pacific
Megascops
Research
Alliance

PMRA Scientific Methods Series (*Part I*)

Call Playback Survey Methods for Coastal Western Screech-Owl (*Megascops kennicottii kennicottii*)

By: *Jeremiah Kennedy*

Fourth edition: *Mar 2022*

Introduction

The Pacific Megascops Research Alliance (PMRA) was established in February of 2021 to fulfil several directives related to Coastal Western Screech-Owls (WESOke; *Megascops kennicottii kennicottii*). The mission of the PMRA is to *encourage and foster collaboration between future, present and past coastal BC nocturnal wildlife researchers, and to provide outreach and engagement to the public, using Western Screech-Owls as our umbrella organism.* To do this, the organization set several goals, the first of which was to *develop scientifically defensible Western Screech-Owl survey protocols for a) playback and b) remote sensing surveys and to make sure that these are easily accessible to the public and free through the PMRA website.*

Over the last fifty years WESOke research has been conducted in BC using an array of different survey methodologies. The BC Nocturnal Owl Survey Protocol, developed and run by Birds Canada, and the Resource Information Standards Committee (RISC) protocol, developed for the BC Ministry of Environment, were the two standard protocols used by most of the surveys completed in BC up until 2021. Our protocol is compatible with both of these methodologies.

Methods

Transects and Stations

Each survey is composed of a linear transect, usually along a road or path. Each transect should be spaced at least 5km from any previously existing transect. Within a transect, there are between 10 and 20 point count stations. These stations are spaced 800m from one another, using a straight-line measurement. This is important, as playback should not be presented to birds at subsequent stations prior to visiting that station. Stations should be visited at least 3 times in a season, but ideally 4-5 times. Visits should be spaced out as well as possible, but should only take place between February 1st and April 31st.

Station order, within the transect, should be mixed up as much as possible. Completing the surveys in different directions on different visits (ie from point 1 – 8 on visit 1, and point 8 – 1 on visit 2) is the easiest way to do this.

Nightly timing

Playback can be completed starting ***a half hour after sunset*** until an hour before sunrise. Because WESO vocal activity tends to peak soon after sunset (1 – 2 hours) ideally the survey should start a half hour after sunset.

Station order, within the transect, should be mixed up as much as possible. Completing the surveys in different directions on different visits (ie from point 1 – 8 on visit 1, and point 8 – 1 on visit 2) is the easiest way to do this. This way points are visited at different times relative to peak vocal activity.

Call Playback

The only recording being presented during these surveys should be your regionally-specific audio recording found on the PMRA website. ***Do not present other recordings during these surveys unless written into the protocol.*** If your project requires that you locate nests using other playback when you detect an owl, we request that you return at another date to do this. Playback should be presented at 70-75db. See the instructional section of the PMRA website for more details on how to test the volume of your playback device. If your audio device is directional, then make sure to present a full vocalization in each cardinal direction during each minute-long playback.

The playback recordings found on the website are timed to present playback for a complete survey. The time frame within the survey and the method for that time frame (silent or playback) is listed in the datasheet. The 17-minute survey is composed of the following:

a) 2-minute silent listening period
b) 1-minute playback
c) 4-minute silent listening period
d) 1-minute playback
e) 4-minute silent listening period
f) 1-minute playback
g) 4-minute silent listening period

You can start your 2-minute silent listening period as soon as all car doors are finished closing, lights are turned off and everyone present is silent and has begun listening. In cases where you may be concerned about bears, wolves, moose, elk or puma approaching you in the dark, you may keep a low light or red light headlamp beam on. If you are on the side of a road with traffic, make sure you have reflective gear so that passing cars are aware of your presence.

Body and Vehicle Positioning

When presenting the playback make sure that it is not being masked by yourself, other observers, or your vehicle. Along the same thread, make sure your hearing is not masked by these same obstacles. Moving away from the car (by 10-20 feet) to reduce sound masking is a good idea. At the very least***, the vehicle should be turned off (prior to the start of the survey) and you should be outside of the vehicle for the duration of the survey***.

Post-survey Scanning

Once the survey is completed, use a flashlight or headlamp to slowly turn in a circle and scan the surrounding trees for any owls that may have silently approached. If you detect an owl this way, that you have not detected during the survey, there should be no *time of first detection,* but please make sure to make a note in the *observation notes* section that this was seen while scanning and use the code ***S*** in the *vocalization type* section. ***Lights should not be used during the survey except at very low level to help with writing down observations.***

After Detecting an Owl

When you detect an owl of any species we request that you complete the survey in its entirety. This includes all remaining playbacks and listening periods. In the case that you are not comfortable doing so, please note the *'Minute playback stopped'* as minute within the survey period (1-17). Make sure you document if, when and why the playback was stopped during the survey in the '*observation notes'* section. If you do stop the playback, make sure that you continue listening until the end of the 17 minute period is complete.

Data collection

Transect and visit information can be written down on the first sheet used on that transect on that night. This sheet should then be stapled to the other sheets from that same transect visit so that you don't need to write down date, transect, visit number etc, for every data sheet. All sheets should also be photographed well enough to be able to read the information on them, after every transect visit. Data can be shared either physically or electronically, but there should always be an electronic backup of the data on hand.

Transect data

Date should include day, month (in letters) and year. **Region/transect** is left vague for project-specific use, but should have both the transect ID and the region ID written clearly. **Visit** is the visit number from that year. If that is the first visit of the year to that transect you should write 1, if it is the second visit you should write 2. If you return to complete a survey transect on a subsequent night, that is still the first visit unless you are repeating survey points again. **Protocol and project** should clearly and briefly reference changes to standard PMRA protocol being used and name the project. Standard project is *PMRA Volunteer*.

Station data

Station is the number of the station being visited within the transect. **Time start** is the time on the 24 hour clock when the 2min silent listening period starts at the beginning of the survey. All weather metrics are described in the associated datasheet definitions document. All **Observers** should be named on the first sheet (full name) and 3-letter codes for all observers present for

the station should be listed in the Observers section**.** Making sure that these codes are complete and distinct is important, because this will be used to count the number of observers at each station. **Station notes** can include, but are not limited to, sources of noise, issues with count etc.

Observation data
There should be one line per individual owl detected on each survey station. For example, if you detect 3 Western Screech-Owls and 1 Barred Owl, there should be a total of 4 rows, each describing the owl detections for each individual through the survey.

If you are unsure of species, sex or vocalization types, write unknown or U and take an audio recording as best you can. We will review this at a later date. **Species** should be the 4-letter code for the species details on the associated definitions sheet. **Sex** should identify whether or not the owl is male or female or juvenile. The codes for sex are *M for Male, F for Female, U for Unknown, J for Juvenile***. Minute of first detection** is the time at which you first detected an individual on a survey starting from 0 at the start of the survey and ending at 17 at the end. If you detect an owl 10 seconds into the survey, time of first detection should read *0,* or at 1:30 into survey, it should read *1.* **Direction of first detection** is the direction in which the individual was first detected. This is simply the cardinal directions *eg. N, NNW, W, SW, S, ESE*

The **Distance estimations** are likely the most complicated parts of your survey. These should all be between 1 and 5. They are between 1 and 5 because these represent different distance bins (Table 1 below). If you can't remember the distance bin codes you can write down your distance estimation and translate it into a bin after the survey.

Table 1: Distance bins

Bin ID	Distance (m)
1	0-50
2	50-100
3	100-200
4	200-400
5	400+

Each section for you to write your estimates in, corresponds with a different time frame in the survey, and each time frame is labeled with the call playback activity. For example the first two minutes in the survey are silent listening and are therefore labeled 0-2 min *Silent.* The first time you detect an individual in any of these frames, you should write the distance bin that you think this owl is from where you are standing. For example, if you detect an owl 7 minutes and 30 seconds into the survey, and you think that it's 100 – 130 m away, you would write 3 in the 7-8 min *Playback* section of your sheet. If this is the first time you detected this individual you should not write anything in the frames prior to it. If you continue to detect this individual, you should write how far away it is when you detect it in the subsequent frames. For example, if you detect

it again at 12:20 and it has moved to about 20-30 m away, you should write 1 in the 12-13 min section of the sheet for that individual. If it moves closer within that frame, don't change the distance estimation for that time frame. The distance is an estimate of how far away it is when you first detect it within that time frame. If you are unclear about this, then please see our *how to* videos on the volunteer survey page of the PMRA website.

Vocal activity is represented by a one letter code to distinguish between vocal and visual detections. Courtship

Table 2: Breeding evidence codes from vocalizations heard during survey

Evidence Code	Definition
H	Heard vocalizing at any point in the survey
S	Seen only
C	Courtship display (counter singing between male and female or copulation display vocalizations)

There are a number of vocalizations that each owl species can make. Please familiarize yourself with the more common ones from each of the common species listed on the survey reminder sheet, before completing a survey.

APPENDIX B
Health and Safety Plan

APPENDIX C

Permissions for Study Area Access Including Land Access Agreement with BC Parks Foundation and Letter of Authorization from BC Parks

May 30, 2022

File: 98700-20/Carmanah Walbran
98700-20/Lower Tsitika River
98700-20/Schoen Lake
98700-20/Strathcona

Jeremiah Kennedy
Pacific Megascops Research Alliance
4515 Central Boulevard
Burnaby BC V5H 0C6

Via Email: pacificmegascops@gmail.com

Dear Jeremiah Kennedy:

Re: Letter of Authorization: Acoustic Recording Unit (ARU) Coastal Western Screech-Owl

This authorization is issued pursuant to the Park, Conservancy and Recreation Area Regulation, for the purposes of authorizing Pacific Megascops Research Alliance to conduct the following activity in Lower Tsitika River Provincial Park, Schoen Lake Provincial Park, Carmanah Walbran Provincial Park and Strathcona Provincial Park.

Activity: Passive bioacoustics surveys, using Acoustic Recording Units (ARU) for bats and owls, and active bioacoustic surveys, using Echo Meter Touch (EMT) units for bats, and call-playback for owls.

Call-playback surveys for owls will be conducted at 8 to 12 points along transects following existing roads with the points spaced 800 meters apart. Surveyors will visit each transect three times between mid-February and mid- April. Each survey involves presenting male WESOke breeding vocalizations in a set pattern over a 17 minute survey at each location along the transect. There will be one to two transects in each Park.

ARU surveys will involve deploying ARU along road-side or non-roadside transects spaced at 800 meters.

ARU units will be placed on trees <10cm DBH and affixed at 1.5 meters in height. Units are set out from January to mid-February and retrieved by mid-June. This data will be processed using rapid visual assessment method which allows all owl species present to be documented.

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Location:	Ancient and secondary forest types with specific habitat features (fragment size, stand age, species composition, canopy cover) in Lower Tsitika River Provincial Park, Schoen Lake Provincial Park, Carmanah Walbran Provincial Park and Strathcona Provincial Park.
Date/s and Term:	Bird ARUs (February through April 2022) Bat ARU's (November through April 2022) Call- playback surveys (late February through mid-April 2022).

Condition of Activity:

Research Conditions:

- A summary of your research findings must be submitted to the BC Parks West Coast Conservation Specialist, Erica McClaren at the end of your research activities.

- No collection or removal of natural resources, disturbance to soils, rocks, or any plant or animal.

- No improvements (permanent or temporary) may be made to the park.

- No fish, wildlife or invertebrates are to be collected, trapped or handled.

You must follow all terms conditions in this letter, comply with all laws and regulations defined in the Park, Conservancy and Recreation Area Regulation and *Park Act*, and comply with all requirements or directions of any governmental authority such as Park Operator's staff while in the park.

The authorization to conduct the activities listed in this letter does not grant you any exclusive or commercial rights. Only activities outlined in the conditions stated above are authorized by this letter, any additional activities or changes to your activities must be authorized by an amendment to this letter or by a Park Use Permit. Any activities authorized by this letter must not interfere with free public access through any area of the park you are using.

Failure to follow the terms and conditions of this letter will result in this authorization no longer being valid. By violating the terms and conditions of this letter you may be subject to fines and offences under the Park, Conservancy and Recreation Area Regulation and *Park Act*.

A copy of this letter must accompany you at all times while you are undertaking the activity within the Lower Tsitika River Provincial Park, Schoen Lake Provincial Park, Carmanah Walbran Provincial Park and/or Strathcona Provincial Park and must be available for inspection by BC Park Rangers.

…3

If there are any questions about the nature of this Letter of Authorization or the conditions listed within, please contact me at your earliest convenience.

Yours truly,

PPA Section Head

cc: Katy Fulton, Conservation Coordinator, West Coast Region, BC Parks, Ministry of Environment and Climate Change Strategy
Erica McClaren, Conservation Specialist, West Coast Region, BC Parks, Ministry of Environment and Climate Change Strategy
Jessie Moore, Area Supervisor Strathcona, BC Parks, Ministry of Environment and Climate Change Strategy
Christine Rikley, PPA Section Head, BC Parks, Ministry of Environment and Climate Change Strategy

Land Access Agreement

THIS AGREEMENT made and effective the 2nd day of March, 2022 (the "Effective Date")

BETWEEN:

Jeremiah Kennedy, 1817 Morello Road, Nanoose Bay, BC, V9P 9B1

(the "Licensee")

AND:

BC PARKS FOUNDATION, a Society incorporated under the laws of British Columbia, having its registered office at 1800 - 510 West Georgia Street, Vancouver, British Columbia, V6B 0M3

(the "Licensor").

BACKGROUND

A. The Licensee leads a team that is studying the presence of birds, specifically Western Screeching Owls, throughout British Columbia.

B. The Licensor possesses the real property described in Exhibit A (the "Property").

C. The Licensee desires access to the Property for research purposes as described in Exhibit B on the portion of the Property described in Exhibit B (the "Licensed Premises").

D. The Licensor agrees to grant to the Licensee such access on the terms set out in this Agreement.

TERMS OF AGREEMENT

In consideration of the premises and the mutual covenants contained in this Agreement, the parties to this Agreement covenant and agree each with the others as follows:

1. License Grant

1.1 **Grant, Purpose, and Scope of License.** Licensor grants to Licensee a non-exclusive, non-transferrable, non-assignable, revocable right of entry onto and license to use the Licensed Premises for the limited purposes described in, and during the time period (the "Term") set out in, Exhibit B (the "License"). The License extends to Licensee and its employees, contractors, and invited guests. The specific parameters of the License are described in Exhibit B. The Licensee will inform the Licensor of when it plans to enter the properties and will not enter unless permission is granted for the dates and times specified.

1.2 **Fee.** In exchange for the rights provided in this Agreement, the Licensee will pay the Licensor a fee (the "Fee") in the amount, and according to the schedule, set out in Exhibit B.

1.3 Research Results. The Licensee will provide the Licensor with a copy of research results and, upon request, raw data collected. The Licensee will not make public the research results in a manner where doing so could lead to the destruction of plants or animals on the properties.

2. Licensed Premises

2.1 **Limited Rights.** This License gives the Licensee a license only and, notwithstanding anything to the contrary in this Agreement, does not constitute a grant of any ownership, leasehold, easement, or other property interest or estate whatsoever in any portion of the Property.

2.2 **As-Is; No Representation as to Suitability.** The Licensee acknowledges that, except as provided in Section 2.3, the Licensor has not made any representations or warranties, express or implied, concerning any aspect of the Property or the Licensed Premises, including its fitness for the Licensee's purposes, that Licensor disclaims any such representation or warranty, and that the Licensed Premises are being licensed "as is." The Licensee acknowledges that the Licensee has made its own independent evaluation in deciding to enter into this Agreement and conduct activities on the Licensed Premises.

2.3 **No Interference.** The Licensor represents to the Licensee that the Licensor has the power and authority to grant the License to the Licensee. The Licensee will not materially interfere with the Licensee's use of the Licensed Premises.

2.4 **Inspection.** The Licensor may enter the Licensed Premises at all reasonable times to inspect the Licensee's activities on and the condition of the Licensed Premises.

2.5 **The Licensee's Activities.** The Licensee will have sole responsibility for the planning, management, and carrying out of its operations on the Licensed Premises. The Licensee will conduct its activities in a professional manner, take care to prevent waste or damage to the Licensed Premises, and comply with all applicable laws in carrying out its activities on the Licensed Premises. The Licensee will not materially interfere with the normal operations and activities of Licensor's use of the Property.

2.6 **No Improvements.** The Licensee will not make any alterations, additions, or improvements to the Licensed Premises, including erecting any structures, without Licensor's prior written approval.

2.7 **Recordkeeping.** The Licensee will maintain records of its operations on the Licensed Premises. The Licensee will make such records available to the Licensor as the Licensor may reasonably request.

2.8 **Licences and Permits.** The Licensee will be responsible for obtaining all necessary licences, permits, and consents from applicable Canadian federal, provincial, territorial, or municipal authorities, courts, other tribunals or commissions, regulatory, administrative or other agencies, or any political or other subdivision, department or branch of any of the foregoing, for possession and use of the Licensed Premises.

3. Waiver and Release, Indemnification and Insurance

3.1 **Waiver and Release.** The Licensee waives and release any and all claims against thre Licensor and the Licensor's directors, officers, employees and affiliates (together, the "Licensor Parties") for any liability, loss, damage, expenses and attorneys' fees, resulting from (i) death or injury to person or (ii) loss, theft or damage to property of the Licensee caused by or arising from the Licensee's presence or activities on the Licensed Premises, regardless of the cause and even if caused by negligence, active or passive. The Licensee agrees not bring any action or claim against the Licensor on the basis of these waived and released claims.

3.2 **Indemnification.** The Licensee will defend, indemnify and hold the Licensor and the other Licensor Parties harmless from and against any and all claims, liabilities, losses, damages and attorney's fees that may be suffered by the Licensor (i) as a result of a claim by a Licensee employee, contractor, collaborator, volunteer or guest, or any other third party, arising directly from the Licensee's presence and activities on the Licensed Premises and the Property under this Agreement, or (ii) from any breach by the Licensee of its obligations under this Agreement, except to the extent that the liability is caused by the relevant Licensor Party's gross negligence or willful misconduct.

3.3 **Insurance.** The Licensee, at its sole expense, will maintain insurance of types and amounts as set out on Exhibit B. If applicable, the Licensee will provide the Licensor upon request with a certificate of insurance confirming this coverage and naming the Licensor as an additional insured.

4. Termination

4.1 **Term.** This Agreement will begin on the Effective Date and will expire at the end of the Term, unless extended by written agreement of the Licensor and the Licensee, terminated under Section 4.2 below, or revoked under Section 4.3 below.

4.2 **Termination by Licensee.** The Licensee has the right to terminate this License at any time by giving written notice to the Licensor at the address written above or at any other address as the Licensor may from time notify the Licensee of in writing. Such termination will be effective 10 days after Licensor's receipt of such notice. Termination by the Licensee will not entitle the Licensee to withhold or obtain a refund of the Fee or other sum due under this Agreement or to obtain any compensation or damages from the Licensor.

4.3 **Revocation by Licensor.** Notwithstanding any other provision of this Agreement or any course of performance under this Agreement, the Licensor may at its sole option freely revoke the License at any time by giving written notice to the Licensee at the address written above or at any other address as the Licensee may from time notify the Licensee of in writing. Such a revocation will be effective 10 days after Licensee's receipt of such notice. Revocation by the Licensor may occur without cause and will be without liability or obligation to pay consideration to the Licensee, including, without limitation, any obligation to return to the Licensee any part of the Fee.

4.4 **Consequences of Expiration and Termination.**

4.4.1 *Surrender; Payment.* Upon expiration or termination of this Agreement, the Licensee will (i) surrender the Licensed Premises in good condition, order and repair, (ii) remove it property from the Licensed Premises, and (iii) repair, at its

cost, any damage to the Licensed Premises solely caused by the Licensee, reasonable impacts excepted. The provisions of Sections 3.3, 4, and 5 will remain effective after expiration or termination of this Agreement.

4.4.2 *Personal Property After Termination.* If the Licensee leaves any of its personal property on the Licensed Premises after the termination of this Agreement, the Licensor may store it at a warehouse or any other location for the Licensee's account and at the Licensee's risk and expense. The Licensor will release the property only when the Licensee pays all charges relating to storage and all other amounts it may owe the Licensor under this Agreement. If the Licensee does not reclaim its property within 30 days, the Licensor may sell it and apply the proceeds of the sale to any amounts the Licensee owes the Licensor under this Agreement, or retain the Licensee's property, granting the Licensee credit for the reasonable value of Licensee's property against any amounts the Licensee owes the Licensor.

5. General Provisions

5.1 **Entire Agreement; Amendments.** This Agreement, together with Exhibits A and B, is the entire agreement between the Licensor and the Licensee and supersedes all prior or contemporaneous communications, representations, understandings, and agreements, either oral or written, relating to the subject matter of this Agreement. This Agreement may be amended only as stated in a written document signed by both the Licensor and the Licensee which states that it is an amendment to this Agreement. If there are any inconsistencies between this Agreement and other documents, including Exhibits A and B, this Agreement will control and prevail.

5.2 **Severability.** If any provision of this Agreement is held illegal, invalid, or unenforceable, all other provisions of this Agreement will remain enforceable, and the illegal, invalid, or unenforceable provision will be considered modified so that it is valid to the maximum extent permitted by law.

5.3 **Waiver.** Any waiver under this Agreement must be in writing and signed by the party granting the waiver. Waiver of any breach or provision of this Agreement will not be considered a waiver of any later breach or of the right to enforce any provision of this Agreement.

5.4 **Third-Party Beneficiaries.** Each Licensor Party other than the Licensor is an express third party beneficiary of this Agreement. Except as specifically provided in this Section 5.4, this Agreement is for the exclusive benefit of the Licensor and the Licensee, and not for the benefit of any third party.

5.5 **Governing Law**. This Agreement is governed by British Columbia law. The parties consent to the exclusive jurisdiction of the Supreme Court of British Columbia.

5.6 **Enurement.** This Agreement shall enure to the benefit of and be binding upon the parties and, except as otherwise provided or as would be inconsistent with the provisions of this Agreement, their respective heirs, executors, administrators, successors and assigns.

5.7 **Time.** Time is of the essence in this Agreement.

5.8 **Headings.** The headings used in the Agreement are for convenience and reference only and shall not affect the construction or interpretation of this Agreement.

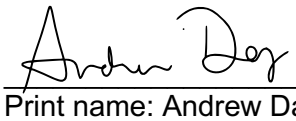
5.9 **Counterparts.** This Agreement may be executed in one or more counterparts, each of which will be deemed an original and all of which will be taken together and deemed to be one instrument. Transmission by fax or PDF of executed counterparts constitutes effective delivery.

AS EVIDENCE OF THEIR AGREEMENT, the parties have executed this Agreement as of the date and year first above written.

Jeremiah Kennedy
by its authorized signatory:

Print name: Jeremiah Kennedy

BC PARKS FOUNDATION
by its authorized signatory:



Print name: Andrew Day

Exhibit A

Legal descriptions of the properties:

Young Point, Lasqueti Island

Parcel Identifier: 009-718-257

Part 1 S Section 3 Land District 32 Lasqueti Island

West Ballenas Island

Parcel Identifier: 004-606-353

Parcel A (DD20684W) of Lot 100, being West Ballenas Island, Nanaimo District

Upper Pitt River

District Lot 1723 Group 1 Except: Firstly: Parcel "A" (Reference Plan 3791)

Secondly: Parcel "B" (Reference Plan 3791)

Thirdly: Parcel "C" (Reference Plan 3791)

Fourthly: Parcel "D" (Reference Plan 3791)

Fifthly: Part Shown on Plan 3625, New Westminster District; PID: 002-308-444

District Lot 2043 Group 1 Except Part Shown on Reference Plan 6573 New Westminster District; PID: 001-072-447

District Lot 3162 Group 1 Except: Firstly: Part Shown on Plan 3625 Secondly: Parcel "A" (Reference Plan 3952), New Westminster District; PID: 003-885-411

District Lot 3168 Group 1 New Westminster District Except: Part Dedicated Road Plan 82475; PID: 003-958-850

District Lot 3173 Group 1 New Westminster District; PID: 012-986-500

District Lot 4920 Group 1 New Westminster District; PID: 012-986-658

District Lot 4922 Group 1 New Westminster District; PID: 012-986-691

Saturnina Island

Parcel Identifier: 009-772-090

Lot 21 (Flat Top Islands) Nanaimo District

Exhibit B

Portion of land being used

This agreement is for the Legal Property described in Exhibit A.

Purpose

Ballenas Islands Owl and WIldlife Bioacoustic Surveys

Coastal Western Screech-Owls (*Megascops kennicottii kennicottii)* have disappeared from much of their historical range over the last 50-70 years. Recently, through citizen-science driven research, this threatened owl has been shown to be much more of an old growth obligate than historically thought. The dry Douglas Fir/Arbutus ecosystems found around the edge of the southern and central Salish Sea have few remaining old growth patches. One of the areas that contains such a forest is the Ballenas Islands. These islands are remote and small enough that they likely don't host Barred Owls (invasive predators of western screech-owls) and provide year-round access to food for screeches, who are known to feed intertidally.

These unique islands are not only possible refugia for western screech-owls, but represent an ecosystem that is rare and disappearing on the coast. By recording audio during the spring and breeding seasons, researchers will be able to describe, for the first time, the bird communities that breed on these islands. This work is part of a BC-wide collaboration on Coastal Western Screech-Owl and old growth bird community research.

The purpose of this license is for the installation, maintenance, and retrieval of automatic recording units to detect the presence of birds in the area.

Time period

This license is for March 1, 2022 – March 1, 2023.

Fee and fee schedule

There is no fee for this license.

Insurance required

Licensee shall, at Licensee's expense, maintain Commercial General Liability coverage, or Professional Liability Insurance as applicable. The liability insurance certificate shall contain coverage of a minimum of $2 million on an occurrence basis with a deductible of not more than $5,000. BCPF should be named as an additional insured.

Licensee shall, at Licensee's expense, maintain appropriate Worker's Compensation Insurance coverage.

File Number: *98700-20/LowerMainlandGoldenEars*

March 2, 2022

Toby St Clair, Jeremiah Kennedy
Pacific Megascops Research Alliance
c/o Hemmera, an Ausenco Company
18th Floor, 4515 Central Boulevard, Burnaby, BC, V5H 0C6

Letter of Authorization: Acoustic Recording Unit (ARU) Owl Surveys, Golden Ears Park

Dear Toby and Jeremiah,

This authorization is issued pursuant to *the Park, Conservancy and Recreation Area Regulation*, for the purposes of authorizing **Pacific Megascops Research Alliance** to conduct the following activity in ***Golden Ears Provincial Park.***

Activity: Install up to five acoustic recording units (ARUs) along the East Canyon Trail to conduct non-invasive surveys for owls, with a focus on Western Screech Owl, *kennicotti* subspecies, which is listed as Threatened under the *Species at Risk Act*. The units passively record owl calls. They will be deployed in February, set to record through to the end of April, and retrieved by mid-June. The units are attached with plastic wrapped cable to tree trunks, causing no damage to the trees. No other disturbance to vegetation or ground is required. This work is part of a larger initiative to improve understanding of habitat requirements for coastal Western Screech-Owls (WESOke), the impacts of invasive Barred Owls and landcover change, and the interactions between these two threats, on WESOke abundance.

Location: ***East Canyon Trail. Golden Ears Provincial Park***
Date/s and Term: ***February–June 2022***

Condition of activity:

Research Conditions:

- A summary of your research findings must be submitted to the *BC Parks Area Supervisor Daris Lapointe* and *BC Parks Conservation Specialist Joanna Hirner* at the end of your research activities. Results must also be shared with Katzie First Nation, Kwikwetlem First Nation and Kwantlen First Nation.
- No collection or removal of natural resources, disturbance of soils, rocks, or any plant or animal.
- No improvements (permanent or temporary) may be made to the park
- No fish, wildlife or invertebrates are to be collected, trapped or handled.

Ministry of Environment and Climate Change Strategy
BC Parks and Conservation Officer Service Division
South Coast Region

Mailing Address:
1610 Mount Seymour Road
North Vancouver BC V7G 2R9

Telephone: (604) 924-2200
Facsimile: (604) 924-2244
http://www.gov.bc.ca/
http://www.gov.bc.ca/env/

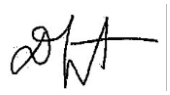
You must follow all terms conditions in this letter, comply with all laws and regulations defined in the *Park, Conservancy and Recreation Area Regulation* and *Park Act*, and comply with all requirements or directions of any governmental authority while in the park.

The authorization to conduct the activities listed in this letter does not grant you any exclusive or commercial rights. Only activities outlined in the conditions stated above are authorized by this letter, any additional activities or changes to your activities must be authorized by an amendment to this letter or by a Park Use Permit. Any activities authorized by this letter must not interfere with free public access through any area of the park you are using.

Failure to follow the terms and conditions of this letter will result in this authorization no longer being valid. By violating the terms and conditions of this letter you may be subject to fines and offences under the *Park, Conservancy and Recreation Area Regulation* and *Park Act*. A copy of this letter must accompany you at all times while you are undertaking the activity within the *Golden Ears Provincial Park* and must be available for inspection by BC Park Rangers.

If there are any questions about the nature of this Letter of Authorization or the conditions listed within, please contact me at your earliest convenience.

Yours sincerely,



Daris Lapointe, North Fraser Area Supervisor
Lower Mainland Section, South Coast Region
Daris.Lapointe@gov.bc.ca
778 752-5955

cc *Dylan Eyers, Parks and Protected Areas Section Head, Lower Mainland*
Riley Kennedy, North Fraser Senior Park Ranger
Joanna Hirner, Conservation Specialist, South Coast Region

APPENDIX D

Photographs of Habitat in Study Areas

Photo 1 Mid productivity ancient forest. Transitional habitat between Western Redcedar and Sitka Spruce dominated forests in Carmanah Walbran (March, 2022)

Photo 2 High productivity ancient forest. Western Redcedar dominated with high undergrowth and many light gaps near Carmanah Walbran (June, 2018)

Photo 3 High productivity second growth riparian forest. Dominated by Big Leaf Maple and Red Alder along Squamish River transect (April, 2021)

Photo 4 High productivity ancient forest. Dominated by Sitka Spruce and Western Hemlock. Open undergrowth typical of riparian habitats here in Tsitika River (March, 2022)

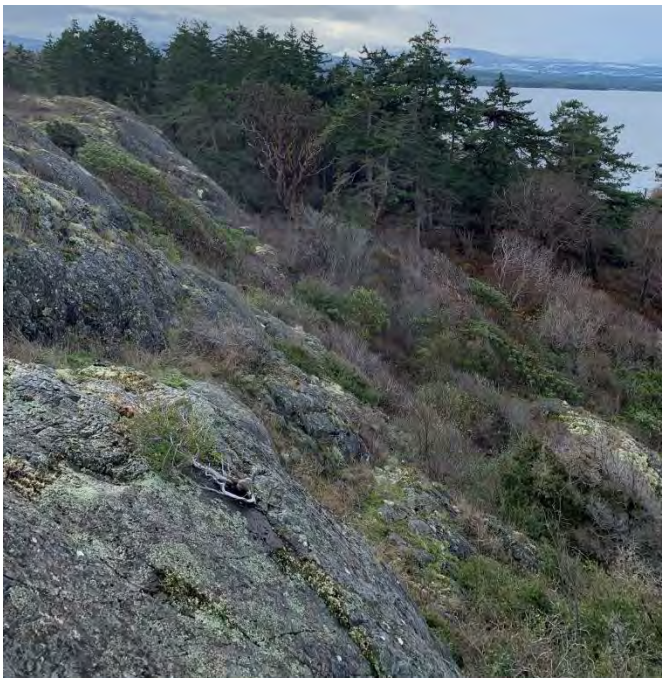


Photo 5 Low productivity ancient forest. Coastal Douglas Fir, Arbutus forest with exposed rocks and shrub on Ballenas Island transect (March, 2022)

APPENDIX E

Naïve Occupancy Estimates and Survey Effort including April 2022 Surveys

Table E-1 Number of playback survey visits, echometer touch bat survey visits and number of ultrasonic and sonic ARUs deployed at each transect between April 2021 and April 2022.

Transect Name	CPB		S-ARUs		EMT		U-ARU	
	2021	2022	2021	2022	2021	2022	2021	2022
Carmanah Walbran - Roadside		2		7		2		4
Carmanah Walbran - Remote				14				
Strathcona – Buttle Lake		2		3		2		4
Wolf Lake[1]	3		6					
Gold Creek to Fergusson Lake				8				
Tofino Creek	2		2					
San Juan River	2	1	2					
Edinburgh Mountain	2	2						
Schoen Lake Provincial Park [1]								
Coquitlam Lake - East		3		8		3		4
Squamish River Valley	3	3	5	4	2	2		
Tsitika River - Main		1		8				
Tsitika River - Lower		3		4				
Tsitika River - Upper		1		8				

[1] Data unavailable due to permissions or inaccessible in both 2021 and 2022

Note: WESOke – Coastal Western Screech-Owl (Megascops kennicottii kennicottii), Area ID – Defined in **Table 1**, CPB – call playback surveys using PMRA Western Screech-Owl survey standards (pacificmegascops.org), S-ARU – sonic autonomous recording unit for passive acoustic surveys for owls, EMT – Echo Meter Touch, active surveys for bats, U-ARU – ultrasonic autonomous recording unit for passive acoustic surveys for bats

Table E-2 Naïve occupancy for owls between April 2021 and April 2022, using call playback surveys and sonic ARUs

Transect Name	Species	Naïve Occupancy			
		2021		2022	
		CPB	S-ARU	CPB	S-ARU
Squamish River Valley	WESOke	0	0	0	
	BADO	0.08	0.80	0.08	
	NOPO	0	0.20	0	
	GHOW	0	0	0	
	NSWO	0.08	0.40	0.08	
Coquitlam Lake - East	WESOke			0	
	BADO			0.30	
	NOPO			0	
	GHOW			0	
	NSWO			0	
San Juan River	WESOke	0.08	0	0	
	BADO	0.08	0	0	
	NOPO	0	0	0	
	GHOW	0	0	0	
	NSWO	0	0	0.17	
Tofino Creek	WESOke	0.50	1.00		
	BADO	0	0		
	NOPO	0	0		
	GHOW	0	0		
	NSWO	0	0		
Carmanah Walbran - Roadside	WESOke			0.20	
	BADO			0	
	NOPO			0	
	GHOW			0	
	NSWO			0	
Edinburgh Mountain	WESOke	0		0.10	
	BADO	0		0	
	NOPO	0		0	
	GHOW	0		0	
	NSWO	0		0	

Transect Name	Species	Naïve Occupancy			
		2021		2022	
		CPB	S-ARU	CPB	S-ARU
Strathcona - Buttle Lake	WESOke			0	
	BADO			0.20	
	NOPO			0	
	GHOW			0	
	NSWO			0	
Tsitika River - Main	WESOke			0.30	
	BADO			0.30	
	NOPO			0	
	GHOW			0	
	NSWO			0	

Note: Naïve occupancy – proportion stations in transect where species was detected at least one visit in the listed year. Because naïve occupancy doesn't take into account any detectability, effort or landscape variables, and since visit effort was inconcistent across transects and years, these values are only meant to be used to track research progress and are likely not representative of the true occupancy values in their current state. WESOke – Coastal Western Screech-Owl (Megascops kennicottii kennicottii), BADO – Barred Owl (*Strix varia*), NOPO - Northern Pygmy-Owl (*Glaucidium californicum*), GHOW – Great Horned Owl (*Bubo virginianus*), NSWO – Northern Saw-whet Owl (*Aegolius acadicus*), CPB – call playback surveys using PMRA Western Screech-Owl survey standards (pacificmegascops.org), S-ARU – sonic autonomous recording unit for passive acoustic surveys for owls