PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Recovery Strategy for the Pallid Bat (*Antrozous pallidus*) in Canada

Pallid Bat

2017

Government of Canada
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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

RECOVERY STRATEGY FOR THE PALLID BAT (*Antrozous pallidus*) IN CANADA

2017

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of British Columbia has given permission to the Government of Canada to adopt the *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Pallid Bat in Canada consists of two parts:

Part 1 – Federal Addition to the *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia*, prepared by the Pallid Bat Recovery Team for the British Columbia Ministry of Environment.

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Part 1 – Federal Addition to the *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Pallid Bat and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of British Columbia and the Pallid Bat Recovery Team, as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Province of British Columbia provided the attached recovery plan for the Pallid Bat (Part 2) as science advice to the jurisdictions responsible for managing the species in British Columbia. It was prepared in cooperation with Environment and Climate Change Canada.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Pallid Bat and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=6B319869-1%20

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Bird Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The development of this recovery strategy addition was led by Tanya Luszcz, with input and support from Kella Sadler and Matt Huntley (Environment and Climate Change Canada, Canadian Wildlife Service - Pacific Region (ECCC CWS-PAC). Additional comments and/or collaborative support was provided by Brian Campbell and Paul Johanson (ECCC CWS – National Capital Region), Orville Dyer (B.C. Forests, Lands and Natural Resources Operations), Purnima Govindarajulu, and Peter Fielder (B.C. Ministry of Environment). Species experts Daniela Rambaldini, Mark Brigham, Mike Sarell, Allison Haney, Cori Lausen, Dave Johnson, Tom O'Shea, Greg Falxa, and Lori Pruitt (US Fish and Wildlife Service) also contributed valuable inputs on bat data and/or related science advice. Danielle Yu and Sean Butler (ECCC CWS-PAC) provided additional assistance with mapping and figure preparation.

Additions and Modifications to the Adopted Document

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia* (Part 2 of this document, referred to henceforth as "the provincial recovery plan") and/or to provide updated or additional information.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery plan referring to protection of survival/recovery habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

1. Critical Habitat

This section replaces section 7 “Species Survival and Recovery Habitat” in the provincial recovery plan.

Section 41 (1)(c) of SARA requires that recovery strategies include an identification of the species’ critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. The provincial recovery plan for the Pallid Bat includes a description of the biophysical attributes of survival/recovery habitat. This science advice was used to inform the following critical habitat sections in this federal recovery strategy. Detailed methods and decision-making processes relating to critical habitat identification are archived in a supporting document.

Critical habitat is partially identified in this recovery strategy. A schedule of studies has been included that describes the activities required to complete the identification of critical habitat in support of the population and distribution objectives[4] for the species.

Critical habitat for Pallid Bat is identified in this document to the extent possible; as responsible jurisdictions and/or other interested parties conduct research to address knowledge gaps, the existing critical habitat methodology and identification may be modified and/or refined to reflect new knowledge.

[4] Referred to as “recovery (population and distribution) goal” in the provincial recovery plan.

1.1 Identification of the Species' Critical Habitat

Geospatial location of areas containing critical habitat

Critical habitat for the Pallid Bat is identified based on all available verified occurrence records[5] for the species, in the southern Okanagan Valley in south-central British Columbia (Ponderosa Pine very hot (PPxh1), and Bunchgrass very hot (BGxh1) biogeoclimatic ecosystem subzones (Meidinger and Pojar 1991)). Within these environments, Pallid Bats require both roosting and foraging habitat to support their life history stages.

Roosting habitat is necessary to support the activities and biological needs of all life history stages (including sleeping, mating, raising young, cover from predators, torpor, and hibernation). Roosting habitat is mainly comprised by cliffs and rock crevices, which are stable features on the landscape; however, Pallid Bats will also use trees for night roosting (e.g., Ponderosa Pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), deciduous trees in riparian areas, and fruit trees in orchards). Pallid Bats appear to be loyal to specific roosting areas, and they are continually used across generations (Rambaldini and Brigham 2004). Critical habitat for roosting is identified based on: (1) known/observed roosting locations, as well as (2) the application of habitat suitability models (Warman et al. 1998[6]; Sinnerman 1982[7]) to other types of occurrence observations (e.g. observations while flying, vocalizations, mist-netting and dead bats). Where roosting habitat that is of high to moderate suitability for Pallid Bat roosting is found within foraging distance (4.5 km) of an occurrence observation, it is identified as roosting critical habitat.

Foraging habitat is necessary to support adults and volant (capable of flight) juveniles between April and October. The specific area around roosts used as foraging habitat by the Pallid Bat in B.C. requires additional research; however, the best available information (i.e., existing data from B.C. and the U.S.A.) supports a 4.5 km maximum

[5] Critical habitat is based on all known verified occurrence records that were available to Environment and Climate Change Canada as of 2016. Potential records at 2 sites (north Skaha Lake and Lower Similkameen Valley) are currently not verified and therefore have been excluded from the critical habitat identification.

[6] Roosting habitats in the Warman *et al.* 1998 model are identified as horizontal rock crevices of steep cliffs, canyon walls, rock outcrops, or talus within the PPxh1 or BGxh1 biogeoclimatic ecosystem subzones. The model applies a four-class rating system. Habitat ranked as High or Moderate suitability for roosting for Pallid Bat are used in the critical habitat identification, where they occur within foraging distance (4.5 km) of occurrence records.

[7] The Okanagan Cliffs layer (Sinnerman 1982) is a product based on the evaluation of 91 cliffs in the South Okanagan-Similkameen for 15 priority wildlife species including Pallid Bat (classified within this model as a "large bat"). There are eight categories that are of significance to the cliff evaluation: cliff type, bedrock type, amount of fracturing, fracture angle, amount of ledging, amount of overhangs, amount of talus and type of talus. Habitat ranked as High or Moderate suitability for roosting for Pallid Bat are used in the critical habitat identification, where they occur within foraging distance (4.5 km) of occurrence records.

average foraging distance.[8] Therefore the area containing foraging critical habitat is identified as those areas within 4.5 km of roosting critical habitat.

Biophysical attributes of critical habitat

- Roosting habitat: Naturally occurring rock crevices (≥ 3 cm wide; Miller and Jensen 2013; Schorr and Siemers 2013) of all orientations (from vertical to horizontal) within cliff faces and talus slopes:
    - Day Roosts (used April to October, inclusive): Naturally occurring rock crevices within cliff faces, or large diameter talus
    - Hibernacula (used October to April, inclusive[9]): Day roost locations, deep narrow crevices inside caverns, and caves

- Foraging Habitat (used April to October, inclusive):
    - Natural features (preferred use): natural grassland, shrub-steppe habitat, or open forest (Ponderosa Pine) habitat types, talus slopes that support larger, ground-based prey
    - Anthropogenic features (opportunistic use): agricultural and/or modified habitats that support prey (large arthropods, small vertebrates), including ranch pastures, vineyards, and old fruit orchards, gravel roads

The areas containing critical habitat for the Pallid Bat (totalling 35,945.6 ha) are presented in Figures 1 and 2. Critical habitat for the Pallid Bat in Canada occurs within the shaded polygons (units) shown on this map, where the biophysical attributes described in the above section are met. As the Pallid Bat will forage in/near areas characterized as roosting habitat, the pink polygons (units) represent areas containing roosting and foraging habitat, whereas the yellow polygons (units) outside the roosting areas represent only foraging habitat. Unsuitable habitats such as the running surface of paved roads and railways, open water (lakes, rivers), and all habitat above 800 m in elevation are not known to possess the attributes required by the Pallid Bat for roosting and/or foraging, and they are not identified as critical habitat even when they occur within the shaded polygons (i.e., detailed geospatial units containing critical habitat).

[8] Information (from B.C., and the U.S.A.) indicates that foraging distances range from 1.5 km to 11 km (Chapman et al. 1994; Lewis 1996; Brown et al. 1997; Rambaldini 2006; Baker et. al 2008). Rambaldini (2006) found that seven male conspecifics from the same roosting area all foraged within 1.5 km of the day roost in the Okanagan. Research from Chapman et al. (1994) shows maximum nightly movements of up to 4.3 km from day roost to foraging areas in the south Okanagan. Researchers in the U.S.A. provide movement estimates of 3 km (Bell 1982), 4 km (Lewis 1996), and 6.7 km (Baker et al. 2008). In the same study, Baker et al. (2008) found that six lactating females from six different roosts traveled a maximum average foraging distance of 4.52 km. Thus a 4.5 km distance was considered to represent the majority of best available data for Pallid Bat foraging.

[9] Pallid Bat use of winter hibernacula in Canada has been recently confirmed by species experts, (C.Lausen and C.Corben), based on acoustic calls recorded December 3 and 5, 2015.

A schedule of studies has been included to provide the information necessary to complete the identification of critical habitat. The identification of critical habitat will be updated when the information becomes available, either in a revised recovery strategy or action plan(s).

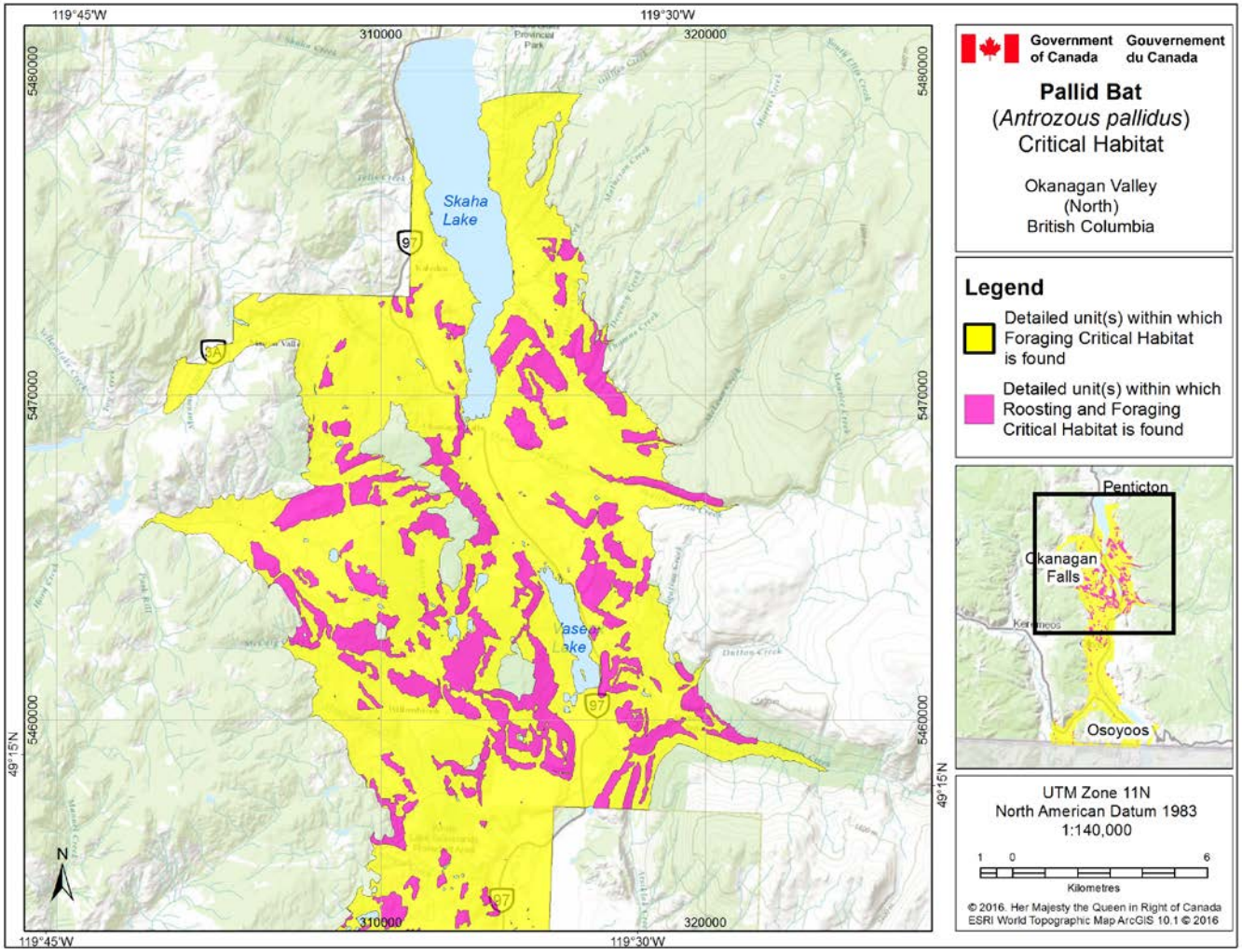

Figure 1. Critical habitat for Pallid Bat in the Okanagan Valley (north) of B.C. is represented by the shaded pink polygons (roosting and foraging critical habitat), and the shaded yellow polygons (additional foraging critical habitat), where the criteria set out in Section 1.1 are met.

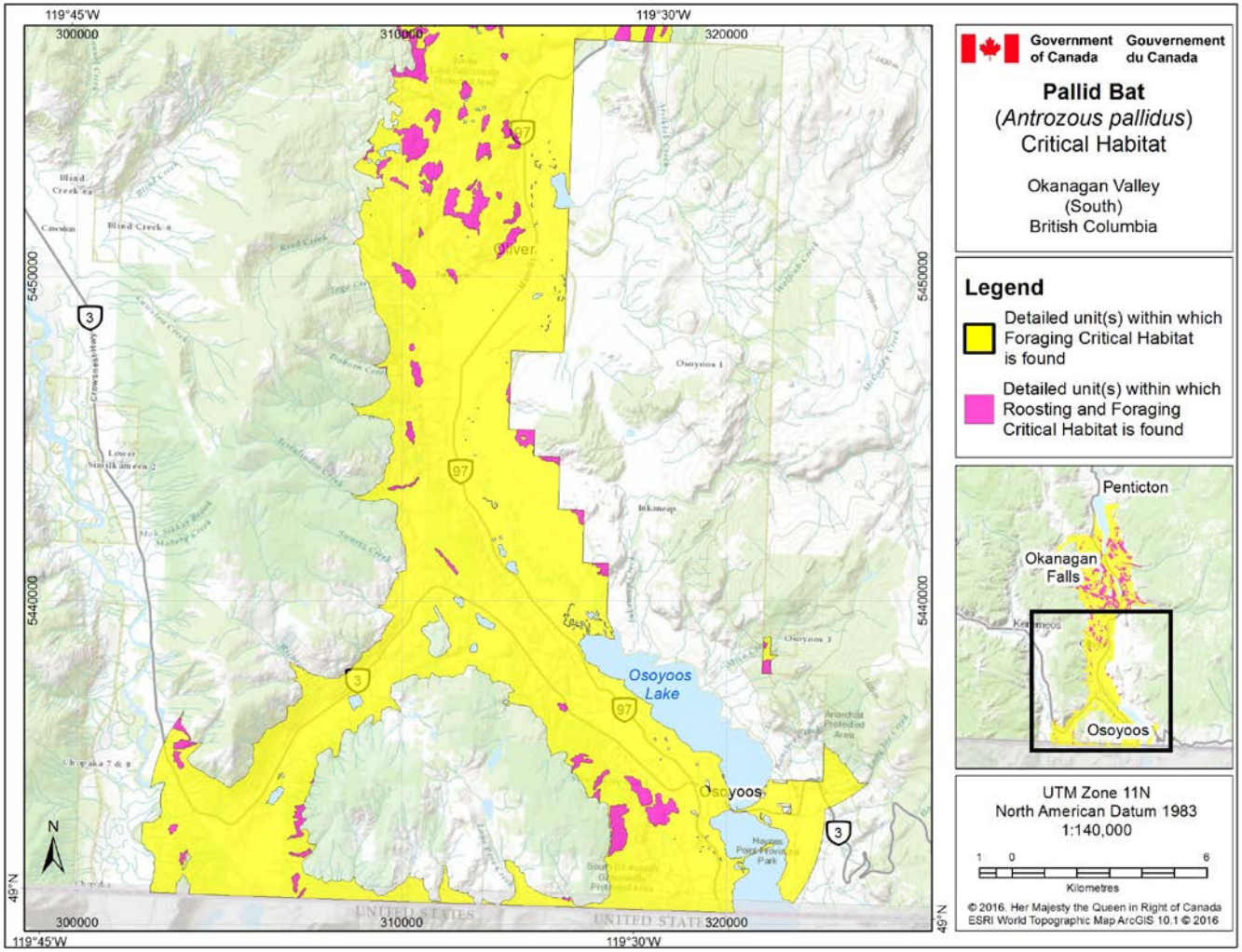

Figure 2. Critical habitat for Pallid Bat in the Okanagan Valley (south) of B.C. is represented by the shaded pink polygons (roosting and foraging critical habitat), and the shaded yellow polygons (additional foraging critical habitat), where the criteria set out in Section 1.1 are met.

1.2 Schedule of Studies to Identify Critical Habitat

The following schedule of studies (Table 1) describes the activities required to complete the identification of critical habitat for the Pallid Bat. This section addresses parts of critical habitat that are known to be missing from the identification based on information that is available at this time. Actions required to address future *refinement* of critical habitat (such as fine-tuning boundaries, and/or providing greater detail about use of biophysical attributes) are not included here. Priority recovery actions to address these kinds of knowledge gaps are outlined in the recovery planning table in the adopted provincial recovery plan.

Table 1. Schedule of studies required to identify critical habitat for the Pallid Bat

Activity	Rationale	Timeline
Work with applicable organizations to complete the identification of critical habitat for the Pallid Bat occurring at locations near Osoyoos and Oliver.	Critical habitat has not been identified for a portion of lands in these areas. This activity is required such that sufficient critical habitat is identified to meet the population and distribution objectives (Part 2, Recovery Goal and Objectives).	2017 - 2022
Determine the composition, quantity, and biophysical attributes of trees that are required for night roosting	Pallid Bat requires habitat for night roosting. Night roost habitat has been partially identified in this recovery strategy, based on rock crevice habitat that is identified for day roosts (i.e., Pallid Bat uses these features for all types of roosting). However, the specific composition, quantity, and quality of coniferous and/or deciduous trees required for night roosting is unknown. This activity is required to complete the identification of critical habitat.	2017 - 2022
Identify the biophysical attributes of roosting habitat that occurs in anthropogenic structures	Pallid Bats have been observed to use old mines, buildings, and bridges as day roosts and/or hibernacula in other parts of their range. The extent of information available is inadequate to describe the specific attributes of anthropogenic features that are required by Pallid Bat in Canada. This activity is required to complete the identification of critical habitat.	2017 - 2022

1.3 Activities Likely to Result in Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 1 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Table 2. Examples of activities likely to result in the destruction of critical habitat for the Pallid Bat. IUCN Threat numbers are in accordance with the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (CMP 2010).

Description of activity	Description of effect (biophysical attribute or other) in relation to habitat function loss	Details and relationship threats
Development and/or use of rock climbing routes in roosting habitat.	Installing rock climbing routes can result in the removal or modification of rock and crevice surfaces, which can degrade or destroy the attributes that make it a suitable roost or hibernacula for Pallid Bat (e.g. changing opening structure, or cause slabs to break off) Recreational users can also destroy roosting habitat by introducing the fungus that causes White-nose Syndrome (WNS).	Related IUCN Threat # 6.1, 8.1 Rock climbing is a growing recreational activity in the area and could pose a threat to day roosting habitat. Introduction of WNS may result in permanent or temporary destruction of roosting habitat. Destruction is most likely when recreational users do not follow proper decontamination protocols as described by provincial Best Management Practices.[10]
Blasting, quarrying or other cliff/rock removal (e.g. for highway widening or rock quarrying) in roosting habitat.	Blasting of rock outcroppings and rock quarrying would likely result in direct and permanent loss of roosting or hibernation habitat. Blasting, quarrying and other types of rock removal can also result in local acoustic or mechanical disturbance to the extent that the habitat is either temporarily or permanently unusable by Pallid Bat for this function	Related IUCN Threat #: 3.2, 4.1
Conversion of native foraging habitat to residential and commercial development, agricultural, roads and railroads and/or other modified habitat (including conversion of “preferred use” native habitat types to “opportunistic use” anthropogenic habitat types outlined in Section 1.1).	Results in the degradation and /or direct loss of optimal Pallid Bat foraging habitat from the landscape. Conversion results in a reduction and/or elimination of the prey species that the Pallid Bat is dependent upon, and thereby a reduction in the capacity of the area to support Pallid Bats.	Related IUCN Threat # 1.1, 1.2, 1.3, 2.1, 2.3, 4.1 These threats are on-going although likely at lower levels than in the past as many of these areas have already been converted. Conversion of native habitat into residential housing and urban areas, and/or for agricultural operations (primarily orchards and vineyards) are currently the most likely to cause destruction, however additional development threats (commercial, industrial, tourism, and/or recreation – individually described as negligible threats) may combine to have significant cumulative impacts.
Conversion of existing agricultural and/or other modified anthropogenic habitat types (e.g. ranch pastures, vineyards, old fruit orchards) to residential and commercial development such that there is permanent net loss of opportunistic foraging habitat for Pallid Bat.	Modified habitats are sub-optimal for foraging (compared to native habitat) but they are necessary to ensure there is sufficient prey within foraging distance of roosting habitat. Conversion without replacement of functionally equivalent habitat within foraging distance of roosting habitat results in a reduction and/or elimination of the prey species that the Pallid Bat is dependent upon, and thereby a reduction in the capacity of the area to support the Pallid Bat.	Related IUCN Threat # 1.1,1.2,1.3 See related comments above.

[10] Best Management Practices for Bats in British Columbia

2. Statement on Action Plans

One or more action plans will be posted on the Species at Risk Public Registry by 2022.

3. Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[11]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[12] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The provincial recovery plan for the Pallid Bat contains a section describing the effects of recovery activities on other species (i.e., Section 9). Environment and Climate Change Canada adopts this section of the provincial recovery plan as the statement on effects of recovery activities on the environment and other species.

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Part 2 – *Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia*, prepared by the Pallid Bat Recovery Team for the British Columbia Ministry of Environment

Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia

Prepared by B.C. Ministry of Environment

November 2016

About the British Columbia Recovery Series

This series presents the recovery documents that are prepared as advice to the Province of British Columbia on the general approach required to recover species at risk. The Province prepares recovery documents to ensure coordinated conservation actions and to meet its commitments to recover species at risk under the *Accord for the Protection of Species at Risk in Canada* and the *Canada–British Columbia Agreement on Species at Risk*.

What is recovery?

Species at risk recovery is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a provincial recovery document?

Recovery documents summarize the best available scientific and traditional information of a species or ecosystem to identify goals, objectives, and strategic approaches that provide a coordinated direction for recovery. These documents outline what is and what is not known about a species or ecosystem, identify threats to the species or ecosystem, and explain what should be done to mitigate those threats, as well as provide information on habitat needed for survival and recovery of the species. The provincial approach is to summarize this information along with information to guide implementation within a recovery plan. For federally led recovery planning processes, information is most often summarized in two or more documents that together make up a recovery plan: a strategic recovery strategy followed by one or more action plans used to guide implementation.

Information in provincial recovery documents may be adopted by Environment and Climate Change Canada for inclusion in federal recovery documents that federal agencies prepare to meet their commitments to recover species at risk under the *Species at Risk Act*.

What's next?

The Province of British Columbia accepts the information in these documents as advice to inform implementation of recovery measures, including decisions regarding measures to protect habitat for the species. Success in the recovery of a species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this document. All British Columbians are encouraged to participate in these efforts.

For more information

To learn more about species at risk recovery in British Columbia, please visit the B.C. Recovery Planning webpage at:
<http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning>

Recovery Plan for the Pallid Bat (*Antrozous pallidus*) in British Columbia

Prepared by B.C. Ministry of Environment

November 2016

Recommended citation

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Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:
http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/recovery-planning

Disclaimer

This recovery plan has been prepared by the British Columbia Ministry of Environment, as advice to the responsible jurisdictions and organizations that may be involved in recovering the species. The B.C. Ministry of Environment has received this advice as part of fulfilling its commitments under the *Accord for the Protection of Species at Risk in Canada* and the *Canada–British Columbia Agreement on Species at Risk*.

This document identifies the recovery strategies and actions that are deemed necessary, based on the best available scientific and traditional information, to recover Pallid Bat populations in British Columbia. Recovery actions to achieve the goals and objectives identified herein are subject to the priorities and budgetary constraints of participatory agencies and organizations. These goals, objectives, and recovery approaches may be modified in the future to accommodate new findings.

The responsible jurisdictions have had an opportunity to review this document. However, this document does not necessarily represent the official positions of the agencies or the personal views of all individuals.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that may be involved in implementing the directions set out in this plan. The B.C. Ministry of Environment encourages all British Columbians to participate in the recovery of Pallid Bat.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The Pallid Bat (*Antrozous pallidus*) is a relatively large bat (102–135 mm body length) with long, prominent ears and large eyes. It has a strikingly unique appearance with creamy-white dorsal fur, ivory or white ventral fur, and grey or pinkish brown wing membranes. These bats have been observed in Canada, most commonly from late May to mid-October, in cliff, shrub–steppe, and open ponderosa pine (*Pinus ponderosa*) habitats below 800 m in the south Okanagan valley of British Columbia.

The Pallid Bat is designated as Threatened in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the species is included on Schedule 1 of the *Species at Risk Act* (SARA). The Threatened designation by COSEWIC is related to the bat's small estimated population size, restricted distribution, restricted availability of roosting habitat, a continued decline in foraging habitat, and because a rescue effect from neighbouring populations in Washington State has been assessed as highly unlikely.

In British Columbia, the Pallid Bat is ranked S2 by the B.C. Conservation Data Centre and is on the provincial Red list. The B.C. Conservation Framework ranks the Pallid Bat as a priority 2 under goal 3 (maintaining the diversity of native species and ecosystems). It is an offence to kill or capture the Pallid Bat under the provincial *Wildlife Act*.

Known threats to the Pallid Bat in Canada include the emerging threat of white-nose syndrome, as well as the loss and degradation of foraging and roosting habitat from transportation and service corridors, residential development, agricultural development, and recreational activities.

The recovery (population and distribution) goal is to maintain current Pallid Bat populations within their Canadian range.

The following are the recovery objectives for the Pallid Bat:

1. to protect,[1] manage, and monitor Pallid Bat habitats, including maternity roosts, day roosts, hibernacula, night roosts, and foraging habitat, to ensure that suitable characteristics of the habitat remain available to the species;
2. to determine Pallid Bat population trends and vital rates (e.g., survival rates, reproductive rates);
3. to identify the full range extent of the Pallid Bat in British Columbia, with a focus on identifying the location of maternity roosts and hibernacula;
4. to conduct research into the impact of threats to roosts and foraging habitat (e.g., habitat conversion and development, grazing, fire and fire suppression), threats to bats (e.g., white-nose syndrome, recreational activities, human disturbance, and pesticide use) and effectiveness of recovery actions; and
5. to improve our understanding of key factors contributing to Pallid Bat decline, and possible constraints to recovery.

[1] Protection can be achieved through various mechanisms, including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, protected areas, and mitigation of threats.

RECOVERY FEASIBILITY SUMMARY

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are some unknowns regarding the feasibility of recovery of the Pallid Bat in British Columbia. However, recovery is deemed feasible and this recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. **Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.**
   YES. The Canadian population of Pallid Bats includes animals capable of reproduction. Reproductive females, sexually mature males, and juveniles have been captured.

2. **Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.**
   YES. It is believed that sufficient suitable roosting and foraging habitat exists at currently occupied sites. A substantial amount of foraging habitat has been lost to agricultural and urban conversion and loss and degradation of habitat is still occurring. Although the species is known to use human-modified habitats such as agricultural fields (e.g., pastures, vineyards, and fruit orchards), it uses these modified habitats significantly less than native foraging habitats (i.e., grassland, shrub–steppe, and ponderosa pine (*Pinus ponderosa*) habitats). In addition to retaining currently available habitat, it is possible that suitable foraging habitat could be created or restored through habitat restoration.

3. **The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.**
   UNKNOWN. The primary threats to the species are White-nose Syndrome (WNS), which is anticipated to be detected in B.C. within the next 5 years, habitat loss and disturbance due to development, and disturbance due to recreational activities. The recent detection of WNS on the west coast of the United States indicates that WNS will arrive and/or be detected in B.C. within the next few years. Bat-to-bat transmission of the fungus can not be easily managed; however, inadvertent spread through human vectors can be avoided or mitigated. Techniques do not yet exist to minimize or mitigate the effects of this disease on bats but intensive research is ongoing and treatment/mitigation measures may be available in the near future. Populations may also develop natural immunity after the first wave of disease spread and could potential recover naturally from the decline as long as suitable high-quality habitat remains available and other non-disease threats are minimized. Habitat loss and disturbance can be at least partially avoided or mitigated through habitat protection, habitat management, restoration, and voluntary stewardship programs. Other activities such as grazing, mining, fire suppression, predation from domestic cats and the effects of pollution may affect the species but the impact of these threats is currently unknown. Research is required to better understand these threats and to develop mitigation strategies where necessary.

4. **Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.**
   YES. Habitat protection, habitat rehabilitation, and habitat management are recovery techniques that can be used to achieve the population and distribution objectives. Habitat protection options include creation of wildlife management areas, provincial parks, and

protected areas; acquisition; creation of wildlife habitat areas if the species is included in the Identified Wildlife Management Strategy (Province of British Columbia 2004); and designation of critical habitat under the SARA. Habitat management and restoration through voluntary stewardship by landowners will be essential to meeting objectives. Research on the ecology of the species and habitat use are essential to setting restoration targets for the species.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Date of Assessment: November 2010
Common Name (population): Pallid Bat
Scientific Name: *Antrozous pallidus*
COSEWIC Status: Threatened
Reason for Designation: This relatively large but rare bat is restricted to the semi-arid shrub-steppe of the southern Okanagan Valley, BC at the northern limit of its global distribution. Although the number of known individuals has increased since the last assessment, this can be attributed to increased survey effort and the enhanced knowledge of roost sites. Nevertheless, the population is still thought to be small (fewer than 1000 individuals), cliffs available for roosting are very limited and foraging habitat is in continuing decline.
Criteria Applied:[a] D1. The population is estimated to have < 1000 mature individuals.
Canadian Occurrence: British Columbia.
COSEWIC Status History: Designated Special Concern in April 1988. Status re-examined and designated Threatened in May 2000. Status re-examined and confirmed in November 2010.

* Committee on the Status of Endangered Wildlife in Canada.

[a] See COSEWIC quantitative criteria and guidelines for the status assessment of wildlife species (Table 2 of the COSEWIC assessment process guidelines: http://www.cosewic.gc.ca/eng/sct0/assessment_process_e.cfm).

2 SPECIES STATUS INFORMATION

Pallid Bat[a]	
Legal Designation:	
FRPA:[b] No OGAA:[b] No	B.C. *Wildlife Act:*[c] Schedule A SARA:[d] Schedule 1 – Threatened (2003)
Conservation Status[e]	
B.C. List: Red B.C. Rank: S2 (2015) National Rank: N2 (2011) Global Rank:[f] G4 (2015)	
Other Subnational Ranks:[f] Arizona: S4; California: S3; Colorado: S4; Idaho: S3; Kansas: S1; Montana: S2; Navajo Nation: S5; Nevada: S3; New Mexico: S4S5; Oklahoma: S3; Oregon: S2; Texas: S5; Utah: S4; Washington: S2S3; Wyoming: S1	
B.C. Conservation Framework (CF)[g]	
Goal 1: Contribute to global efforts for species and ecosystem conservation.	Priority:[h] 6 (2009)
Goal 2: Prevent species and ecosystems from becoming at risk.	Priority: 6 (2009)
Goal 3: Maintain the diversity of native species and ecosystems.	Priority: 2 (2009)
CF Action Groups:[g]	Compile Status Report; List under *Wildlife Act*; Send to COSEWIC; Planning; Habitat Protection; Habitat Restoration; Private Land Stewardship; Species and Population Management

[a] Data source: B.C. Conservation Data Centre (2015) unless otherwise noted.

[b] No = not listed in one of the categories of wildlife that requires special management attention to address the impacts of forest and range activities on Crown land under the *Forest and Range Practices Act* (FRPA; Province of British Columbia 2002) and/or the impacts of oil and gas activities on Crown land under the *Oil and Gas Activities Act* (OGAA; Province of British Columbia 2008).

[c] Schedule A = designated as wildlife under the B.C. *Wildlife Act*, which offers it protection from direct persecution and mortality (Province of British Columbia 1982).

[d] Schedule 1 = found on the List of Wildlife Species at Risk under the *Species at Risk Act* (SARA; Government of Canada 2002).

[e] Red: Includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. S = subnational; N = national; G = global; T = refers to the subspecies level; B = breeding; X = presumed extirpated; H = possibly extirpated; 1 = critically imperiled; 2 = imperiled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.

[f] Data source: NatureServe (2015).

[g] Data source: B.C. Ministry of Environment (2009).

[h] Six-level scale: Priority 1 (highest priority) through to Priority 6 (lowest priority).

3 SPECIES INFORMATION

3.1 Species Description

The Pallid Bat (*Antrozous pallidus*) is a relatively large bat (102–135 mm body length) with long, prominent ears and large eyes (see cover photo). The ears have a series of horizontal pleats that allow Pallid Bats to furl their ears. The dorsal fur is usually cream-coloured with light grey or light brown tips, ventral fur is ivory or white, and wing membranes are grey or pinkish brown. It has scroll-shaped nostrils and small glands on its muzzle that secrete a musky, skunk-like scent (Nagorsen and Brigham 1993).

3.2 Populations and Distribution

The Pallid Bat inhabits hot, arid regions across western North America (Figure 1), from southern British Columbia to central Mexico with an isolated population in Cuba (Orr and Silva Taboada 1960; Silva Taboada 1976). Less than 1% of the Pallid Bat's known global distribution is in Canada.

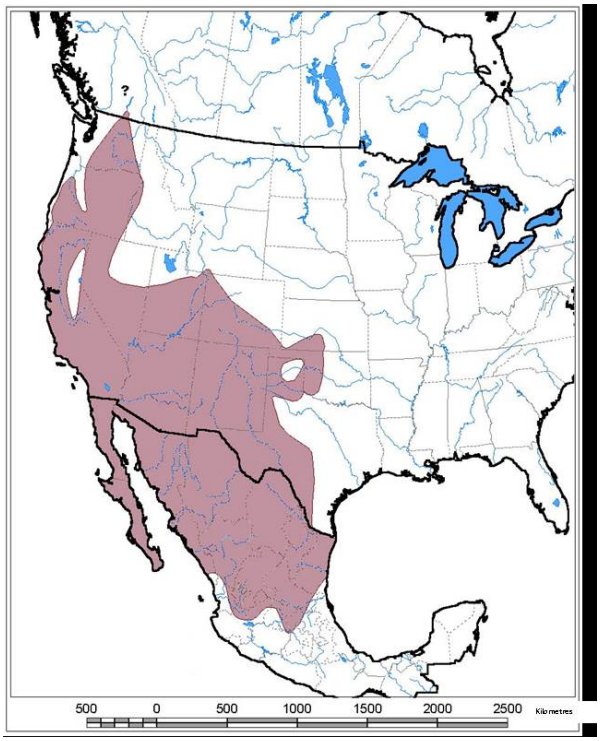

Figure 1. Global distribution of Pallid Bat, excluding an isolated population in Cuba (Pallid Bat Recovery Team 2008).

In Canada, Pallid Bat is known only from the semi-arid shrub–steppe of the southern Okanagan Valley, south of Penticton, in south-central British Columbia at elevations lower than 800 m (Figure 2). The species is difficult to detect using standard bat inventory techniques such as netting and acoustic surveys (B.C. Ministry of Environment, Lands and Parks 1998). The

species is rarely captured, likely because of their small population size. Identification through acoustic surveys is difficult because they limit their use of echolocation for foraging; instead, they listen for sounds their prey makes before landing to capture the prey item (Bell 1982; Fuzessery *et al.* 1993). In addition, their calls are similar to two species with overlapping ranges (Silver-haired Bat [*Lasionycteris noctivagans*] and Big Brown Bat [*Eptesicus fuscus*]), which makes them difficult to identify with certainty even when echolocation calls are detected.

The Canadian population is currently estimated at 250–1000 individuals by COSEWIC (2010). COSEWIC (2010) stated this estimate reflected Rambaldini's (2006) statement that "at least" 250 Pallid Bats reside in the Okanagan Valley based on roost surveys; however, this number was considered an underestimate by both Rambaldini and COSEWIC because other areas known to be occupied by Pallid Bat were not surveyed by Rambaldini (2006).

The capture of sexually mature males and lactating females (Schowalter 1980; Grindal *et al*. 1991; Chapman *et al*. 1994; Willis and Bast 2000; Rambaldini 2005; Rambaldini 2006; Sarell 2007) confirms that individuals capable of reproduction are present in the population. The capture of individuals with worn teeth suggests that these individuals are not dispersing juveniles or yearlings from the United States (Willis and Bast 2000). The majority (85/98, 87%) of captures with suitable data in British Columbia have been of males, with 13 females forming about 13% of captures. In some areas, males and females may be sexually segregated in summer (O'Shea and Vaughan 1977; Hermanson and O'Shea 1983; Lewis 1994), which could make field-based estimates of sex ratio unreliable (Hermanson and O'Shea 1983). The capture of reproductive males and females in the same area (e.g., Collard *et al*. 1990; Rambaldini 2006; Sarell 2007) suggests that this may not be the case in British Columbia. It is unknown whether the apparent male bias in the provincial sex ratio is related to sampling bias or is reflective of a population with few females, which has implications for the reproductive capacity of the population.

Population and distribution trends are not known, but the species may be declining concomitant with a loss of antelope-brush (*Purshia tridentata*; Lea 2008; Iverson 2012), big sagebrush (*Artemisia tridentata* ssp. *tridentata*; B.C. Conservation Data Centre 2016), and open grassland habitats, which have been identified as important foraging habitat in Canada (Chapman *et al.* 1994; Rambaldini and Brigham 2011). While most Pallid Bat records are known from a First Nation's lands in the Osoyoos area, Pallid Bats have also been captured on conservation (e.g., Sage and Sparrow Conservation Area owned by the Nature Conservancy of Canada). and private lands south of Penticton (B.C. Conservation Data Centre 2015).

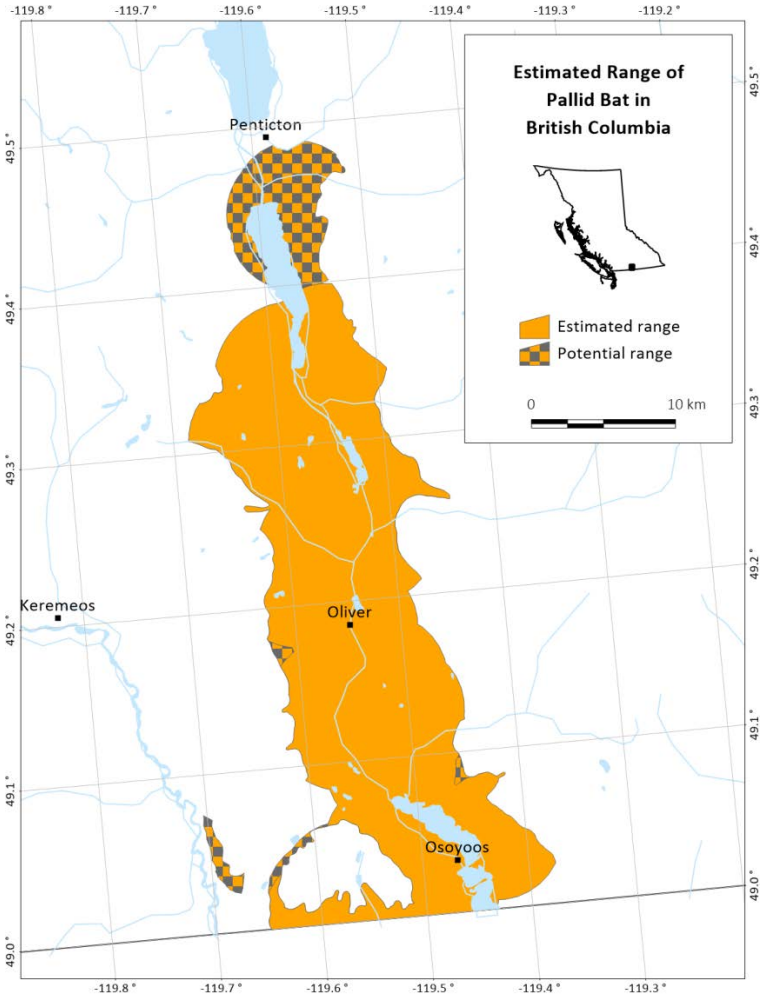

Figure 2. Estimated Pallid Bat distribution (solid orange) in British Columbia created by buffering capture records by 4.5 km, and then clipping the areas to Bunchgrass and Ponderosa Pine biogeoclimatic subzones (BGxh1 and PPxh1). The potential range (checkered orange and grey) is created using the same methodology but includes visual and acoustic records that have not been verified by capture data. The potential range highlight areas for more intensive surveys but these areas are not included in the area of occupancy and other range/occupied area estimations.

3.3 Habitat and Biological Needs of the Pallid Bat

Throughout their range, Pallid Bats are generally found in low-elevation (< 1830 m) hot, dry, shrub–steppe or open forest habitats, especially those characterized by rocky outcrops, canyon landscapes, and rugged terrain (Orr 1954; Hermanson and O'Shea 1983). All confirmed provincial records are from the very hot and dry Bunchgrass and Ponderosa Pine biogeoclimatic subzones (BGxh1 and PPxh1) south of Penticton, B.C., generally below an elevation of 800 m (Grindal *et al*. 1991; Nagorsen and Brigham 1993; Chapman *et al*. 1994; Willis and Bast 2000; Rambaldini 2006; Sarell 2007). Within these areas, Pallid Bats use a variety of habitats for roosting (day, night, and hibernation) and foraging (Table 1).

Table 1. Summary of essential functions, features, and attributes of Pallid Bat habitat in British Columbia.

Life stage(s) supported	Function[a]	Feature (s)[b]	Attributes[c]
All life history stages	Day roosting, summer	Naturally occurring rock crevices within cliff faces, talus slopes, stone piles, and boulders in grassland areas. Elsewhere use crevices and cavities in trees, snags, buildings, caves, and mines	• Used April to October, inclusive • Warm, generally stable temperature • Areas used by female/juvenile groups may not overlap geographically with males • Insufficient information to indicate differences between roosts used by males, females • Typically located near (~ <4.5 km) foraging areas • May require proximity to drinking water
All life history stages	Night roosting, summer	Day roost sites, other rock crevices, small caves, tree cavities (e.g., ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), deciduous trees in riparian areas, and fruit trees in orchards), bridges, carports, and decks; elsewhere also use buildings and mines	• Used April to October, inclusive • Males, females, and volant (able to fly) juveniles use roosts together • Typically located near day roost areas • Typically located near foraging areas and may require proximity to water
All life history stages	Hibernation	Features used in the province are not yet described; presumed similar to day roost sites based on literature. Elsewhere use rock crevices, mines, caves, and buildings	• Used likely October or November through to April, inclusive • Elsewhere use sites where relative humidity remains high and temperature does not drop below freezing in winter
Adult bats, and juveniles able to fly	Foraging	Areas with diverse and abundant prey that are open (little vegetation) to allow Pallid Bats to land to capture prey are preferred; will opportunistically use areas that are open but with less diverse and abundant prey *Preferentially:* natural grassland, shrub–steppe, or open forest *Opportunistically:* open habitats, including modified habitats that support prey at lower amounts than preferred habitat	• Used April to October, inclusive • Forage in open areas that support prey (large arthropods, small vertebrates) • In proximity to day roosts • *Preferentially:* natural grasslands, shrub–steppe habitat, or open forest (ponderosa pine) • *Opportunistically:* modified habitats, including ranch pastures, vineyards, and fruit orchards; talus slopes; and/or gravel roads

[a] Function: Is a life-cycle process of the species.

[b] Feature: Features are the essential structural components of the habitat required by the species.

[c] Attribute: The building blocks or *measurable* characteristics of a feature.

There are limited data on movements of Pallid Bat. The data available indicate that summer roosting and foraging habitat used by the species are usually within a few kilometres of each other. Foraging range may vary by sex and reproductive status (Baker *et al*. 2008). In British

Columbia, Rambaldini and Brigham (2004) tracked seven bats from the same day roost, and found that most foraged within 1 km of their day roost, although one bat travelled almost 18 km from its roost. Rambaldini (2006) similarly reported that seven bats (six males and one female) captured at the same night roost foraged within 1.5 km of their day roosts. Chapman *et al*. (1994) tracked three bats from two roosts for a total of eight nights (roost 1: one bat tracked for one night; roost 2: one tracked for two nights, another tracked for five nights). For these bats the maximum movement per night between roost and foraging areas, calculated as distance moved along elevational contours and not by using straight-line distance, averaged 1740 m (range 309–4288m; Dyer, pers. comm., 2016). Research outside the province suggests a foraging range of 3–4.5 km (Bell 1982; Lewis 1996; Baker *et al.* 2008), with some longer-range movements of 6.7–30 km recorded (Davis 1966; Brown *et al.* 1997; Baker *et al.* 2008). It is likely that Pallid Bat foraging distances depend on the quality and configuration of surrounding habitat. The mostly shorter-range movements of this species suggests that the spatial arrangement of different required habitat types may be an important determinant of overall habitat suitability, and that the species might be negatively affected by habitat changes that require it to regularly fly further afield to forage.

3.3.1 Roosting Habitat

Roosting habitat for Pallid Bat consists of day roosts (including maternity roosts), night roosts, and hibernacula.

Day and night roosts are occupied from early spring to late fall (i.e., April to October, inclusive). Males and females may share roosts until parturition, at which point mature males leave the maternity roost to roost elsewhere (review in Gervais 2016). Parturition (the process of giving birth) is believed to occur in a maternity roost (a type of day roost) in July (Nagorsen and Brigham 1993). Yearling Pallid Bats do breed, at least in their more southern range, but produce only one young, whereas older females produce twins (Grinnell 1918; Hall 1946; Orr 1954; Hermanson and O'Shea 1983; Sidner 1997). In parts of their range outside Canada, hibernacula are occupied throughout winter. Exact dates of occupancy vary across the range and between years, depending on climate. Hibernation dates in British Columbia likely range from late October to late April, similar to other bat species in the province. Elsewhere, Pallid Bats mate in the hibernacula (Orr 1954; Hermanson and O'Shea 1983) or other roosts (e.g., swarming sites; Fenton 1969; Parsons *et al.* 2003) between October and February.

Summer Day Roosts

In summer, males and females roost gregariously; adult females and juvenile males and females roost together in maternity groups, and adult males usually roost separately (Vaughn and O'Shea 1976; Lewis 1996). In some areas, male and female ranges do not overlap, which can bias apparent sex ratios (Hermanson and O'Shea 1983; Lewis 1994). The largest known grouping at a day roost in the province is of adult and yearling males, where up to 130 individuals have been recorded (Rambaldini 2006; Sarell 2007; Rambaldini and Brigham 2011). Much of the information on provincial roosting sites is from males, which reflects the skewed sex ratio of captures to date. Males use rock crevices in cliff faces (Chapman *et al*. 1994; Rambaldini 2006; Sarell 2007) with warm, stable temperatures (daytime mean ranging from 23–30°C; Rambaldini 2005). One adult male was also found roosting under a pile of stones in a sand pit (Racey 1933).

Schorr and Siemers (2013) reported that 53 day roosts used by 10 radiotracked males in Colorado used crevices 9-1500 cm long, 3-25 cm wide, and an average of 46 cm deep (the depth could be measured only for 5 roosts). Little information is available about maternity roosts in the province. Rambaldini (2006) tracked one lactating female and reported she used a rock crevice that was occupied by males in previous years. The radio-tracked female and three males all roosted in the same cliff face but in different crevices. Sarell (2007) also reported that a radio-tracked female used a maternity roost in a cliff. Elsewhere, Vaughn and O'Shea (1976) reported that groupings of females and young in Arizona preferred horizontal crevices with chambers at least 30 cm wide, 12 cm high, and 60 cm deep. Miller and Jensen (2013) reported that crevices used by males and females in Kansas and Oklahoma were 3-20 cm wide. In Oregon, Lewis (1996) reported that females and young roosted in crevices when ambient temperature was warmer than average, and slabs when ambient temperature was cooler than average. Other daytime roosts reported for female Pallid Bats include cavities in large ponderosa pine live trees and snags (Arizona: Rabe *et al.* 1998; California: Baker *et al*. 2008), buildings (Orr 1954; Baker *et al*. 2008), rock crevices (Vaughan and O'Shea 1976), crevices in mines (Arizona: Sidner 197), and bridges (Arizona: Sidner 1997).

Pallid Bats show high fidelity to roosting areas but data indicate they frequently switch among several regularly used roost sites. Rambaldini and Brigham (2008) reported that males switched day roosts in British Columbia an average of every 4 days (range: 1–13 days). Females also switch roosts in the province: Rambaldini (2006) reported that a radio-tracked, lactating female switched roosts at least three times between 10 August and 4 September. Elsewhere, Lewis (1996) reported that females in Oregon switched roosts every 1.4 days on average, and that the rate of roost switching was similar among pregnant and lactating bats. However, Sidner (1997) reported that female Pallid bats studied in Arizona showed strong site fidelity to their roosts and did not move frequently between roosts. Some roosts, such as those habitually used by large aggregations (i.e., 20-100+ individuals), are occupied in consecutive years (Rambaldini and Brigham 2004; Rambaldini 2006; Rambaldini and Brigham 2008, Rambaldini and Brigham 2011).

Although Pallid Bat exhibits adaptations to a desert environment, such as the ability to concentrate urine and the ability to withstand dehydration (review in Hermanson and O'Shea 1983), proximity of the roost to a source of fresh drinking water may be important (Orr 1954; Hermanson and O'Shea 1983). In California, roosts were typically less than 600 m from water (Baker *et al.* 2008); in Colorado roosts were less than 820 m from the nearest water (Schorr and Siemers 2013); and in Kansas and Oklahoma, most were within 50 m of a water source (Miller and Jensen 2013). Additional research on the importance of drinking water to Pallid Bat is required.

Summer Night Roosts

Night roosts are typically close to day roost sites and foraging areas (Rambaldini 2006; Sarell 2007). Night roosts are used by bats to rest and consume prey. Lewis (1994) proposed that night roosts used by Pallid Bats may also serve a social function, based on her observations of bats flying directly to a night roost from a day roost, the arrival of bats at the night roost without prey, and the arrival of bats in groups. Rambaldini (2006) reported that, at a cave night roost in British

Columbia, males, females, and juveniles roosted together. Pallid Bats show fidelity to specific night roosts within and between years (Lewis 1994; Rambaldini 2006; Sarell 2007).

In British Columbia, night roost structures may include day roost locations, as well as other rock crevices, small caves, trees (e.g., ponderosa pine, Douglas-fir, deciduous trees in riparian areas, and fruit trees in orchards), bridges (Chapman *et al.* 1994; Rambaldini and Brigham 2004; Rambaldini 2006), and carports and decks (Sarell, pers. comm., 2015). Elsewhere, Pallid Bats also use buildings (Lewis 1994).

Hibernacula

To date, no hibernacula for Pallid Bat have been located in Canada, but recent recordings of Pallid Bat echolocation calls in early December 2015 at one location (confirmed by C. Corben and C. Lausen; T. Luszcz, pers. comm., 2016) indicate that individuals are present in winter; therefore, local hibernation is highly probable. At more southerly latitudes, Pallid Bats hibernate within deep narrow crevices inside caverns, caves, abandoned mines, and buildings where relative humidity remains high and temperature does not drop below freezing throughout the winter (Hall 1946; review in Orr 1954; Twente 1955a, 1955b; Johnston 2004).

3.3.2 Foraging Habitat

Pallid Bats in Canada forage over open native habitat (i.e., grassland, shrub–steppe, and ponderosa pine habitats), modified habitats (e.g., ranch pastures, vineyards, and fruit orchards; and gravel roads), and talus slopes (Chapman *et al.* 1994; Rambaldini and Brigham 2011). Rambaldini and Brigham (2011) reported that Pallid Bat foraging activity in the province was significantly higher over native shrub–steppe habitat, which was dominated by antelope-brush, big sagebrush, gray rabbitbrush (*Ericameria nauseosa* var. *nauseosa*), open ponderosa pine, and bunchgrasses, than over vineyards. The authors suggested the use of vineyards was primarily opportunistic (i.e., foraging while flying over the habitat enroute to other foraging habitats), and that the large areas of open ground in vineyards may provide a suitable location to land and catch prey (Rambaldini and Brigham 2011). Although the vineyard habitat provided suitable areas of open habitat, Rambaldini and Brigham (2011) found that prey quality was significantly lower in vineyards than in native habitat. The insect population was less diverse and individual insects in vineyards tended to be smaller than in native habitat. In addition, Jerusalem crickets (*Stenopelmatus fuscus*), which are an important food source for Pallid Bats (Ross 1961; Ball 1998 *cited in* Rambaldini and Brigham 2011; Johnston and Fenton 2001), were found only in the native habitat (Rambaldini and Brigham 2011).

Pallid Bats feed on a variety of large arthropods (Ross 1961; O'Shea and Vaughan 1977; Hermanson and O'Shea 1983; Johnston and Fenton 2001), occasionally taking small vertebrates (O'Shea and Vaughan 1977; Bell 1982). The most common foraging strategy for Pallid Bat involves listening for prey (usually terrestrial) rather than using echolocation, and then gleaning larger prey items from the ground (Bell 1982; Johnston and Fenton 2001) and consuming them later, either in flight or at a night roost (O'Shea and Vaughan 1977; Bell 1982; Fuzessery *et al.* 1993). As a result of this foraging strategy, Pallid Bats often forage in open areas where it is easier to land and to hear prey (Huey 1936; Bell 1982; Chapman *et al.* 1994; Ball 2002). Pallid Bats will also catch smaller prey items on the wing (Johnston and Fenton 2001), and will glean

insects from vegetation (O'Shea and Vaughan 1977; Gervais 2016). Based on an analysis of fecal pellets from bats in the province, Grindal *et al*. (1991) reported that beetles were the most common prey item for Pallid Bat (present in 70% of the 29 pellets examined), followed by moths (28%) and neuropterans (7%). Rambaldini and Brigham (2011), in a study of 93 fecal pellets from bats in British Columbia, reported that approximately 70% of the prey taken by Pallid Bats in the Okanagan was scarab beetles; Jerusalem crickets were the second-most consumed prey item (12%). Rambaldini and Brigham (2011) also reported that Jerusalem crickets were the dominant food item (35.5% of prey eaten) present in 39 fecal pellets from Pallid Bats in Washington State.

3.4 Ecological Role

The Pallid Bat's ecological role is not well known. It provides ecosystem services as a predator of large arthropods, including several that are considered crop pests. The value of these types of services can be significant (Kunz *et al.* 2011). In Canada, diet studies indicate that Pallid Bats eat ten-lined June beetle (*Polyphylla decemlineata*), California root borer (*Prionus californicus*), scarab beetles (*Phyllophaga* spp.) and other Coleoptera; moths (Lepidoptera); crickets (Orthoptera), including Jerusalem cricket; and Neuropterans (Grindal *et al.* 1991; Rambaldini and Brigham 2011). A study of the Big Brown Bat, which also eats a diet comprised largely of beetles such as cucumber beetles, beetles, leafhoppers, and stinkbugs, predicted that a colony of 150 bats would consume approximately 1.28 million of these insects annually and prevent the production of 33 million cucumber beetle larvae, which is a crop pest (Whitaker 1995). The Pallid Bat's foraging strategy, which includes landing on the ground to capture prey, can make it vulnerable to capture by owls, snakes, and domestic cats (review in Hermanson and O'Shea 1983). Because of the Pallid Bat's small population size and limited distribution in Canada, its impact on food webs is likely localized.

3.5 Limiting Factors

Limiting factors are generally not human-induced and include characteristics that make the species less likely to respond to recovery/conservation efforts (e.g., small population size, few females known to occur in the population, and limited availability of habitat).

Pallid Bat in British Columbia is at the extreme northern extent of its global distribution, is dependent on a habitat type rare north of the 49th parallel, and has a preference for dry, hot climates. Suitable habitat for Pallid Bat is thus naturally limiting for this species in Canada, and recent loss of foraging habitat related to agricultural and urban conversion has exacerbated this problem. The small population size (estimated at < 1000 individuals) and apparently low numbers of females in the province will limit population growth and persistence. The full suite of biologically limiting factors for Pallid Bat in the province is not well known.

4 THREATS

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational) (adapted from Salafsky *et al.* 2008). For purposes of threat assessment, only present and future threats are considered.[2] Threats presented here do not include limiting factors,[3] which are presented in Section 3.5.

[2] Past threats may be recorded but are not used in the calculation of threat impact. Effects of past threats (if not continuing) are taken into consideration when determining long-term and/or short-term trend factors (Master *et al.* 2012).

[3] It is important to distinguish between limiting factors and threats. Limiting factors are generally not human-induced and include characteristics that make the species less likely to respond to recovery/conservation efforts (e.g., inbreeding depression, small population size, and genetic isolation).

4.1 Threat Assessment

The threat classification below is based on the IUCN–CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system and is consistent with methods used by the B.C. Conservation Data Centre. For a detailed description of the threat classification system, see the Open Standards website (Open Standards 2014). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For information on how the values are assigned, see Master *et al*. (2012) and table footnotes for details. Threats for the Pallid Bat were assessed for the entire province, and were based on a three-generation time frame of 15 years (Table 2).

Table 2. Threat classification table for Pallid Bat in British Columbia.

Threat #[a]	Threat description	Impact[b]	Scope[c]	Severity[d]	Timing[e]
1	Residential & commercial development	Low	Small	Extreme–Serious	High
1.1	Housing & urban areas	Low	Small	Serious	High
1.2	Commercial & industrial	Negligible	Negligible	Extreme–Serious	High
1.3	Tourism & recreation areas	Negligible	Negligible	Serious	High
2	Agriculture & aquaculture	Low	Small	Serious	High
2.1	Annual & perennial non-timber crops	Low	Small	Serious	High
2.3	Livestock farming & ranching	Unknown	Pervasive	Unknown	High
3	Energy production & mining	Medium–Low	Restricted–Small	Serious–Moderate	High
3.2	Mining & quarrying	Medium–Low	Restricted–Small	Serious–Moderate	High
4	Transportation & service corridors	Medium–Low	Pervasive	Moderate–Slight	High
4.1	Roads & railroads	Medium–Low	Pervasive	Moderate–Slight	High
6	Human intrusions & disturbance	Low	Small	Slight	High
6.1	Recreational activities	Low	Small	Slight	High
6.3	Work & Other Activities	Negligible	Small	Negligible	High
7	Natural system modifications	Unknown	Small	Unknown	High
7.1	Fire & fire suppression	Unknown	Small	Unknown	High
8	Invasive & other problematic species, genes & diseases	Very High	Pervasive	Extreme	Moderate
8.1	Invasive non-native/alien species/diseases	Very High	Pervasive	Extreme	Moderate
9	Pollution	Unknown	Restricted–Small	Unknown	High
9.3	Agricultural & forestry effluents	Unknown	Restricted–Small	Unknown	High

[a] Threat numbers are provided for Level 1 threats (i.e., whole numbers) and Level 2 threats (i.e., numbers with decimals).

[b] **Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on severity and scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population. The median rate of population reduction for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75%), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment time (e.g., timing is insignificant/negligible [past threat] or low [possible threat in long term]); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[c] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. The Scope for this species was extended to a three-generation time frame to include longer-term threats that need to be addressed within this recovery planning window. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible < 1%).

[d] **Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation time frame. For this species, a generation time of 5 years was used, resulting in severity being scored over a 15 year time frame. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible < 1%; Neutral or Potential Benefit ≥ 0%).

[e] **Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or three generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

The overall province-wide Threat Impact for this species is Very High.[4] This ranking considers the cumulative impacts of multiple threats led by disease, development resulting in habitat loss and habitat fragmentation, and human disturbance. The most serious threat to Pallid Bat is white-nose syndrome (Threat #8.1). Although this disease has not yet been discovered in British Columbia, its discovery in Washington State in March 2016 indicates that, if it is not yet in the province, it will likely be detected within the period included in this Threat Assessment.[5] Other important threats are related to habitat loss or degradation from development, including road-related construction and road-widening activities (Threats #1.1, #2.1, and #4.1). Details are discussed below under the Threat Level 1 headings.

Because suitable habitat limits the potential expansion of Pallid Bat populations, fragmentation of existing habitat is a persistent threat. Behavioural studies indicate that Pallid Bats select sites where the distance between roosting and foraging habitat is ~ < 4.5 km. Fragmentation of native grasslands (preferred foraging habitat) increases this distance and reduces habitat suitability, particularly for females with dependent young.

Pallid Bats are reported to be sensitive to human disturbance (O'Shea and Vaughan 1977; Chapman *et al*. 1994), and will change or abandon roost sites even with indirect disturbance (e.g., movement within a few metres of a night roost; Chapman *et al*. 1994). Given the increasing human population in their only known Canadian range (see "1.1 Housing & urban areas" below), disturbance rates are likely increasing and may threaten the viability of otherwise suitable Pallid Bat habitat.

Little information is available on generation time of Pallid Bats (Hermanson and O'Shea 1983). Yearling Pallid Bats do breed, at least in their more southern range, but produce only one young,

[4] The overall threat impact was calculated following Master *et al.* (2012) using the number of Level 1 Threats assigned to this species, where timing = High or Moderate, included 1 Very High, 2 Medium–Low and 3 Low (Table 2). The overall threat impact considers the cumulative impacts of multiple threats.

[5] This Threat Assessment was calculated over a three-generation timeframe (15 years); see Section 4.2 for details.

whereas older females may produce twins (Hermanson and O'Shea 1983, Sidner 1997). Data on longevity of Pallid Bat in the wild are limited; Cockrum (1973) reported that the minimum age of a banded Pallid Bat was 9 years. Sidner (1997) reported a male Pallid Bat that was 10 years old and a female that was at least 11 years old. Pallid Bats in captivity are known to live 8 years (Orr 1958) and 9 years (Brown *et al.* 1978), with a maximum longevity record in captivity of 14.8 years (Weigl 2005). For *Myotis lucifugus* and *M. septentrionalis*, which are insectivorous, hibernating bats (which likely is associated with longer lifespans; Wilkinson and South 2002), and for which more information is available about lifespan and population demography, COSEWIC (2013) estimated generation time as 5–10 years. Based on the available information, a generation time of 5 years was used for Pallid Bat, which resulted in the scoring of this Threat Assessment over a 15-year time frame.

Threat 1. Residential & commercial development

1.1 Housing & urban areas

Foraging and roosting habitat quality may be degraded or permanently destroyed by residential development in native shrub–steppe habitat. Urban development is an important cause of reduction of foraging habitat for Pallid Bat. Over 67% of the antelope-brush/needle-and-thread grass ecosystem, an important foraging habitat for Pallid Bat (Rambaldini and Brigham 2011), has been lost since 1800, and the ecosystem is projected to continue this decline until the community is extirpated in all but protected sites (Iverson 2012). Seventeen percent of the remaining antelope-brush/needle-and-thread grass ecosystem was protected as of 2012 (Iverson 2012). None of the remaining habitat was considered to have "excellent" ecological integrity, although 54% of the remaining habitat was considered to have "good" ecological integrity (Iverson 2012). The big sagebrush shrub–steppe ecosystem has also declined significantly, with 33% of the ecosystem lost since 1800 (Lea 2008). This ecosystem is also projected to continue its decline (B.C. Conservation Data Centre 2016). Native grassland habitat is the best-quality foraging habitat for Pallid Bats (Rambaldini and Brigham 2011), and its conversion will fragment remaining habitat, having a negative effect on individuals because they will need to spend more time foraging or travel further to access suitable foraging habitat.

Although the cliff habitat used by Pallid Bats for roosting is unlikely to be directly affected by urban development, talus roosting habitat and night roosts in trees could be removed during development. In addition, the apparent sensitivity of Pallid Bats to disturbance (Orr 1954; Beck and Rudd 1960; Chapman *et al*. 1994; O'Shea and Vaughan 1999) could cause them to move or abandon their roost because of nearby activity.

The threat of converting native habitat into residential housing is ongoing, although currently it likely occurs at lower levels than in the past. Therefore, the severity will be Serious where it occurs, but the proportion of the population affected by development in future will be small.

1.2 Commercial & industrial areas

Similar to the threat posed by "Housing & urban areas," increasing human population within the Pallid Bat's range will likely result in continued commercial development. The severity will be Extreme to Serious for the local population where commercial development occurs, as it will

degrade or remove foraging or roosting habitat, and involve associated disturbance; however, the proportion of the population that will be affected is anticipated to be Negligible.

1.3 Tourism & recreation areas

Similar to the threat posed by "Housing & urban areas," tourism and recreation development of Pallid Bat habitats will disturb bats at roost sites, and/or degrade or destroy both foraging and roosting habitat (depending on the type of development). Developments such as golf courses or activities such as off-road vehicle use in native shrub–steppe habitat will degrade or destroy foraging habitat; developments such as rock-climbing recreational areas could disturb bats and alter the suitability of a Pallid Bat roosting area. Where recreation and tourism development alters roosting or foraging habitat, the effect would be serious; however, the proportion of the population that will be affected is anticipated to be Negligible. As tourism and recreation increases in the south Okanagan, the impact of this threat may increase.

Threat 2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops

Historically, the greatest threat to the Pallid Bat was the conversion of native habitat to agricultural crops, primarily orchards and vineyards. The most important foraging habitat for Pallid Bat has declined significantly (see Threat 1.1 for information), and the remaining habitat is projected to continue to decline in abundance and suitability (Iverson 2012; B.C. Conservation Data Centre 2016). Pallid Bats forage in open areas where they can hear prey and land on the ground to capture them (Bell 1982). Although Pallid Bats forage over agricultural areas such as vineyards where cleared areas occur, the diversity, suitability, and abundance of prey is reduced compared to native habitat (Rambaldini and Brigham 2011). Conversion of native grasslands to areas with more homogeneous and dense vegetation, such as through development of fruit-growing operations, will fragment the remaining grassland habitat and reduce the availability of the highest-quality foraging habitat for the species. Although the rate of conversion may remain stable (Iverson 2012), the overall impact is increasing because of the decreasing availability of the highest-quality habitat. Continued fragmentation of the habitat will negatively affect the species by requiring that they increase their foraging effort to maintain their prey intake.

2.3 Livestock farming & ranching

Grazing is considered Pervasive in the antelope-brush/needle-and-thread grass ecosystem (Iverson 2012) and the big sagebrush ecosystem (B.C. Conservation Data Centre 2016), which is the preferred foraging habitat of Pallid Bat. Grazing affects the soil and plant communities (Jones 2000), which are related to invertebrate abundance and diversity (Selinger 2010; Bassett and Fraser 2015). Studies have not determined whether grazing affects the preferred prey species of Pallid Bat; therefore, the specific effect of grazing on Pallid Bat prey is Unknown and requires research. If grazing negatively affects the prey of Pallid Bat, grazing could further fragment the habitat for the species, requiring bats to travel further to forage. Associated effects of converting native habitat to agriculture, including removal of trees, could negatively affect the availability of night roost trees where large ponderosa pine snags or trees are removed.

Threat 3. Energy production & mining

3.2 Mining and quarrying

Mining and quarrying activities have the potential to disturb bats or degrade bat habitat in mines, cliff/talus crevices, or rock crevices/talus, all of which may be used by Pallid Bats (e.g., Hall 1946; Twente 1955a, 1955b; Hermanson and O'Shea 1983; Johnston 2004; Godwin-Shepard 2008, *cited in* Sarell *et al.* 2012; Willis and Bast 2008). Several historic non-operating mines occur within the Pallid Bat's range and mining activity and geologic exploration is still occurring in the area (Sookochoff 2015; B.C. Ministry of Energy and Mines 2016); therefore, activities in and around mines remain a threat to Pallid Bat habitat. Reopening or permanent closure of old mines could cause direct mortality of any bats present, change the microclimate characteristics or internal structure of the site, or prevent bats from entering, which would render the site ineffective as a Pallid Bat hibernaculum. Bat-sensitive mine closures, including bat-friendly gating, can maintain important habitat attributes for bats.

Quarrying of talus or other rock may also affect Pallid Bats and their habitat. Although the number of quarries within the range of the species may be small, where quarrying of talus or other rock associated with roosts or hibernacula occurs, it may cause direct destruction of important habitat attributes and kill bats if activity occurs when the roost is occupied. Pallid Bats may also be disturbed by noise and activity around their roost from exploration and mining activities, which could cause bats to move or abandon their roost (Orr 1954; Beck and Rudd 1960; Chapman *et al*. 1994; O'Shea and Vaughan 1999; Rambaldini and Brigham 2004).

Overall, the limited data on bat use of mines and habitats subject to these activities makes the scope of the threat Restricted–Small. Where these activities occur, the potential severity can be Serious–Moderate resulting in an overall impact on the population of Medium–Low. The largest effect will occur if an important habitat feature (e.g., hibernaculum) is destroyed, or if the activity occurs when the feature is occupied by bats. In other cases (e.g., activity in an area outside of the season of use with no damage to the feature; efforts taken to mitigate effects), the impact may be Low.

Threat 4. Transportation & service corridors

4.1 Roads & railroads

Pallid Bats forage low over the ground in open areas, and use tertiary roads as foraging corridors (Collard *et al.* 1990; Chapman *et al.* 1994), which may put them at greater risk of collision with motor vehicles than other bat species. The number of Pallid Bats killed by motor vehicles is unknown but is probably small because of the likely infrequent presence of vehicles on tertiary roads during periods when bats are active.

Development is a threat to Pallid Bat roosting and foraging habitat throughout its range. Urban and commercial development may be associated with road construction or enhancement of transportation corridors. Blasting or removal of cliff and/or rock areas during infrastructure work may remove roosts, causing loss of habitat. If the roost is occupied, these activities will cause direct mortality of individuals, and/or could cause abandonment of nearby roosts owing to disturbance (Orr 1954; Beck and Rudd 1960; Chapman *et al*. 1994; O'Shea and Vaughan 1999; Rambaldini and Brigham 2004). In addition, development or expansion of corridors in native

grassland habitat will degrade or destroy important foraging habitat for the species. Bridges built within the range of Pallid Bat may provide suitable night-roosting habitat for the species.

Within the Pallid Bat's range, two proposed roadway developments may affect status and recovery. Highway 97 near Vaseux Lake, which is close to one of the known Pallid Bat roost sites, is slated to be widened within the next 15 years, but the project has not yet been defined (Persello, pers. comm., 2015). Plans for protection of habitat in the Vaseux Lake area may limit future highway development, reducing the overall effect on Pallid Bat habitat (J. Tillie, pers. comm., 2016). White Lake Road, which is identified as a potential highways improvement corridor (B.C. Ministry of Water, Land and Air Protection 2003) goes through important habitat for Pallid Bat, including White Lake Grasslands Protected Area.

Threat 6. Human intrusions & disturbance

6.1 Recreational activities

Tourism and recreation activities, such as rock-climbing and bouldering, have the potential to disturb Pallid Bats roosting in cliff crevices and talus. Pallid Bats appear sensitive to disturbance and may abandon or move roosts when disturbed (Beck and Rudd 1960; Davis 1969; Chapman *et al.* 1994; O'Shea and Vaughan 1999). Disturbance of Pallid Bats by rock climbers has not been documented; however, based on the bat's sensitivity to disturbance, it is a likely effect where climbing occurs in Pallid Bat habitat. Recreational climbing activity is most likely to occur from spring to fall; therefore, bats in summer day roosts in cliff or rock habitat are most likely to be disturbed by this recreational activity. The extent to which rock-climbing can destroy or change rock crevice roosts (e.g., changing opening structure, or causing slabs to break off) is unknown but is another possible effect of rock-climbing. Additional research to identify roost areas and determine overlap with climbing areas is required to better understand the scope of this threat. The Skaha Lake area has potential for significant overlap. The Skaha Bluffs area has been identified as providing high-quality summer daytime roost habitat for Pallid Bat (Robertson 1988; Sarell 2012), and is a popular rock-climbing area in the province (B.C. Parks 2015). Pallid Bat is suspected to occur in the Skaha Bluffs area but has not been confirmed to do so. Other climbing areas are being developed along the east side of Skaha Lake and in the vicinity of Okanagan Falls (T. Luszcz, pers. comm., 2016). Where these developments occur within the range of Pallid Bat they have the potential to affect Pallid Bat habitat. Because of the widespread level of human activity within the bat's range, disturbance at roost sites could be an important and growing threat.

Other types of recreational activities, such as the use of all-terrain vehicles, when it degrades or destroys native grassland, will reduce or remove foraging habitat for Pallid Bat. In some areas, all-terrain vehicles have severely damaged the native antelope-brush/needle-and-thread grass habitat (Iverson 2012). As high-quality native grassland becomes more restricted, even small incremental losses may have high localized impacts.

Recreational activity that disturbs bats has been assessed as having a Low impact based on its Small scope. Nevertheless, as overlap increases between recreation areas and Pallid Bat roosts (e.g., new recreation areas established in Pallid Bat roosting habitat, or additional roosts

discovered in recreation areas) or foraging habitat (use of novel off-road areas), the threat impact may also increase.

6.3 Work & Other Activities

Research activity such as visiting roost sites and capture and tagging/tracking of individual bats has the potential to disturb bats and may affect survival rates (Barclay and Bell 1988; Sidner 1997). Researcher activity near roosts has been noted to disturb Pallid Bats (e.g., Chapman *et al*. 1994). Marking Pallid Bats with bands has the potential to affect the survivorship of bats and cause trauma to the banded area (Sidner 1997; Ellison 2008). Researchers entering winter roosts may disturb bats and affect survival rates (Speakman *et al*. 1991), and/or may spread the spores that cause white-nose syndrome unless appropriate decontamination protocols are followed. Researchers should be aware of their potential effects on bats, take steps to minimize impacts, and record instances of potential disturbance and their effect. Additional research is required to better understand the effects of human activity on Pallid Bat. All activities that involve research and capture of wildlife are subject to the restrictions in the BC Wildlife Act. Researchers who want to capture bats will need a Wildlife Act scientific research permit. These permits will not be issued if population level impacts greater than 1% are expected. Also, all researcher need to comply with the hygiene protocols while working in and around bat roosts or capturing bats. Due to these restrictions, this threat is scored as negligible.

Threat 7. Natural system modifications

7.1 Fire & Fire Suppression

The overall impact of fire suppression on Pallid Bat is Unknown. The antelope-brush and sagebrush habitats used by Pallid Bat for foraging are not fire-dependent, and fire effects in these habitats are both negative (loss of antelope-brush) and positive (removal of a competing alien invasive grass; Krannitz and Mottishaw 2003; Iverson 2012). Fire suppression has resulted in increased tree density in south Okanagan shrub–steppe habitats (Turner and Krannitz 2001; Gayton 2003). This results in less open habitat and may alter habitat use and behaviour of Pallid Bats, which forage primarily in open areas (Chapman *et al.* 1994; Rambaldini and Brigham 2011). Fire in ponderosa pine habitat may destroy large trees used for night roosting (Chapman *et al.* 1994). The potential rate of encroachment and changes in the rate due to climate change (e.g., Gayton 2013), and the overall effect of fire and fire suppression on Pallid Bat habitat requires additional research.

Threat 8. Invasive & other problematic species, genes & diseases

8.1 Invasive non-native/alien species/diseases

The overall threat impact for Threat 8 is based on the significant threat of white-nose syndrome. All other threats are cumulative to this threat.

Invasion of weeds into disturbed grassland habitat changes the plant composition and distribution of plants (Fleischner 1994), which might affect the ability of Pallid Bat to find prey, as well as the prey community that lives there. The spread of invasive species is identified as a significant threat to antelope-brush/needle-and-thread grass habitat (Iverson 2012), which is important

foraging habitat for Pallid Bat (Rambaldini and Brigham 2011). The impact of this threat is currently Unknown.

Pallid Bats, which frequently forage on or near the ground, are vulnerable to predation by domestic cats (Robertson 1998 cited in Willis and Bast 2000). The number of Pallid Bats killed by cats is likely small; however, as urban development continues within Pallid Bat habitat, the impact of this source of mortality may increase. The impact of this threat is assessed as Low–Negligible.

Within this Threat Assessment period (2016–2031), white-nose syndrome is the most significant threat to Pallid Bat populations, with a projected Very High impact, based on a Pervasive scope, and Extreme severity. The timing is rated Moderate because this disease is not yet known to occur in the province but is expected to be discovered within 10 years. Since 2006, hibernating bats in eastern North America have been dying in high numbers (Blehert *et al.* 2009) from a cold-loving fungus, *Pseudogymnoascus destructans* (Minnis and Lindner 2013). The fungus is revealed by white fungal growth on the muzzles, ears, and/or wings of bats as hyphae invade these tissues (Blehert *et al.* 2009). White-nose syndrome is thought to disrupt important physiological functions and cause waking periods during hibernation, resulting in premature depletion of fat stores and in starvation of affected bats (Cryan *et al.* 2010).

White-nose syndrome was discovered in Canada in the winter of 2009–2010 and as of June 2016, its occurrence was confirmed in Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island. In the United States, this disease is confirmed in 29 states (U.S. Fish and Wildlife Service 2016). In three additional states, the fungus has been detected on hibernating bats, but the disease is not yet present (U.S. Fish and Wildlife Service 2016). The May 2016 discoveries in Washington State of a Little Brown Myotis (*Myotis lucifugus)* with the disease and a Silver-haired Bat that tested positive for the fungus that causes the disease, has accelerated the expected date of detection in British Columbia. To date, white-nose syndrome is estimated to have killed 5.7–6.7 million bats since its arrival in North America (U.S. Fish and Wildlife Service 2016). Since its emergence, estimates suggest that affected bat populations in the northeastern United States have declined by 80% (Turner *et al.* 2011). As this disease spreads to new areas, it is assumed that each species of cave-hibernating bats in these areas will be at risk (Cryan *et al.* 2010). The susceptibility of Pallid Bat to white-nose syndrome is unknown because, until recently, the disease has not occurred within the Pallid Bat's range. Susceptibility to the disease may vary by bat species (e.g., Cryan *et al*. 2013) and by geography. In areas with shorter winters, or in areas where bats are able to forage mid-winter and replenish their fat stores, bats may not be as susceptible to white-nose Syndrome (Cryan *et al*. 2013). In British Columbia, Pallid Bat activity has been recorded mid-winter (C. Lausen, pers. comm., 2016), and winter groupings appear smaller than in the east, which means that fewer bats are exposed to the spores within a particular hibernaculum. Because of these factors, white-nose syndrome may spread more slowly in the province than in the east. If it is not susceptible to the disease, the Pallid Bat could still serve as a vector for spread of fungal spores when it shares hibernation sites with other species of bats.

In British Columbia, very few hibernacula have been found for any bat species, and none are known for Pallid Bat, so it will be difficult to observe and measure the arrival, distribution, and effects of white-nose syndrome.

Threat 9. Pollution

9.3 Agricultural & forestry effluents

Pesticide use in agriculture may affect Pallid Bats directly and indirectly; however, the overall impact is Unknown. Much of the Pallid Bat range in Canada is dominated by agricultural land use, managers of which often employ pesticides and other chemicals (Verrin *et al.* 2004) to facilitate crop production. The direct effect of pesticides on Pallid Bat is unclear as no records exist of Pallid Bat poisoning from pesticides. Bat mortality related to organochlorine insecticide exposure was documented in Gray Bats in the United States (Clark *et al.* 1978) and the chemical is still present in bat tissues years after their use ceased (review by O'Shea and Clark 2002). Currently-used insecticides such as pyrethroids and organophosphates have been detected in bat tissues and guano, but the effect of these chemicals on bats is not known (Eidels *et al.* 2007; review in Bayat *et al.* 2014). Although exposure to pesticides is less than in the past, current exposure levels may be sufficient to generate sub-lethal effects (Bayat *et al.* 2014). The level of exposure required to generate sub-lethal effects is not understood and requires additional research. Herbicides may benefit Pallid Bats by reducing vegetation and creating more open areas, or negatively affect them by reducing vegetation important to their insect prey (Gervais 2016). Use of insecticides in Pallid Bat foraging habitat will reduce insects (review in Williams-Guillén *et al.* 2015) and may negatively affect prey species of Pallid Bat. Research to clarify the impact of pesticides on Pallid Bats is required.

5 RECOVERY GOAL AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goal

The recovery (population and distribution) goal is to maintain current Pallid Bat populations within their Canadian range.

5.2 Rationale for the Recovery (Population and Distribution) Goal

The current known range and population estimate of the Pallid Bat in Canada is based on approximately 125 records. Although the known range is quite restricted, the actual range may be larger because suitable habitat exists in Canada outside of the South Okanagan Valley. Therefore, it is possible that the species may currently occupy, or have occupied in the past, a larger range than known at present. The recovery goal focuses on ensuring that Pallid Bat populations are maintained. Actions identified to meet the goal recognize that data on the population size and species range are incomplete. Species recovery will require additional research to document the extent of the species' known range and habitat associations. Actions are also identified to determine trends in Pallid Bat roosting and foraging habitat within its range, and to address gaps in knowledge about Pallid Bat ecology and threats to the species, which will contribute to the goal of maintaining extant populations.

The Pallid Bat is difficult to detect using standard bat inventory techniques, and there is no means for direct measurement of population size. COSEWIC (2010) assessed the species as Threatened owing to its small estimated population size; that is, likely more than 250 mature individuals (the quantitative threshold between assessment as Threatened vs. Endangered) but fewer than 1000 (the quantitative threshold between assessment as Threatened vs. Special Concern). The lower bound in population size was based on Rambaldini (2006), who estimated that "at least" 250 Pallid Bats reside in the Okanagan Valley during summer months, based on roost surveys where one roost used by males had up to 130 individuals, and several additional roosts with fewer bats were discovered. Nevertheless, she indicated this is likely a "gross underestimate" of the total population as several additional sites known to be occupied by the species were not included in the surveys.

A specific population target (i.e., number of mature individuals) is not specified in the recovery goal because of the uncertainty surrounding the number of mature Pallid Bats in Canada, and the difficulty associated with directly monitoring population size. Instead, it is recommended that current numbers (comprising at least 250, and possibly up to 1000 individuals) are maintained. Until such time as population size can be accurately and directly measured, the recovery goal will be measured through ongoing vital rate monitoring, thus ensuring Pallid Bat occupancy of known roost sites, and through monitoring abundance of suitable foraging habitat. Recovery actions must include surveys to determine species distribution, roost locations, and hibernacula. If the species is ultimately detected outside of its current known range, the population and associated habitat should also be considered important for the species' survival and recovery, and maintained.

5.3 Recovery Objectives

The recovery objectives for the Pallid Bat are to:

1. Protect[6], manage, and monitor Pallid Bat habitats, including maternity roosts, day roosts, hibernacula, night roosts, and foraging habitat to ensure that suitable characteristics of the habitat remain available to the species;
2. Determine Pallid Bat population trends and vital rates (e.g., survival rates, reproductive rates);
3. Identify the full range extent of the Pallid Bat in British Columbia, with a focus on identifying the location of maternity roosts and hibernacula;
4. Conduct research into the impact of threats to roosts and foraging habitat (e.g., habitat conversion and development, grazing, fire and fire suppression), threats to bats (e.g., white-nose syndrome, recreational activities, human disturbance, and pesticide use) and effectiveness of recovery actions; and
5. Improve our understanding of key factors contributing to Pallid Bat decline, and possible constraints to recovery.

[6] Protection can be achieved through various mechanisms, including: voluntary stewardship agreements, conservation covenants, sale by willing vendors on private lands, land use designations, protected areas, and mitigation of threats.

6 APPROACHES TO MEET RECOVERY OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized under the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2009). Status of the action group for this species is given in parentheses.

Compile Status Report (complete)

- COSEWIC report completed (Willis and Bast 2000; COSEWIC 2010).

List under *Wildlife Act* (complete)

- It is an offence to kill or capture the species under the provincial *Wildlife Act*.

Send to COSEWIC (complete)

- Pallid Bat assessed as Threatened (Willis and Bast 2000; COSEWIC 2010).

Planning (completed)

- Provincial Recovery Strategy completed (Pallid Bat Recovery Team 2008). Updated Recovery Plan completed (this document, 2016).

Habitat Protection (in progress)

- Table 3 includes examples of protected habitat in the south Okanagan at the time of writing. Protected areas are regularly changing with the addition of new properties; therefore, this list is not complete. Although none of the identified areas were specifically established to protect Pallid Bat habitat, the species will benefit from protection of natural ecological systems, including native grassland and cliffs. Pallid Bat has not been confirmed to use all of the areas identified.

Table 3. Examples of areas in the south Okanagan that are being managed to maintain natural ecological systems. New properties are regularly added to protected areas. This is not a complete list. Pallid Bat has not been confirmed to use all of the habitat listed.

Name	Potential Pallid Bat habitat protected	Land owner	Size (ha)[a]
Skaha Bluffs Provincial Park	Foraging and roosting	Province of BC	489
Skaha Lake	Foraging and roosting	Nature Trust (managed by FLRNO)	114.2
White Lake Grasslands Protected Area	Foraging and roosting	Province of BC	3741
South Okanagan Grasslands Protected Area	Foraging (note that mine audits are present on the site)	Province of BC	9364

Name	Potential Pallid Bat habitat protected	Land owner	Size (ha)[a]
South Okanagan Wildlife Management Area	Foraging	Province of BC	903
Haynes Lease Ecological Reserve	Foraging	Province of BC	101
Antelope Brush Conservation Area	Foraging	Nature Trust	117.1
Vaseux Lake	Roosting and foraging	Nature Trust	479.8
Kilpoola Lake	Foraging	Nature Trust	46.8
Okanagan Falls Grassland	Foraging and roosting	Nature Trust	7
Sage and Sparrow Grasslands	Foraging, potentially roosting	Nature Conservancy of Canada	1390
White Lake Basin Biodiversity Ranch	Foraging, potentially roosting	Nature Trust	905.9
Okanagan Falls Biodiversity Ranch	Foraging, potentially roosting	Nature Trust	713.2
Mahoney Lake Ecological Reserve	Foraging	Province of BC	29.5
Vaseux Protected Area	Foraging	Province of BC	2015
Vaseux Bighorn National Wildlife Area	Roosting and foraging	Crown (federal; Environment and Climate Change Canada)	812
McTaggart-Cowan/ Nsək'łniw't Wildlife Management Area	Foraging habitat and potentially roosting habitat	Province of BC	6491
ʷəx̌ʷnitkʷ (Okanagan Falls) Provincial Park	Drinking water	Province of BC	2
Vaseux Lake Provincial Park	Foraging	Province of BC	12
Inkaneep Provincial Park	Drinking water, foraging habitat	Province of BC	16

[a] This is the size of the property; not all of the area will necessarily be suitable for roosting and/or foraging.

Table 4. Existing mechanisms that afford habitat protection for the Pallid Bat.

Existing mechanisms that afford habitat protection	Threat[a] or concern addressed	Site
Purchase and management of land for natural ecosystem values	All	See Table 3
Provincial parks managed for maintaining natural values while allowing some recreation and other activities	All	See Table 3
Wildlife management areas	All	None yet identified specifically for Pallid Bat; however, portions of the South Okanagan Wildlife Management Area and McTaggart-Cowan/ Nsək'łniw't Wildlife Management Area may have suitable habitat for Pallid Bat
Best practices documents for working in grassland	2.3, 6.1	All foraging habitat
Best practices documents for recreational users, such as climbers and cavers), concerning disturbance of bats, white-nose syndrome, motorized recreation	6.1	All cliff habitat and caves
Decontamination protocols for cavers and researchers to prevent spread of white-nose syndrome	6.3, 8.1	All caves and mines
Guidelines for assessments before mine closure, and strategies to minimize effects of the closure on bats (e.g., using gating to allow bat access but maintain microclimate)	3.2	All mines

[a] Threat numbers according to the IUCN–CMP classification (see Table 2 for details).

Habitat Restoration (in progress)

Stewardship groups are active in the Okanagan, working to restore natural wetlands and grasslands. Although none of these projects specifically benefit the Pallid Bat, natural habitat restoration in this species' range will likely improve its foraging opportunities. Wetland restoration will provide drinking water for the species. The effect of these activities on the Pallid Bat's use of the ecosystem is unknown.

- Active restoration management actions have been undertaken by the province in the White Lake Grassland Protected Area. The goal is to restore pre-fire vegetation composition and structure and to reduce invasive species (Millar 2007).
- Restoration in the Vaseux Bighorn National Wildlife Area included prescribed burning and control of invasive alien plant species (Environment Canada 2011).
- In the Okanagan, the Nature Trust of British Columbia, in partnership with B.C. Ministry of Environment, has begun grassland restoration projects on two ranches—the White Lake Basin and Okanagan Falls Biodiversity ranches. Biodiversity ranches use grazing as a management tool to maintain and/or restore the natural grassland ecosystem and associated habitats (Warman and Adair 2013).
- Kreitzman *et al.* (2015) provided an overview of some conservation and restoration work in the south Okanagan-Similkameen.

Private Land Stewardship (in progress)

- No habitat areas are currently managed specifically for Pallid Bat; however, the species will benefit from any activities that maintain or enhance native grassland habitat, or maintain cliff and cave habitat.
- Private lands account for approximately 30% of the Okanagan-Similkameen's land base (Wildlife Habitat Canada 2015).
- Numerous stewardship documents have been developed (e.g. *BC Grasslands Stewardship Guide: A Guide for Ranchers and Recreation Users* (Chutter 1997). Use of stewardship/best management principles is voluntary.
- Numerous areas have been purchased by conservation organizations and are managed with the goal of maintaining natural ecosystem values (see Table 3).

Species and Population Management (in progress)

- It is an offence to kill or capture the species under the province's *Wildlife Act*.
- Bat surveys in the south Okanagan, and in other potentially suitable grasslands elsewhere in the province (e.g., Lillooet), have included surveys for Pallid Bat to determine presence, identify roosts, and to confirm hibernation sites (in Vaseux-Bighorn National Wildlife Area). Some of the work completed includes: Robertson (1988); Collard *et al*. (1990); Chapman *et al*. (1994); Holroyd *et al*. (1994); Sarell *et al*. (1997); Sarell and Haney (2000); Rambaldini (2006); Sarell (2007); Rambaldini and Brigham (2008); Sarell *et al*. (2011); Rambaldini and Brigham (2011); Sarell (2012); Sarell *et al*. (2012); Hemmera Envirochem Inc. (2015); C. Lausen, pers. comm. (2015); and T. Luszcz, pers. comm. (2016).
- A habitat capability-suitability model has been created for Pallid Bat and was recently updated (Warman *et al*. 1998; Haney, pers. comm., 2015). The model includes breeding, summer roosting, and foraging habitat, and provides ratings by biogeoclimatic zone, ecosystem, ecosystem attributes (aspect and slope), and ecosystem condition (range condition and forest successional stage). The model also includes rating adjustments for vegetation stand closure (the presence of dense shrub cover or moderate or dense tree cover lowers a rating), and proximity of the breeding/roosting habitat to foraging habitat, where foraging habitat more than 8 km from roosting/breeding is considered less suitable.
- Ecosystem mapping for the area has been conducted (e.g., Iverson and Haney 2012).
- Protocols have been developed to minimize the spread of the fungus causing white-nose syndrome (B.C. Ministry of Environment and B.C. Ministry of Forests, Lands and Natural Resource Operations 2015a, b), as well as a national plan to manage this disease in Canada (Canadian Wildlife Heath Cooperative 2015).

6.2 Recovery Action Table

Table 5. Recovery actions and performance measures for Pallid Bat for each recovery objective.

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
1	Actions 2-1, 3-1, 3-2, 3-3 will assist in meeting Objective 1.					
	1	Habitat Protection, Habitat Restoration, Private Land Stewardship	For each known roost, and foraging area within 4.5 km of roosts, identify type of habitat, ownership, type of existing protection if any, current threats, and current management protocols. Use information to identify priority areas for habitat protection and threat mitigation.	Process: 1. A protocol for monitoring changes in habitat availability and suitability is developed and implemented. 2. Creation of spatially explicit maps of habitat for the species. 3. Database updated as new habitat located. 4. Roosts and foraging habitat are prioritized for protection, habitat restoration, and threat mitigation. Achievement: 1. Baseline information is used to guide recovery actions, and is used to assess the effect of recovery actions	All	Essential
	2	Habitat Protection	Investigate and implement potential strategies for habitat protection for specific areas of habitat. Options: • Include Pallid Bat in the Identified Wildlife Management Strategy (IWMS) and identifying Wildlife Habitat Areas. • Designate habitat as a wildlife management area, conservation area, or provincial park. • Collaborate with land conservancy organizations and	Process: 1. # projects implemented to protect habitat for Pallid Bat. 2. Pallid Bat assessed for its potential to be included as an Identified Wildlife species. 3. Pallid Bat designated as Identified Wildlife (if suitable). 4. # of Wildlife Habitat Areas proposed (if suitable). 5. # (%) of landowners/managers contacted. 6. # (% of area) of unprotected areas where protection is established. 7. % of priority areas that are protected. Achievement: 1. All landowners/managers contacted. 2. % of all important roosts protected. 3. % of suitable foraging habitat within 4.5 km of important roosts protected.	All	Essential

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
			owners/managers of priority areas to implement and/or develop options to protect Pallid Bat roosts and foraging habitats (e.g., through acquisition, conservation, covenant, etc.).			
	3	Habitat Restoration	In areas of existing protected habitat (municipal, provincial, or federal) within the range of the species, encourage land managers/park planners to survey for and manage (including threat mitigation) Pallid Bat habitat on the area.	Process: 1. # of land managers/park planners contacted and provided with information about Pallid Bat. 2. # (%) of areas where Pallid Bat habitat is considered in management. 3. # (%) of areas where surveys are conducted for Pallid Bats or Pallid Bat habitat. 4. # (%) of areas where a monitoring program to assess the effect of mitigation options is implemented. Achievement: Inclusion of Pallid Bat habitat and/or consideration of the species' life history requirements in management plans.	All	Essential
	4	Habitat Protection, Habitat Restoration, Private Land Stewardship	Investigate potential strategies for threat mitigation, develop best practices documents for all threats, implement threat mitigation at high priority sites, and assess the effectiveness of the actions.	Process: 1. # funding proposals submitted and amount of funding secured for threat mitigation. 2. # (% of sites where considered necessary) of sites where threat mitigation initiated. 3. # of threats for which a best practices document is developed. 4. % of areas that are managed to retain suitable characteristics for Pallid Bat. 5. For activities requiring permits that may disturb potential habitat (e.g., cliff, cave, mine, grassland habitat), # (%) of permits that require the proponent to conduct surveys for Pallid Bat and their habitat as part of the permit procedure. 6. % of threat mitigation projects in which a monitoring program to	All	Essential

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
				assess the effectiveness of threat mitigation is implemented. 7. At least one threat mitigation project is initiated by end 2019. Achievement: 1. Assessment of threat mitigation effectiveness used to improve techniques and gather information on habitat use by Pallid Bat. 2. Monitoring of amount of suitable foraging habitat within 4.5 km of each significant roost shows no loss, or increase, over baseline. 3. Roosts in proximity to habitat where threat mitigation has occurred show continued occupancy, and population size is maintained or increased.		
	5	Private Land Stewardship	Encourage landowners/ leaseholders to voluntarily manage their properties so as to maintain suitable habitat for bats and bat habitat (e.g., implement best management practices, threat mitigation) and monitor effect of management actions.	Process: 1. # (%) of landowners contacted and stewardship documents and/or management guidance shared, where appropriate. 2. # (%) sites where landowners engage in voluntary stewardship options or implement best practices. Achievement: 1. # (%) of unprotected properties that are protected or managed in a manner that will benefit Pallid Bat through voluntary stewardship actions. 2. Assessment of threat mitigation effectiveness used to improve techniques and gather information on habitat use by Pallid Bat.	All	Necessary
	6	All	Develop and deliver an outreach strategy on best practices and threat mitigation to stakeholders that are active in or around Pallid Bat habitat. The outreach strategy should aim to raise awareness of how activities can affect bat species, particularly where bats might be killed or disturbed, or habitat	Process: 1. Development of an outreach strategy and materials for each group of stakeholders/threat. 2. Initiation of an outreach program for species (and bat) awareness, general conservation approaches that would benefit the species, and the use of best practices. 3. # people targeted through outreach (e.g., # people contacted, # recreation groups or societies contacted, # downloads of materials, website traffic data, # attendees at presentations). 4. # (%) of recreation groups or societies that distribute best practice information to their members	1.1, 1.2, 1.3, 3.2, 4.1, 6.1, 8.1	Beneficial

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
			degraded (e.g., climbing areas, areas of recreation overlap with bats), and encourage recreational users to restrict their activities to established recreation areas instead of creating new routes.	Achievement: 1. Monitoring of amount of suitable foraging habitat within 4.5 km of each significant roost shows no loss (over baseline) related to recreational activities. 2. Monitoring at roost sites shows no new climbing routes established.		
2	Actions 3-1, 3-2, 3-3 and 5-3 will assist in meeting Objective 2					
	1	Species Population Management	Monitor occupancy and population trends at known roosts where the roost type allows such surveys, or techniques can be developed to facilitate surveys. Techniques should consider the species' sensitivity to disturbance.	Process: 1. Implementation of monitoring program by end 2018. 2. # (%) of roosts monitored each year. 3. # (%) of known roosts occupied each year. 4. Implementation of pilot program to test effectiveness of new survey techniques. 5. # of novel, more efficient, techniques developed to identify and monitor roosts and habitat, and to capture and track individuals. 6. # of times bats vacate/abandon roosts because of disturbance. Achievement: 1. Information on Pallid Bat disturbance used to refine survey techniques. 2. Important roosts are monitored annually. 3. Information from surveys used to update estimate of population size of Pallid Bat in province and at least 250 mature individuals are estimated to remain in the population. 4. Populations at all monitored roosts stable or increasing. 5. Data on population trends used to assess success of threat mitigation or management in the area.	Knowledge Gaps	Essential
	2	Species Population Management	Determine vital rates of Pallid Bat.	Process: 1. Research protocol developed to minimize negative effects; peer-review finds benefits outweigh costs. 2. # of projects initiated to research Pallid Bat vital rates. 3. # of bats captured and marked; number of recaptures. Achievement:	Knowledge Gaps	Beneficial

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
				1. Clarification of Pallid Bat ecology and vital rates assist in understanding limiting factors and threats for Pallid Bat. 2. Vital rate measurement used as a method of assessing mitigation efforts in specific habitats.		
3	Actions 4-2, 5-1, and 5-2 will assist in meeting Objective 3.					
	1	Species Population Management	Determine the species' range.	Process: 1. The potential range for the species and priority areas for inventory outside the current known range are identified based on previous surveys, habitat suitability mapping, and expert opinion. 2. # potential roosting and foraging sites with surveys in progress. Sampling intensity should be sufficient to state that, in areas in which the species was not detected, the species does not occur. 3. Change in size of known range based on surveys. 4. Proportion of potential range surveyed. Achievement: 1. All areas of potential habitat outside the species' known range surveyed with sufficient intensity to be confident that the species does or does not occur. 2. Data on absence of Pallid Bat within its range used to inform habitat and/or threat management as appropriate.	Knowledge Gaps	Essential
	2	Species Population Management	Identify additional maternity roosts and collect information on habitat attributes used by individuals.	Process: 1. Priority areas for inventory identified based on previous surveys inside and outside its known range, habitat suitability mapping, and expert opinion. 2. # surveys initiated to identify maternity roosts. 3. # of females radio-tracked. 4. # of new roosts/areas discovered (maternity, night). 5. # of females tracked to collect data on distance travelled to foraging areas, type of foraging habitat used, distance to night roost and type of night roost. 6. # of maternity roosts and night roosts at which data collected on attributes of the roost. 7. Identification of the location of at least five additional maternity	Knowledge Gaps	Essential

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
				roosts by end of 2020. Achievement: 1. Additional maternity roosts added to monitoring programs, threat assessments, and threat mitigation programs. 2. Data on absence of Pallid Bat within its range used to inform habitat and/or threat management as appropriate. 3. Data on types of habitat used by Pallid Bat for maternity roosts, night roosts, and movement patterns of individuals is incorporated into habitat descriptions for the species and is used in modeling to identify areas of high potential suitability habitat, and in management and mitigation plans.		
	3	Species Population Management	Identify the location of hibernacula and collect information on habitat attributes.	Process: 1. # surveys initiated to identify hibernacula. 2. # of bats radio-tracked. 3. # hibernacula discovered. 4. # of other roosts discovered (day roosts, maternity roosts, night roosts, swarming sites) during research project. 5. Collection of data on attributes of hibernacula and other roosts discovered and used to refine search for additional hibernacula. Achievement: 1. Improved understanding of winter ecology of Pallid Bat. 2. Hibernacula added to monitoring programs, threat assessments, and threat mitigation programs. 3. Data on types of habitat used by Pallid Bat for hibernacula and movement patterns is incorporated into habitat descriptions for the species and is used in modeling to identify areas of high potential suitability habitat, and in protection, management, and mitigation plans.	Knowledge Gaps	Essential

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
4	Actions 1-1, 1-3, 1-4, 1-5, and 1-6 will assist in meeting Objective 4.					
	1	Species Population Management	Implement decontamination protocols for winter research in caves and mines.	Process: 1. % of winter research in caves and mines that use decontamination protocols. 2. # contacts with the caving community to distribute best practices information on decontamination. Achievement: 1. Research permits require the use of decontamination protocols. 2. All winter research in caves and mines implement decontamination protocols. 3. Cavers aware of and use decontamination protocols appropriately.	6.3, 8.1	Essential
	2	Species Population Management	Develop, in collaboration with partner organizations, an aggressive white-nose syndrome program for the province that includes a monitoring program and research on mitigation.	Process: 1. Monitoring program is initiated by winter 2016–2017 using methods/survey intensity with high confidence to detect white-nose syndrome, if present. 2. # hibernacula monitored for signs of white-nose syndrome (bat activity in winter, dead bats in or near hibernacula, etc.). 3. # bats encountered in hibernacula. 4. # bats captured in summer examined for signs of white-nose syndrome. 5. # hibernacula sampled for presence of the fungus that causes white-nose syndrome. 6. # dead bats examined/sampled for presence of the fungus. 7. Initiation of mitigation research. Achievement: 1. Data collection in summer used to assess presence of white-nose syndrome (e.g., sudden decline in a roost population, signs of scarring or other symptoms of white-nose syndrome on captured bats, presence of fungus in hibernacula). 2. Discovery of the presence of white-nose syndrome in the province used to inform threat mitigation actions.	8.1, Knowledge Gaps	Essential

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
	3	Species Population Management	Conduct research to clarify the threat of human disturbance on Pallid Bat.	Process: 1. # of sites where data are collected on impact of human activity on bat activity (e.g., roost abandonment). 2. # of types of activity that are included in research projects (e.g., researchers, climbing, loud noise, etc.). 3. # sites where research to assess the effect of mitigation is initiated. Achievement: 1. Information on the effect of human disturbance on Pallid Bat is used to inform research techniques, and our understanding of causes of decline and constraints to recovery of the species. 2. Information is incorporated in threat assessments and mitigation and management plans.	6.1, 6.3 Knowledge Gaps	Beneficial
	4	Species Population Management	Conduct research to clarify effect of threats where impact is unknown (e.g., grazing, fire and fire suppression, and pesticides).	Process: 1. # and size of areas where each threat has a potential effect on Pallid Bat habitat. 2. # of sites and proportion of area included in research on the effect of each threat. 3. # occasions where research on threat impacts resulted in mitigation to minimize the threat at that or other sites. Achievement: 1. Clarification of the impact of threats on Pallid Bat habitat or Pallid Bat vital rates. 2. Information used to update the threat assessment for the species, prioritize threats for Pallid Bat at each location, and to guide mitigation/management options and development of best management practices.	2.3, 7.1, 9.3, Knowledge Gaps	Beneficial
5	Actions 2-1, 2-2, 3-2, 3-3, 4-3, and 4-4 will assist in meeting Objective 5.					
	1	Species Population Management	Compile information on availability of roost habitat.	Process: 1. Habitat suitability mapping to identify areas of potential roost habitat is completed and is updated based on surveys and latest data on types of suitable habitat.	Knowledge Gaps	Necessary

Objective	Action	Conservation Framework action group[a]	Actions to meet objectives	Performance measures	Threat[b] or concern addressed	Priority[c]
				2. Area of suitable roosting habitat lost (calculated by disturbance type and roost type) or gained (through mitigation or management). Achievement: 1. Data on availability of roost habitat is used to inform surveys for the species. 2. Information on availability of roost habitat is used to inform our understanding of limiting factors for Pallid Bat recovery, and used in management and mitigation plans.		
	2	Species Population Management, Habitat Restoration	Compile information on availability of suitable foraging habitat.	Process: 1. Habitat suitability mapping to identify areas of suitable foraging habitat (native grassland habitat and modified grassland identified separately) is completed and updated based on site surveys. Achievement: 1. Data on availability of suitable foraging habitat is used to inform our understanding of limiting factors for Pallid Bat recover, and is included in threats assessments, and in management and mitigation plans.	Knowledge Gaps	Necessary
	3	Species Population Management	Conduct research on the sex ratio of Pallid Bat in British Columbia.	Process: 1. # bats captured. 2. % of total bats captured that are female. Achievement: 1. Information on sex ratio of Pallid Bat is used to inform our understanding of limiting factors, causes of decline, and threats to recovery.	Knowledge Gaps	Beneficial

[a] Conservation Framework designation: HP = habitat protection; HR = habitat restoration; PLS – private land stewardship; SPM = species and population management.

[b] Threat numbers according to the IUCN–CMP classification (see Table 2 for details).

[c] Essential (urgent and important, needs to start immediately); Necessary (important but not urgent, action can start in 2–5 years); or Beneficial (action is beneficial and could start at any time that was feasible).

6.3 Narrative to Support Recovery Action Table

Recommended actions have been categorized by the action groups of the B.C. Conservation Framework. Necessary actions to support recovery include habitat protection, habitat restoration, private land stewardship, and species and population management.

6.3.1 Habitat Protection, Restoration, and Private Land Stewardship

The unique, arid ecosystem in the southern Okanagan is an area of great conservation interest, and is home to many at-risk ecosystems and species. Recovery of Pallid Bat can be promoted through collaboration with conservation groups and others working toward recovery of ecosystems and other species in the area.

Priority habitat areas for protection, restoration, and private land stewardship should include all known maternity roosts/roosting areas, all hibernacula, other roosts used by more than 10 individuals, and foraging habitat within 4.5 km of known roosts. Threat mitigation should be prioritized in habitat within protected areas or areas managed for conservation, areas with the largest colonies (including the roosting habitat and surrounding foraging habitat), and around hibernacula.

Some Pallid Bat are already protected, such as those recorded from conservation areas and areas owned and managed by conservancy organizations. Recovery actions should include the identification of additional areas that are protected or are candidates for habitat protection, and the investigation of different types of habitat protection. For example, the potential to have Pallid Bat designated as Identified Wildlife under the Identified Wildlife Management Strategy (Province of British Columbia 2004), on the basis of possible negative impacts on foraging and roosting habitat from forestry and range activities, should be explored. Habitat protection by the provincial government through wildlife management areas, ecological reserves, protected areas and provincial parks,[7] and conservation areas owned and managed by conservation organizations, means that connected native habitat in the south Okanagan could be maintained within the known range of the species.

Private land stewardship will be essential to the recovery of the species because many of the known locations of Pallid Bat are on private land. Fundamental protection for a suite of species-at-risk in this area can be achieved through encouraging habitat stewardship by private landowners with a collaborative approach. Proactive contact with landowners/managers can identify opportunities for land stewardship, and identify instances where landowners can be supported, establishing a positive working relationship. Development of best practices documents to address and mitigate threats to the species can provide information to landowners and managers. On private lands, protection of habitat can be achieved through conservation agreements, conservation covenants, and habitat management facilitated by conservation organizations. Landowners/managers can be encouraged to maintain or improve bat habitat by: implementing best management practices around bat habitat (e.g., cave and crevice habitat,

[7] Note that, depending on the park use permit, some activities that disturb bats or degrade habitat may still be permitted.

mines); implementing best practices to maintain or restore native grassland habitat; and actions to mitigate threats identified for the habitat. For public activities that are threats (e.g., rock-climbing, off-road vehicle use) in specific areas, a targeted education outreach program to specific stakeholders to voluntarily implement best practices is important. Encouraging recreational users to restrict their activities to defined areas instead of establishing new climbing routes or riding their vehicles off-trail, will restrict expansion of human activity and disturbance.

For all habitat protection and restoration activities, as well as landowner outreach, securing funding to support activities (from e.g., the federal Habitat Stewardship Fund) will increase the chance of success.

6.3.2 Species and Population Management

Species recovery will require additional research to document the extent of the species' known range and habitat associations, and to clarify limiting factors and the impact of threats on the species.

The Pallid Bat is reported to be sensitive to disturbance. Researchers should recognize their potential effect on the species, and should track instances of disturbance. Any research technique or protocol that involves capture of bats, or potential disturbance of bats, must be carefully considered and a rationale provided that shows the benefits of the activity outweigh the potential costs to the species. Best practices should be used and methods implemented to mitigate any potential negative effects (e.g., Barclay and Bell 1988; Canadian Council on Animal Care 2003; Ellison 2008; Amelon *et al*. 2009; O'Mara *et al*. 2014).

An initial action to support recovery of the species should be the development of a list of threats for each known occurrence of Pallid Bat (including roosts and foraging habitat), and priorities for threat mitigation. In addition, a research and inventory framework should be developed that identifies a prioritized list of research and inventory activities to address knowledge gaps about the ecology of Pallid Bat (current distribution; location of summer day and night roosts; movement patterns, including seasonal movements and movements between roosting and foraging habitat; use, location, and characteristics of winter habitat; and impact of threats). Through the development of these two documents, recovery actions will be prioritized and tracked.

A priority for recovery actions is to survey for the species both inside and outside its known range. A focus of these surveys should be on identifying additional maternity roosts and discovering hibernacula. Discovery of additional populations will increase the proportion of the population that can be protected, and facilitate the ability to provide a more precise population estimate. Surveys should focus on locations:

- outside the range where acoustic detections or expert opinion suggest the species occurs;
- outside the range where habitat suitability modeling has identified suitable habitat for the species; and
- within the range to further elucidate habitat use of the species, and to monitor known populations and habitats.

The species is difficult to survey; therefore, surveys in areas where the species is not known to occur should employ sufficient effort such that, if the species is not detected, the study provides statistical confidence that the species is not present. To support these surveys, investigating and testing novel, efficient, techniques to assist in capturing or verifying the presence of the species is also recommended. Collecting and compiling data on characteristics of habitat used by Pallid Bat for day roosting, night roosting, and foraging will assist in refining habitat suitability models.

Capture surveys of the species will be essential in determining whether the sex ratio of Pallid Bat in the province is skewed toward males as data collected to date indicate, or whether males and females generally roost separately and the male-biased sex ratio reflects limited sampling. This will affect the understanding of factors limiting the recovery of the species.

An important aspect of tracking recovery of the species is monitoring trends in roost occupancy and use, population size, and foraging habitat. Monitoring trends will provide information on whether recovery actions to maintain the species is adequate, and will provide updated information to prioritize conservation actions for specific areas.

The most significant threat to Pallid Bat is suspected to be white-nose syndrome (Threat 8.1), based on the assumption that the species is susceptible to the disease. Monitoring this disease in Pallid Bat should be included as part of a province-wide monitoring program designed to detect its presence in British Columbia, and to determine its impact on provincial bat species. All other threats to Pallid Bat are cumulative to the potentially devastating effect of white-nose syndrome, if the species is shown to be susceptible to the disease.

The impact of some threats to Pallid Bat are unknown (e.g., Threats 2.3, 7.1, and 9.3). Research to identify the impacts of these threats, and how they can be mitigated, is an important action to promote the long-term persistence of the species.

7 SPECIES SURVIVAL AND RECOVERY HABITAT

7.1 Biophysical description of the Species' Survival/Recovery Habitat

Survival/recovery habitat is defined as the habitat that is necessary for the survival or recovery of the species. This is the area in which the species naturally occurs or depends on, directly or indirectly, to carry out its life-cycle processes, or where the species formerly occurred and has the potential to reoccupy.

A description of the known biophysical features and attributes of the species' habitat that are required to support its life-cycle functions are provided in Section 3.3. Work required to identify additional habitat requirements and species distribution are included in the Recovery Action Table (Table 5) in Section 6.2.

7.2 Spatial Description of the Species' Survival/Recovery Habitat

The area of survival/recovery habitat required for a species is guided by the amount of habitat needed to achieve the recovery goal. Although no survival/recovery maps are included with this document, it is recommended that location of survival/recovery habitat is spatially described to help mitigate habitat threats and to facilitate actions for meeting the recovery (population and distribution) goals.

8 MEASURING PROGRESS

Performance indicators provide a way to define and measure progress toward achieving the recovery (population and distribution) goals and objectives. Performance indicators are included with the Recovery Action Table (Table 5; Section 6.2) and explained in Section 6.3.

The target for Pallid Bat is that all important roosts (maternity roosts, hibernacula, and other significant roosts or roosting areas [used by >10 bats]) are secured either through formal protection, such as in a park or with a conservation covenant, or through voluntary stewardship actions with the goals to retain attributes important for the species, and to mitigate threats at the site. Performance indicators in the Recovery Action Table track progress in meeting the target of 100% securement of these roosts. Setting timelines for 100% securement is difficult because much of the Pallid Bat's habitat is on private land and actions are voluntary. Process measures are included to set milestones for recovery.

The interim target for foraging habitat for Pallid Bat is to maintain or increase the amount of suitable foraging habitat for Pallid Bat within 4.5 km of roosts, with the overall target to have 100% of the foraging habitat within 4.5 km of roosts suitable for the species. Performance indicators in the Recovery Action Table track progress in meeting the target of no loss of foraging habitat over the current baseline situation.

To address knowledge gaps about the range of Pallid Bat, the species' ecology and threat impacts to the species, many recovery actions focus on surveys to determine the species' distribution, the locations of summer and winter roosts, occupancy of known roosts, and information about vital rates of the species. Because specific targets for number of individuals have not been established beyond maintaining more than 250 mature individuals in the population, these data will be used to indicate the success of species recovery. Data from surveys will assist in developing a more precise estimate of the population size of the Pallid Bat.

9 EFFECTS ON OTHER SPECIES

Pallid Bat recovery may have little direct effect on other species or ecological processes, especially since there is no intent to enhance the population(s) above natural carrying capacity. Many species will benefit indirectly from recovery efforts. Other SARA-listed bats, such as Spotted Bat (*Euderma maculatum*; Special Concern), Little Brown Myotis (Endangered), and Fringed Myotis (*Myotis thysanodes*; Data Deficient) should be monitored and opportunistically studied when conducting surveys or research on Pallid Bat. Protecting foraging habitats will

benefit many other SARA-listed species, such as the Western Rattlesnake (*Crotalus oreganus*), Desert Nightsnake (*Hypsiglena chlorophaea),* Great Basin Gophersnake (*Pituophis catenifer deserticola*), Western Tiger Salamander (*Ambystoma mavortium*), Great Basin Spadefoot (*Spea intermontana*), Behr's Hairstreak (*Satyrium behrii*), and American Badger (*Taxidea taxus*). Protecting roosting habitat for the species could benefit other cliff-roosting bat species, such as Spotted Bat, Little Brown Myotis, and Fringed Myotis, as well as other cliff-roosting species. Recovery planning activities for Pallid Bat will be implemented with consideration for all co-occurring species at risk, such that no negative impacts occur to these species or their habitats.

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