

Recovery Strategy for the Okanagan Efferia (*Efferia okanagana*) in Canada

Okanagan Efferia



2022



Government
of Canada

Gouvernement
du Canada

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 [Species at Risk \(SAR\) Public Registry](#)¹.

Cover illustration: © Okanagan Efferia (male) at Vaseux Lake, 2018/05/28; Eric Gross

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¹ www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

RECOVERY STRATEGY FOR THE OKANAGAN EFFERIA (*EFFERIA OKANAGANA*) IN CANADA

2022

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 Okanagan Robber Fly (Efferia okanagana) 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 Okanagan Efferia² in Canada consists of two parts:

Part 1 – Federal addition to the *Recovery Plan for the Okanagan Robber Fly (Efferia okanagana) in British Columbia*, prepared by Environment and Climate Change Canada.

Part 2 – *Recovery Plan for the Okanagan Robber Fly (Efferia okanagana) in British Columbia*, prepared by the British Columbia Ministry of Environment.

² This species is referred to as the Okanagan Efferia by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011) and is referred to as the Okanagan Robber Fly by the Province of British Columbia. Both names refer to the same species, *Efferia okanagana*.

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Part 2 – *Recovery Plan for the Okanagan Robber Fly (Efferia okanagana) in British Columbia*, prepared by the British Columbia Ministry of Environment.

Part 1 – Federal Addition to the *Recovery Plan for the Okanagan Robber Fly (Efferia okanagana) in British Columbia*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the [Accord for the Protection of Species at Risk \(1996\)](#)³ 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 Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Okanagan Efferia 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 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 Okanagan Efferia (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 Okanagan Efferia 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.

³ www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

In the case of critical habitat identified for terrestrial species including migratory birds, SARA requires that critical habitat identified in a federally protected area⁴ 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.

⁴ 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 Birds Convention Act, 1994*, or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgements

The federal addition was prepared by Eric Gross and Kella Sadler (Environment and Climate Change Canada, Canadian Wildlife Service – Pacific Region [ECCC-CWS-PAC]). Helpful editorial advice and comment was provided by: Rob Cannings (Curator Emeritus, Royal British Columbia Museum); Jennifer Heron and Alanah Nasadyk (B.C. Ministry of Environment and Climate Change Strategy [ENV]); Todd Kohler (Department of National Defence); Jamie Leathem and R. Reudink (B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development); Véronique Brondex, Thomas Calteau, Matt Huntley, and Aurore Menard (ECCC-CWS – National Capital Region); and Tiana Collins and Noella Trimble (ECCC – Wildlife Enforcement Directorate). Rob Cannings, Tyson Ehlers (Masse Environmental Consultants), Jennifer Heron, Dawn Marks (ENV), Jaime Leathem, and Katrina Stipeck (B.C. Conservation Data Centre) kindly provided supporting data. Danielle Yu (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 Okanagan Robber Fly (Efferia okanaganana) in British Columbia* (Part 2 of this document, referred to henceforth as “the provincial recovery plan”), and/or to provide updated or additional information. Note the provincial recovery plan follows the provincial naming convention for the species; i.e., Okanagan Robber Fly. This federal addition follows COSEWIC (2011) naming conventions, i.e., Okanagan Efferia. Both names refer to the same species, *Efferia okanaganana*.

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 correspond directly 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. Species Status Information

This section replaces “Section 2: Species Status Information” in the provincial recovery plan.

The legal designation for Okanagan Efferia on SARA Schedule 1 is Endangered (2017).

Table 1. Conservation status of Okanagan Efferia (B.C. Conservation Data Centre 2020; NatureServe 2020).

Global (G) Rank*	National (N) Rank*	Sub-national (S) Rank*	COSEWIC Status	B.C. List
G1G2 (2020)	Canada (N1N2)	British Columbia (S1S2)	Endangered (2011)	Red List

*Rank 1– critically imperiled; 2– imperiled; 3– vulnerable to extirpation or extinction; 4– apparently secure; 5– secure; H– possibly extirpated; NR – status not ranked.

2. Species Population and Distribution

This section (Table 2 below) replaces the summary of known populations of Okanagan Efferia in Canada (i.e., Table 1 in section 3.2 of the provincial recovery plan).

Current information for Okanagan Efferia indicates there are six known extant populations in British Columbia (B.C.). All occur in the south-central part of the province. This includes a recently recorded (2019) population (#6) near Kelowna at Bear Creek Provincial Park (Ehlers pers. comm. 2020). With the exception of the Kelowna population, the provincial recovery plan (see Part 2; Appendix 1) provides further detail on each population by describing constituent “sites”, which represent the local areas where point occurrences have been observed. Population “units” have been used to group sites (Table 2 below) where they are clustered closely together, i.e., within 220 m of each other (corresponding with the maximum observed movement distance for

similar asilids⁵), to represent biologically relevant units of occupation on the landscape. The six known extant populations currently are comprised of ten known extant population units. Three units (Vaseux Lake Southeast, Camp Vernon, and Black Sage) are considered historical (species not observed for > 50 years).

Table 2. Summary of Okanagan Efferia populations in Canada as of May 2020. Information for each population unit includes a list of constituent sites as designated in Appendix 1 of the provincial recovery plan (where provided), as well as corresponding B.C. Conservation Data Centre (B.C. CDC) Element Occurrence (EO) numbers and Source Feature Descriptors. Status and year of last verified observation (Last Obs.) are shown for each unit.

Population	Unit	Site	B.C. CDC ^a		Status ^b	Last Obs.
			EO	Source Feature Descriptor		
1 Kamloops	Batchelor Hills	1	1	Batchelor Hills	Extant	1984
	Grace Lake	2	1	Grace Lake	Extant	2010
2 Vernon	Cosens Bay	3-11	8	Cosens Bay Grasslands 1,2,3,5,6,7	Extant	2016
	Cosens Trail	12	8	Cosens Bay Grasslands 4	Extant	2010
	Camp Vernon	-	9	Camp Vernon	Historical	1930
3 Okanagan Falls	Thomas Ranch	13	2	Thomas Ranch	Extant	1993
4 Vaseux Lake	Vaseux Lake	15-21	5	Vaseux Lake (VL) East; VL Park; VL cliff base 1,2,3,4; VL cliff tops	Extant	2018
	Kennedy	22-23	5	Vaseux Creek 1,2 - Nature Trust Kennedy	Extant	2009
	Vaseux Lake Southeast	14	5	Vaseux Lake Southeast	Historical	1959
5 Oliver	Fairview Uplands	24	4	Fairview Uplands	Extant	2010
	Oliver Mountain	24, 25	4	Fairview, Oliver Mountain	Extant	2017
	Black Sage	-	3	Black Sage	Historical	1959
6 Kelowna	Bear Creek	-	11	Bear Creek Provincial Park	Extant	2019

^a Element Occurrence (EO) and Source Feature Descriptor for B.C. CDC occurrence points or polygons.

^b Okanagan Efferia units are marked as “extant” where a record has been verified within the last 50 years. Although the Vaseux Lake Southeast site (#14) is described as extant in the provincial recovery plan, the date of the occurrence record does not match the criteria applied to define extant sites (Heron pers. comm. 2020). Therefore, it is characterized as historical here.

3. Population and Distribution Objectives

The provincial recovery plan contains a statement on population and distribution objectives, and supporting rationale, i.e., “Section 5.1 Recovery (Population and

⁵ Members of the insect family Asilidae, which is the taxon that contains all robber flies.

Distribution) Goal” and “Section 5.2 Rationale for the Recovery (Population and Distribution) Goal”. Environment and Climate Change Canada adopts the intent of the provincial population and distribution goal and supporting rationale with modifications as follows:

Population and Distribution Objectives

To ensure the persistence and improve the redundancy of Okanagan Efferia within all extant population units in Canada (including any additional population units that may be identified in the future) by ceasing or mitigating human-caused threats causing decline in the area, extent, and quality of suitable habitat at known extant population units.

Rationale

Okanagan Efferia is a Canadian endemic with a small global range. This species currently is known from ten extant units grouped into six populations in lower elevation grassland habitats of the Okanagan and Thompson valleys. There is no evidence that this species was more widely distributed. Biological information for the species is limited. The specific proportions and types of vegetation and habitat attributes required are unknown, as are other quantifiable metrics such as lifespan, dispersal distance, and population abundance. Okanagan Efferia’s small index of area of occupancy (40 km²) and the continuing declines in the area, extent, and quality of its habitat have led to its assessment as Endangered⁶ in Canada. The survival characteristic that has been compromised is redundancy⁷. The threshold⁸ separating designations of Endangered and Threatened include an index of area of occupancy (>500 km²) and/or more than five locations⁹, without continuing declines in habitat. With the recently recorded (2019) population in Kelowna, it is considered biologically and technically feasible to improve the species’ condition to an assessed status of at least Threatened, primarily by addressing the human-caused threats that have resulted in habitat declines at known extant sites.

4. 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 (section 3.3, Table 2)

⁶ Assessed as “Endangered” in 2011 based on COSEWIC criteria: B2ab(iii). Also met D2 criteria for “Threatened” on the basis of 5 locations, declining habitat, and a large number of threats.

⁷ Redundancy - a species that has multiple subpopulations or locations is more likely to persist over the long term because of reduced risk of catastrophic loss or extirpation from a single, local event.

⁸ For COSEWIC quantitative criteria and guidelines see www.cosewic.ca/index.php/en-ca/assessment-process/wildlife-species-assessment-process-categories-guidelines/quantitative-criteria.

⁹ See www.cosewic.ca/index.php/en-ca/about-us/definitions-abbreviations#L for the definition of location that is applied by COSEWIC in their assessment.

provides a summary of the essential functions and features of Okanagan Efferia habitat in British Columbia. This science advice was used to inform the following critical habitat sections in this federal recovery strategy.

Critical habitat for the Okanagan Efferia is identified in this document to the extent possible and is considered sufficient to meet the population and distribution objectives. Therefore, a schedule of studies to identify critical habitat is not required. As responsible jurisdictions and/or other interested parties conduct research to address knowledge gaps¹⁰, the existing critical habitat methodology and identification may be modified and/or refined to reflect new knowledge.

4.1 Identification of the Species' Critical Habitat

Geospatial location of areas containing critical habitat

Critical habitat for Okanagan Efferia is identified in six geographic areas corresponding with the six known populations as represented by ten extant population units:

1. Kamloops population: Batchelor Hills, Grace Lake (Figure 1)
2. Vernon population: Cosens Bay, Cosens Trail (Figure 2)
3. Okanagan Falls population: Thomas Ranch (Figure 3)
4. Vaseux Lake population: Vaseux Lake, Kennedy (Figure 4)
5. Oliver population: Fairview Uplands, Oliver Mountain (Figure 5)
6. Kelowna population: Bear Creek (Figure 6)

The geospatial location of critical habitat is identified to encompass both local and dispersal movements, which contain the areas required to support life history functions for eggs, larvae¹¹, pupae¹², and adults as described in the provincial recovery plan (section 3.3, Table 2). All life history functions will occur within the areas that the species can disperse to successfully. Currently there is no information about the dispersal of Okanagan Efferia, and there is limited information about the home ranges and movement in asilids in general, including documented transient/dispersal flights. The furthest documented movement distances recorded for similarly-sized (13-25 mm) asilids are 220 m (Lavigne and Bullington 2001) for the open woodland fly *Laphria fernaldi* and >200 m (Onsager and Rees 1985) for the grassland fly *Megaphorus guildiana* (Williston). On this basis, most movements and life history functions of Okanagan Efferia are estimated to occur within a 220 m distance around Okanagan Efferia point occurrences.

¹⁰ Knowledge gaps for Okanagan Efferia are identified in the Recovery Planning Table in the adopted provincial recovery plan (see Part 2; section 6.2).

¹¹ Immature invertebrate, which undergoes gradual metamorphosis before reaching the adult (winged) stage. The larval stage for robber flies lasts 1-2 years.

¹² Life stage of invertebrates in transition (metamorphosis) between immature (larva) and adult (winged) stages. Pupation would occur in the last spring of development before the adult emerges.

The detailed geospatial areas containing critical habitat for Okanagan Efferia are based on the following methodology, which is sequentially applied to all verified extant occurrence records that have adequate location certainty (i.e., records must have been verified by a species expert, collected within the past 50 years in alignment with the criteria used in the provincial recovery plan, and have a location uncertainty distance ≤ 150 m):

- (1) Mapping each point occurrence or polygon, including its associated location uncertainty distance (up to 150 m);
- (2) Further applying a 220 m radial distance to encompass essential areas that are necessary to support life history functions;
- (3) Creating coarse-scale spatial groupings by applying minimum convex polygons¹³ around overlapping areas to ensure habitat connectivity and continuity among local populations; and,
- (4) Geospatial exclusion of large-scale features that Okanagan Efferia are not known to use or require, i.e., large waterbodies (lakes).

Biophysical attributes critical habitat

The biophysical features and attributes required for the Okanagan Efferia (outlined in the provincial recovery plan, and summarized here in Table 3) overlap geospatially across life history stages. Within the geospatial areas containing critical habitat, only clearly unsuitable areas that do not support the species in any life history stage (i.e., do not contain any of the biophysical features or attributes required by the species at any time) are not identified as critical habitat.

Table 3. Summary of essential functions, biophysical features, and key attributes of Okanagan Efferia critical habitat by life stage.

Life Stage	Function	Biophysical Feature(s)	Attributes
Egg	Oviposition ^a , incubation	Grassland or very open forest	Presence of Bluebunch Wheatgrass (<i>Pseudoroegneria spicata</i>)
Larva ^b and pupa ^c	Burrowing, foraging, refuge, pupation, emergence	Grassland or very open forest	Presence of coarse surface soils such as stony, gravelly alluvium, sandy loam, with >8% gravel
Larva and adult	Foraging for prey	Grassland or very open forest	Presence of one or more arthropod prey items (e.g., larval, pupal, or adult flies, bees, wasps, grasshoppers, dragonflies, spiders)
Adult	Perching, thermoregulation, mating, roosting	Grassland or very open forest	Presence of vegetation (herb or shrub layers), rocks, bare ground

^a Oviposition (egg laying) occurs during the adult flight period from April - June.

¹³ A minimum convex polygon is the smallest shape connected with straight line segments, which will surround all essential areas as identified in step 2.

^b Immature invertebrate, which undergoes gradual metamorphosis before reaching the adult (winged) stage. The larval stage for robber flies lasts 1-2 years.

^c Life stage of invertebrates in transition (metamorphosis) between immature (larva) and adult (winged) stages. Pupation would occur in the last spring of development before the adult emerges.

The areas containing critical habitat for the Okanagan Efferia (totalling 639.43 ha¹⁴) are presented in Figures 1-6. Critical habitat for the Okanagan Efferia in Canada occurs within the shaded yellow polygon(s) shown on each figure. The biophysical attributes required by Okanagan Efferia overlap geospatially across life history stages, in that they combine to provide an ecological context for the species at sites where it occurs. Therefore, the shaded yellow polygons (units) shown on each figure represent identified critical habitat, excepting only those features that clearly do not meet the needs of the species; these include: existing buildings, running surface of paved roadways, paved parking lots, and large waterbodies (lakes). These features do not possess attributes required by Okanagan Efferia and, therefore, are not identified as critical habitat.

¹⁴ Critical habitat for Okanagan Efferia occurs within the Vaseux-Bighorn National Wildlife Area (38.2 ha) and Vaseux Lake Migratory Bird Sanctuary (16.87 ha) boundaries (see Figure 4).

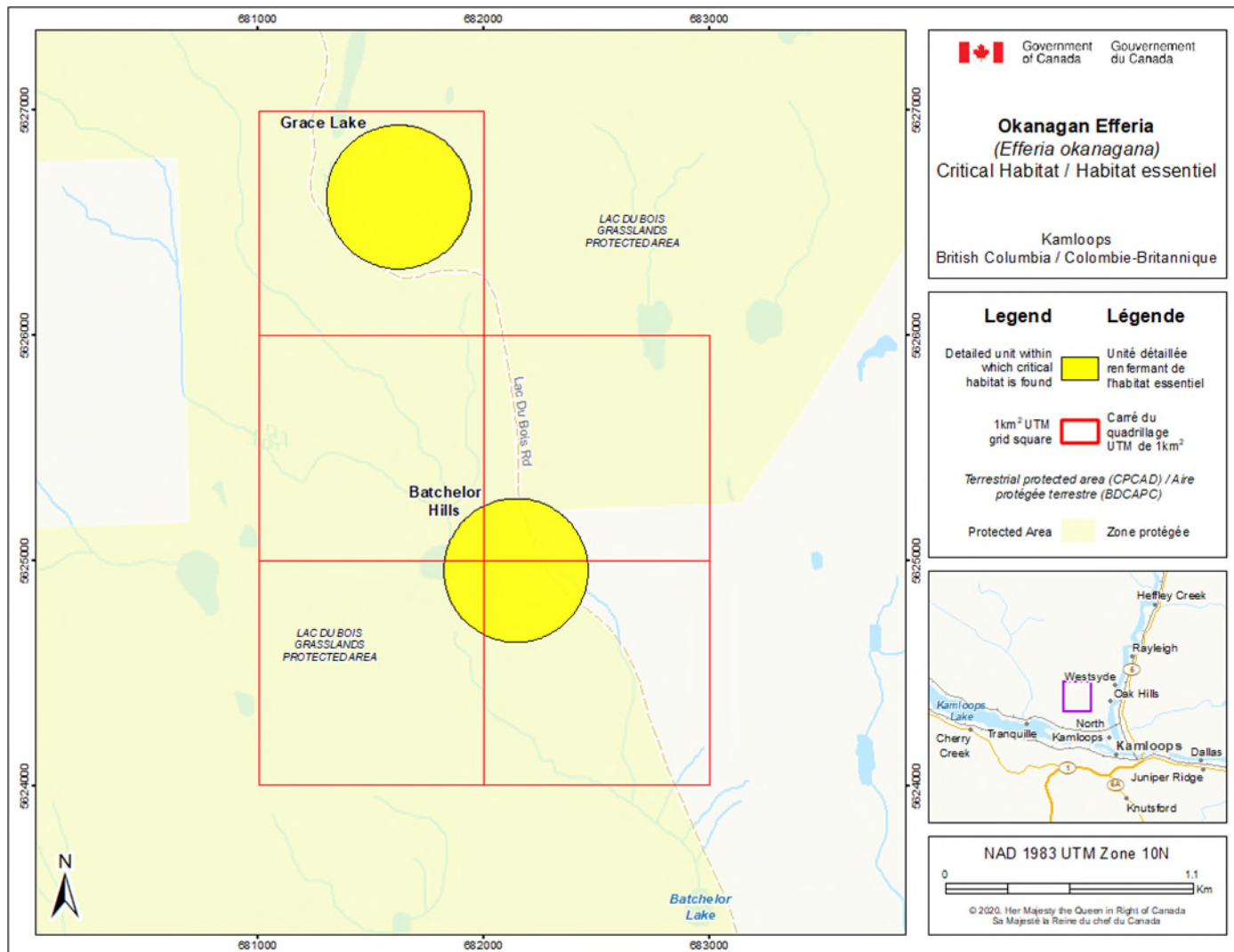


Figure 1. Critical habitat for the Okanagan Efferia at Kamloops, B.C. (Batchelor Hills and Grace Lake population units), is represented by the shaded yellow polygons, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

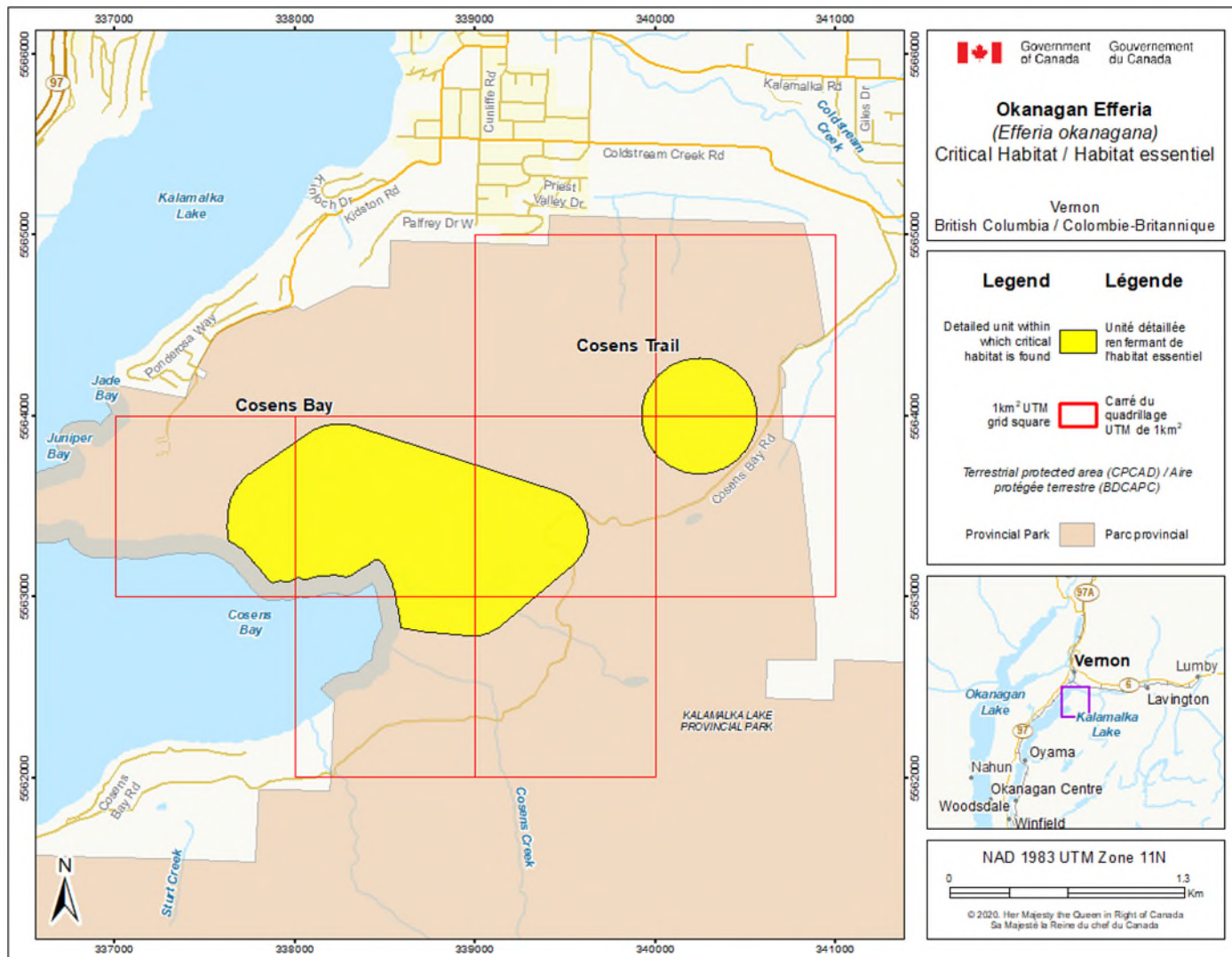


Figure 2. Critical habitat for the Okanagan Efferia at Vernon, B.C. (Cosens Bay and Cosens Trail population units), is represented by the shaded yellow polygons, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

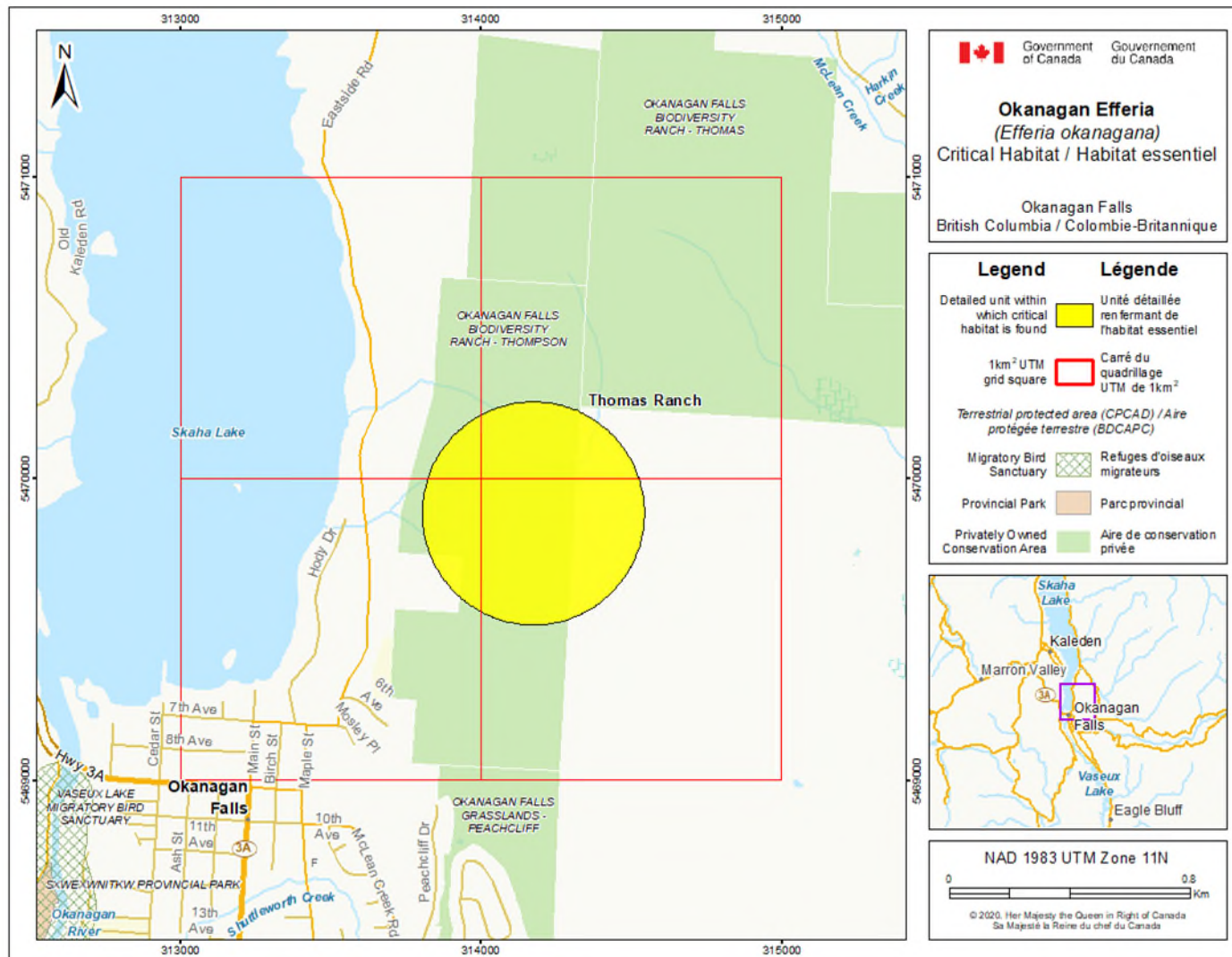


Figure 3. Critical habitat for the Okanagan Efferia at Okanagan Falls, B.C. (Thomas Ranch population unit), is represented by the shaded yellow polygon, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

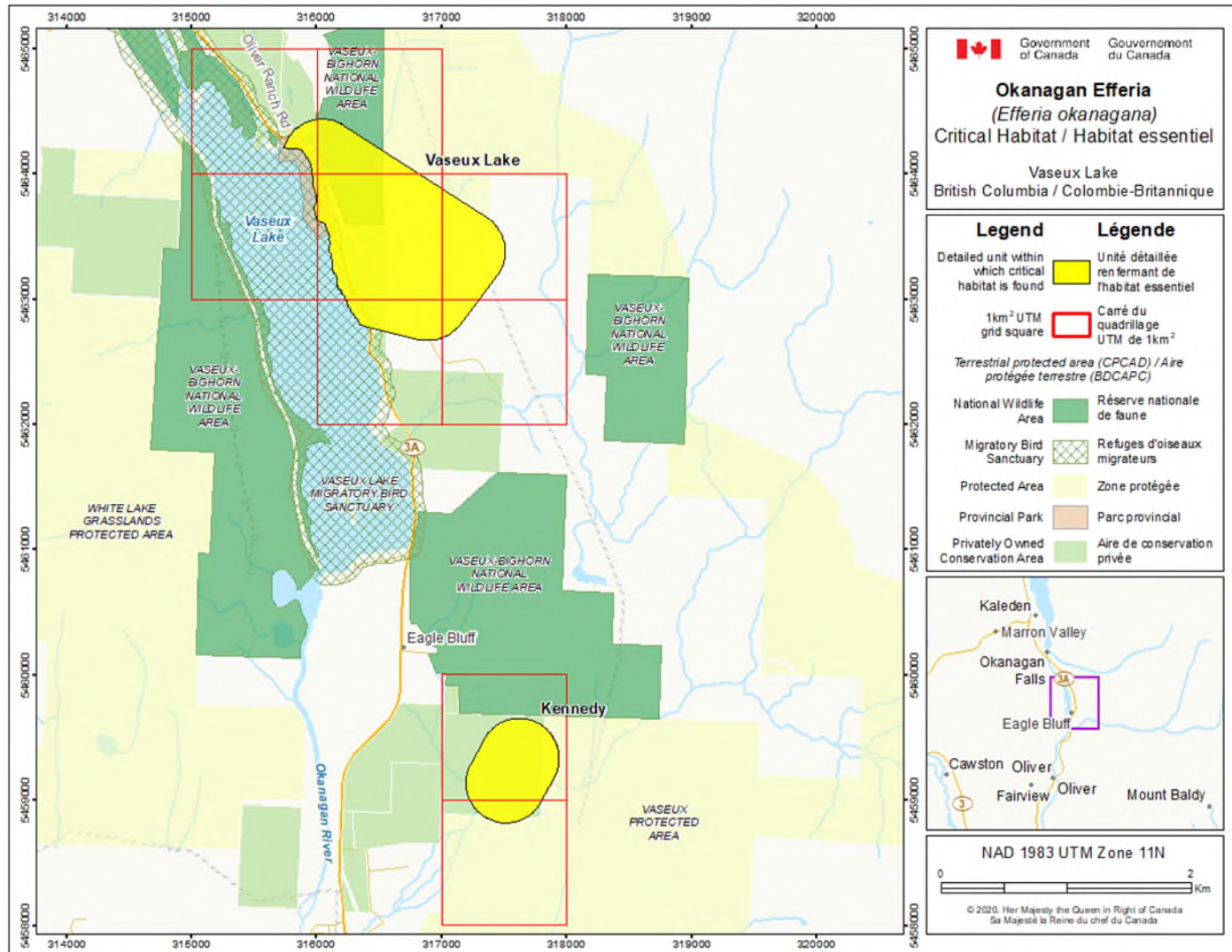


Figure 4. Critical habitat for the Okanagan Efferia at Vaseux Lake, B.C. (Vaseux Lake and Kennedy population units), is represented by the shaded yellow polygons, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

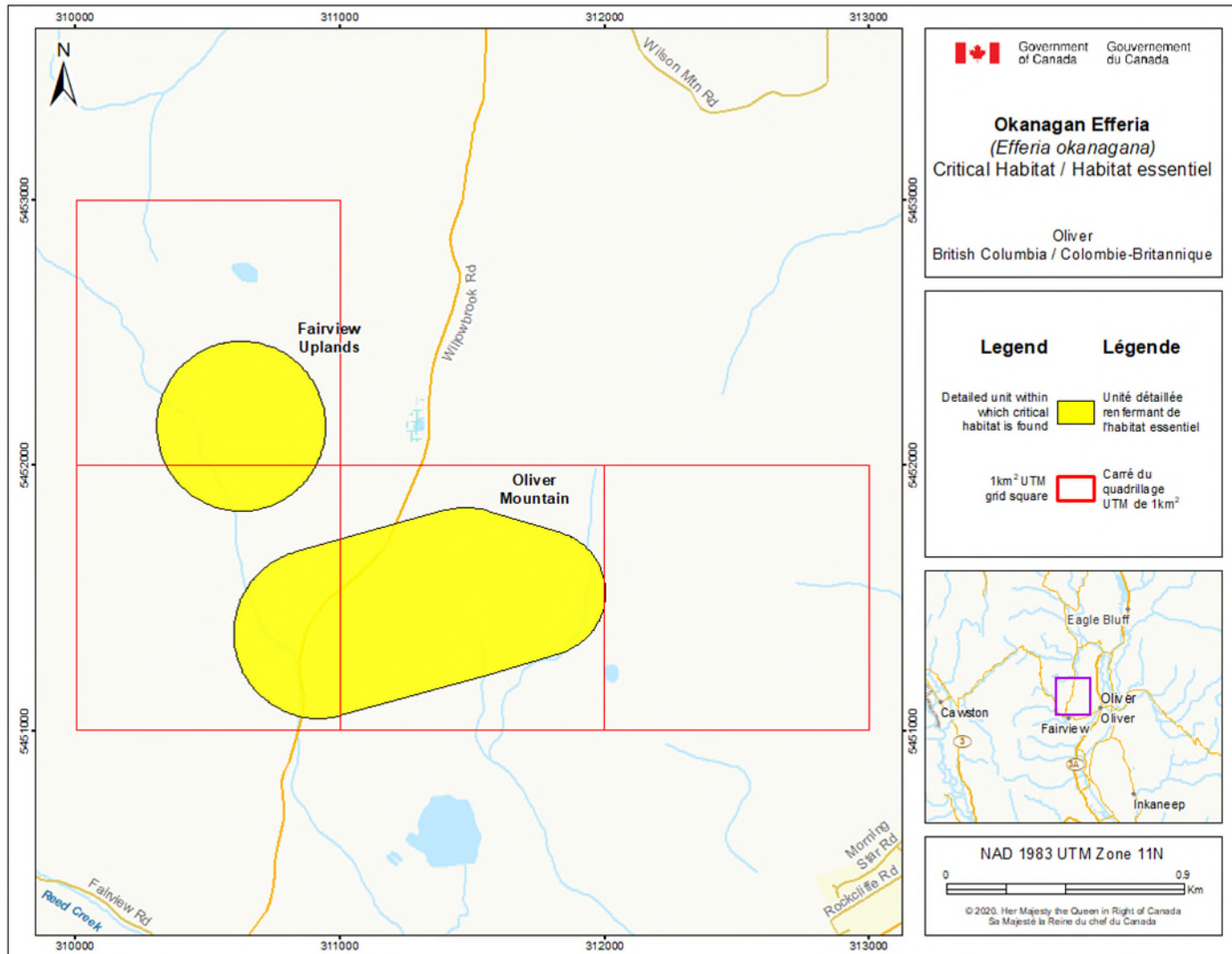


Figure 5. Critical habitat for the Okanagan Efferia at Oliver, B.C. (Fairview Uplands and Oliver Mountain population units), is represented by the shaded yellow polygons, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygons do not contain critical habitat.

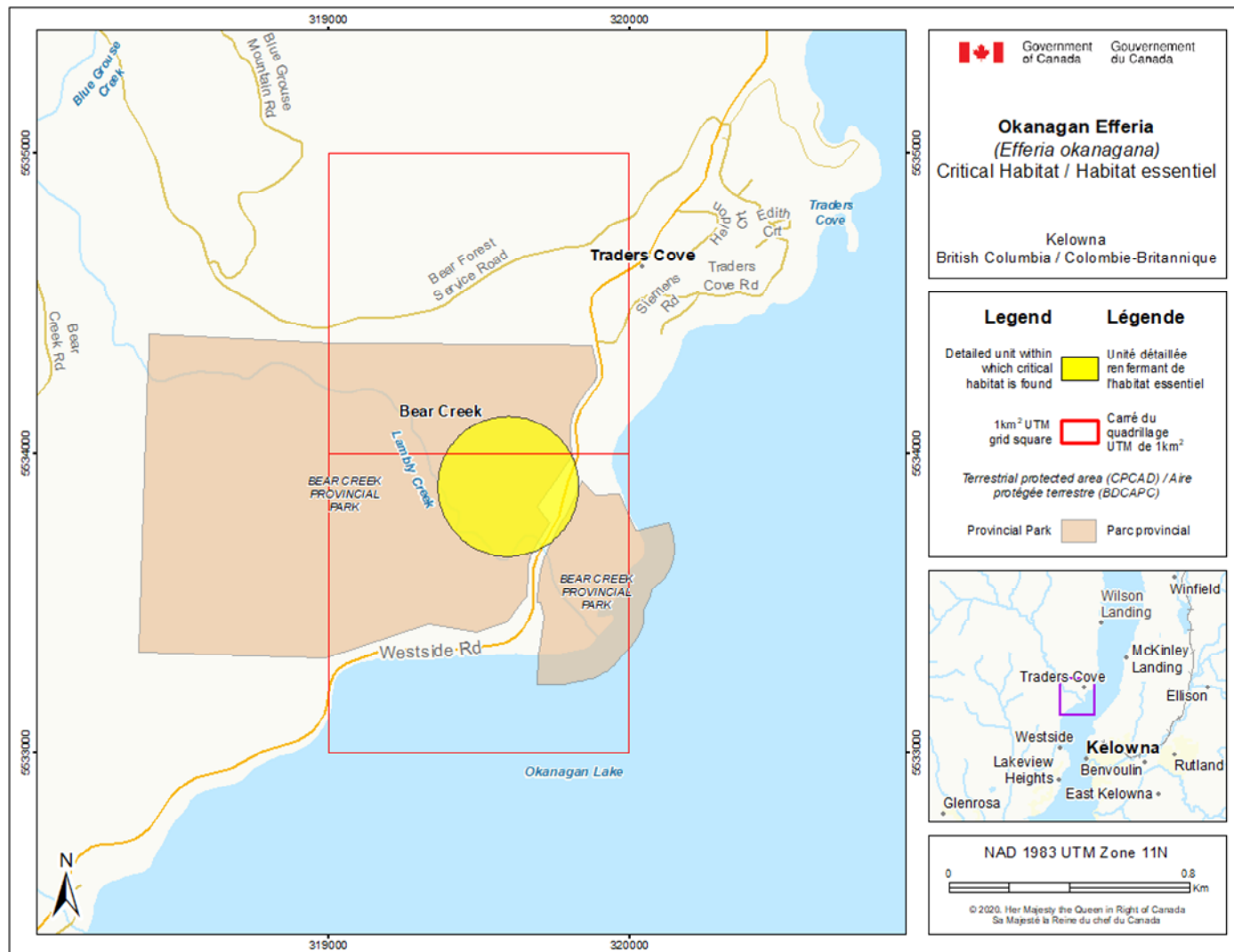


Figure 6. Critical habitat for the Okanagan Efferia at Kelowna, B.C. (Bear Creek population unit), is represented by the shaded yellow polygon, where the criteria and methodology set out in section 4.1 are met. The 1 km x 1 km UTM grid overlay (red outline) shown on this figure is part of a standardized national grid system used to indicate the general geographic area within which critical habitat is found. Areas outside of the shaded polygon do not contain critical habitat.

4.2 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 to successfully complete any part of its life cycle. 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. The provincial recovery plan provides a description of potential threats and limitations to Okanagan Efferia (Part 2, section 4).

Activities, described in Table 4, include those likely to cause destruction of critical habitat for the species. Destructive activities are not limited to those listed.

Table 4. Activities likely to result in destruction of critical habitat for Okanagan Efferia.

Description of Activity	Description of Effect on Attributes of Habitat	Additional Information including related IUCN threat^a
<p>Conversion of natural landscape for residential and commercial development, agriculture (vineyard development), or tourism and recreation (creating or widening trails for hiking, all-terrain vehicles, motorbikes, or mountain bikes).</p>	<p>Results in the loss of critical habitat through removal, replacement, compaction, or burying of the native vegetation and soil biophysical attributes required by the species for all life stage functions, including effects that ultimately result in the reduction or elimination of prey.</p>	<p>Related IUCN-CMP Threat # 1.1, 1.2, 1.3, 2.1, 6.1</p> <p>Destruction of critical habitat by this activity can be caused at any time of the year. Most likely to result in destruction when occurring inside the bounds of critical habitat. However, effects on prey abundance may result from activities occurring in proximal areas outside the bounds of critical habitat.</p> <p>Destruction of critical habitat for residential and commercial development is most likely to occur near areas of high population density, e.g., Vaseux Lake and Oliver. Destruction of critical habitat for vineyards is most likely to occur at Vaseux Lake (site 20). Destruction of critical habitat for tourism and recreation is most likely to occur at Cosens Bay and Trail (3-12) or Bear Creek Provincial Park via creation or widening of hiking trails, and at Oliver Mountain (24-25) where there is already an approved off-road vehicle track. Unauthorized recreational vehicle use also occurs in the Lac du Bois Grasslands Protected Area (1-2).</p>
<p>Inappropriate level^b and concentration of livestock use, i.e., that results in significant adverse effects^c.</p>	<p>Results in the loss of critical habitat through destruction or alteration (removal, replacement, or compaction) of native vegetation and soil biophysical attributes (including change due to urination/defecation) required by the species for all life stage functions, including effects that ultimately result in the reduction or elimination of prey.</p>	<p>Related IUCN-CMP Threat # 2.3</p> <p>Destruction of critical habitat by this activity can be caused at any time of the year. Most likely to result in destruction when occurring inside the bounds of critical habitat.</p> <p>Destruction of critical habitat by grazing, compaction, or change in soil attributes is most likely to occur in areas that are currently subject to livestock grazing at variable intensity and severity, i.e., Kamloops (sites 1-2), Okanagan Falls (13), Vaseux Lake (20-23), and Oliver (24-25).</p>

Description of Activity	Description of Effect on Attributes of Habitat	Additional Information including related IUCN threat ^a
Introduction of alien invasive plants.	Alien invasive species (e.g., cheatgrass (<i>Bromus tectorum</i>), Sulphur Cinquefoil (<i>Potentilla recta</i>), Diffuse Knapweed (<i>Centaurea diffusa</i>), and Dalmatian Toadflax (<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>)) cause destruction of critical habitat by replacing or altering the native vegetation and soil biophysical attributes required by the species for all life stage functions, including effects that ultimately result in the reduction or elimination of prey.	Related IUCN-CMP Threat # 8.1 Destruction of critical habitat by this activity can be caused at any time of the year. Most likely to result in destruction when occurring inside the bounds of critical habitat. However, effects may result from activities occurring in proximal areas outside the bounds of critical habitat, e.g., by increasing the risk of invasive species spread. Invasive plants occur in various concentrations throughout the species' range.
Efforts to control agricultural pests and/or invasive species that do not follow best management practices ^d .	Efforts to control agricultural pests and/or invasive species through chemical means (pesticides, herbicides) can result in the destruction of critical habitat via loss of native vegetation and/or substrate biophysical attributes required by the species, including: soil toxicity for larvae caused by pesticide accumulation and persistence; systemic pesticides may reduce prey populations.	Related IUCN-CMP Threat # 9.3 Destruction of critical habitat by this activity can be caused at any time of the year. Most likely to result in destruction when occurring inside the bounds of critical habitat. However, effects may result from activities occurring in proximal areas outside the bounds of critical habitat, e.g., as a consequence of pesticide/herbicide drift. Effects can be cumulative. Destruction of critical habitat by pesticide application is most likely to occur at or near the 5 sites that border agricultural lands (Vaseux Lake, sites 17, 20, and 21-23; Oliver 24-25).

^a Threat classification is based on the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system (www.conservationmeasures.org).

^b Additional research is required to determine what level of livestock use is considered destructive to Okanagan Efferia, i.e., the level at which the features and attributes necessary for persistence are destroyed. However, it is clear that intensive stocking rates would be likely to result in destruction of critical habitat.

^c Significant adverse effects are those that negatively impact the species' survival and recovery. Success of the species' survival and recovery will be assessed against the adopted population and distribution objective and associated performance measures for Okanagan Efferia as they are set out in this document.

^d For examples, see "Best Management Practices for Invasive Plants in Parks and Protected Areas of British Columbia" or www.bcinvasives.ca/resources/publications.

5. Measuring Progress

The provincial recovery plan (Part 2, section 8) contains a section on measuring progress toward meeting the four recovery objectives that are set out in that plan (Part 2, section 5.3). Environment and Climate Change Canada adopts “Section 8: Measuring Progress” with the addition of the following performance indicators that define and measure progress toward meeting the population and distribution objective as it is set out in this federal recovery strategy, i.e.:

- The persistence of Okanagan Efferia has been maintained within all extant population units; and
- Within all extant population units, the area, extent, and quality of suitable habitat has been maintained.

6. Statement on Action Plans

One or more action plans for the Okanagan Efferia will be posted on the Species at Risk Public Registry within 10 years of the posting of the final recovery strategy.

7. 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](#)¹⁵. 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](#)'s¹⁶ 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 also are summarized below in this statement.

The provincial recovery plan for the Okanagan Efferia contains a section (i.e., section 9) describing the effects of recovery activities on other species. 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.

¹⁵ www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html

¹⁶ www.fsds-sfdd.ca/index.html#en/goals/

Recovery planning activities for the Okanagan Efferia will be implemented with consideration for all co-occurring species, with focus on species risk, such that inadvertent negative impacts to these individuals and their habitats are minimized or avoided. Some recovery actions for the Okanagan Efferia (e.g., inventory and mapping, threat mitigation, habitat conservation, education, and research) may promote the conservation of other species at risk that overlap in distribution and rely on similar habitat attributes.

Other SARA Schedule 1 wildlife species that may benefit from protective measures taken for Okanagan Efferia include: Behr's Hairstreak (*Satyrium behrii*; Endangered), Branched Phacelia (*Phacelia ramosissima*; Endangered), Great Basin Gophersnake (*Pituophis catenifer deserticola*; Threatened), Great Basin Spadefoot (*Spea intermontana*; Threatened), Lewis's Woodpecker (*Melanerpes lewis*; Threatened), Nuttall's Cottontail *nuttallii* subspecies (*Sylvilagus nuttallii nuttallii*; Special Concern), Rubber Boa (*Charina bottae*; Special Concern), Western Harvest Mouse *megalotis* subspecies (*Reithrodontomys megalotis megalotis*; Special Concern), Western Rattlesnake (*Crotalus oreganos*; Threatened), Western Screech Owl *macfarlanei* subspecies (*Megascops kennicotti macfarlanei*; Threatened), Western Skink (*Plestiodon skiltonianus*; Special Concern), Western Toad (*Anaxyrus boreas*; Special Concern), and Western Yellow-bellied Racer (*Coluber constrictor mormon*; Special Concern).

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**Part 2 – *Recovery Plan for the Okanagan Robber Fly*
(*Efferia okanagana*) in *British Columbia*, prepared by the
British Columbia Ministry of Environment**

Recovery Plan for the Okanagan Robber Fly (*Efferia okanagana*) in British Columbia



Prepared by the Okanagan Robber Fly Technical Working Group



Ministry of
Environment

May 2016

About the British Columbia Recovery Strategy 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. This information may be summarized in a recovery strategy followed by one or more action plans. The purpose of an action plan is to offer more detailed information to guide implementation of the recovery of a species or ecosystem. When sufficient information to guide implementation can be included from the onset, all of the information is presented together in a recovery plan.

Information provided in provincial recovery documents may be adopted by Environment and Climate Change Canada for inclusion in federal recovery documents that the 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. Ministry of Environment Recovery Planning webpage at:

<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>

**Recovery Plan for the Okanagan Robber Fly
(*Efferia okanagana*) in British Columbia**

Prepared by the Okanagan Robber Fly Technical Working Group

May 2016

Recommended citation

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Cover illustration/photograph

Okanagan Robber Fly (*Efferia okanagana*). Photograph by Werner Eigelsreiter, Okanagan Wildlife Photography, Penticton, BC

Additional copies

Additional copies can be downloaded from the B.C. Ministry of Environment Recovery Planning webpage at:

<<http://www.env.gov.bc.ca/wld/recoveryplans/rcvry1.htm>>

Disclaimer

This recovery plan has been prepared by the Okanagan Robber Fly Technical Working Group, 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 Okanagan Robber Fly 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 and all members of the working group 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 on the working group.

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 Okanagan Robber Fly.

ACKNOWLEDGEMENTS

Jennifer Heron (B.C. Ministry of Environment) wrote the recovery plan, with input from Orville Dyer (B.C. Ministry of Forests, Lands and Natural Resource Operations) and Dennis St. John (independent entomologist). Rob Cannings (Curator Emeritus, Royal British Columbia Museum) provided advice on robber flies, recent search effort, and natural history. Leah Westereng (B.C. Ministry of Environment) and Peter Fielder (B.C. Ministry of Environment) provided scientific and editorial review and policy guidance. Brenda Costanzo (B.C. Ministry of Environment) provided information about plant communities in the southern interior of British Columbia. Kristina Robbins (B.C. Ministry of Forests, Lands and Natural Resource Operations), Leah Ramsay and Lea Gelling (B.C. Conservation Data Centre) assisted with records, natural history, habitat information, and recent observations. Thank you to Dave Trotter and Laila Salm (B.C. Ministry of Forests, Lands and Natural Resource Operations), Kella Sadler and Matt Huntley (Environment and Climate Change Canada, Canadian Wildlife Service, Pacific Region), and Véronique Lalande (Environment and Climate Change Canada, Canadian Wildlife Service, National Capital Region) for review comments. Thank you to Werner Eigelsreiter (www.okanaganwildlifephotography.com) for the use of Okanagan Robber Fly photographs within this report.

TECHNICAL WORKING GROUP MEMBERS

Rob Cannings, Curator Emeritus, Royal British Columbia Museum, Victoria, BC

Orville Dyer (Co-chair), B.C. Ministry of Forests, Lands and Natural Resource Operations, Penticton, BC

Jennifer Heron (Co-chair), B.C. Ministry of Environment, Vancouver, BC

Dawn Marks, B.C. Ministry of Forests, Lands and Natural Resource Operations, Penticton, BC

Kirk Safford, Parks Conservation Specialist, B.C. Ministry of Environment, BC Parks, Penticton, BC.

Dennis St. John, Independent Entomologist, Agassiz, BC.

EXECUTIVE SUMMARY

The Okanagan Robber Fly (*Efferia okanagana*) is a large, brown, bristly robber fly approximately 1.2–2 cm in length. Morphological features distinct to the adults (in both sexes) include striking orange-golden occipital bristles, or “eyebrows,” around the upper rim of the eyes and a tuft of white bristles on the face which are often pale golden at the base. The last three abdominal segments in males are silver white (females do not have this feature).

The Okanagan Robber Fly was assessed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2011 and is currently not listed on Schedule 1 of the federal *Species at Risk Act* (SARA). In British Columbia, the Okanagan Robber Fly is ranked S2 (Imperiled) by the Conservation Data Centre and is on the provincial Red list. Recovery is considered biologically and technically feasible.

Okanagan Robber Fly is a Canadian endemic and known globally from five populations in the Okanagan and Thompson valleys, British Columbia. These five populations, from north to south, are: (1) Kamloops, (2) Vernon, (3) Okanagan Falls, (4) Vaseux Lake, and (5) Oliver. The species inhabits twelve plant communities dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) within in the low-elevation (280–760 m) areas of the Bunchgrass, Ponderosa Pine, and Interior Douglas-fir biogeoclimatic zones. The species’ grassland habitat continues to be degraded in quality by cumulative low-impact threats that include: the introduction and spread of invasive plants and insects and the impacts these species have to adult forage and larval burrow sites; changing fire regimes and natural succession into open grassland habitats; pesticide drift and the potential harm to adults and their food supply; unrestricted all-terrain vehicle use; and land conversion.

The recovery (population and distribution) goal is to maintain the abundance of Okanagan Robber Fly populations at all extant sites within the province, including any additional populations that may be identified in the future.

The recovery objectives are:

1. to secure protection¹ for the known extant sites of Okanagan Robber Fly with no loss or degradation of occupied habitat;
2. to confirm the distribution of Okanagan Robber Fly within its range in British Columbia;
3. to assess the extent of threats to each of the known extant sites and reduce their impacts; and
4. to address knowledge gaps (e.g., habitat requirements for each life stage, natural history information, dispersal, etc.).

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

RECOVERY FEASIBILITY SUMMARY

The recovery of Okanagan Robber Fly in British Columbia is considered technically and biologically feasible based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility.

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 – Okanagan Robber Fly is recorded from 26 extant sites grouped into five populations within the open and dry lower-elevation grassland habitats of the Okanagan and Thompson valleys of British Columbia. Each population is considered separate, and some populations have multiple sites. Each of these five populations appears to be sustaining itself, as evidenced by occurrence records at these sites that span multiple decades. This information gives evidence there are individuals capable of reproduction to sustain each population.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes – Each of the five Okanagan Robber Fly populations is within grassland habitat that appears to be functional to support the population, based on evidence that the species continues to remain at these sites over multiple years. Numerous sites are also within protected parks and private conservation land. It is presumed that there is sufficient habitat to support the species as long as threats are ceased and/or mitigated, and the availability of habitat does not decline in area, extent or quality. Although the specific habitat requirements for this species are not fully known, the fly appears to be associated with bluebunch wheatgrass and coarse gravel and sandy loam soils with more than 10% gravel.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes – The primary threats to Okanagan Robber Fly are: the introduction and spread of invasive plants and insects and the impacts these species have to adult forage and larval burrow sites; changing fire regimes and natural succession into open grassland habitats; pesticide drift and the potential harm to adults and their food supply; unrestricted all-terrain vehicle use; and land conversion, including urban, commercial, recreational and agricultural development. These threats can be avoided or mitigated by: improving signage and further restricting access to all-terrain vehicle use; and working with landowners on stewardship and best practices to help reduce site-specific threats. Lower-level cumulative threats applicable to Okanagan Robber Fly are similar to other grassland species living within bunchgrass habitats in the Okanagan and Thompson valleys. Threat mitigation approaches can be combined with approaches used with other species that have similar threats.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable time frame.

Yes – Existing techniques to achieve population and distribution objectives include developing species-specific inventory techniques that can record emergence dates, monitor abundance; record oviposition sites, prey items, site-specific threats to confirm the level of threat at a site; implement habitat protection measures at known sites and/or improve habitat management within protected areas, and complete inventory in unchecked habitats. Additional recovery techniques to achieve the population and distribution objectives are expected to be developed within a reasonable time frame.

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1 COSEWIC* SPECIES ASSESSMENT INFORMATION

Assessment Summary: November 2011
Common Name (population):** Okanagan Efferia
Scientific Name: *Efferia okanagana*
Status: Endangered
Reason for Designation: This Canadian endemic is known from only five locations within a very small area of south-central British Columbia. The species' grassland habitat is limited and continues to be degraded. Threats include introduction and spread of invasive species, changing fire regimes, pesticide drift and unrestricted ATV use.
Criteria*:** B2ab(iii)
Occurrence: British Columbia
Status History: Designated Endangered in November 2011.

* Committee on the Status of Endangered Wildlife in Canada.

** The common name reported in this recovery plan (Okanagan Robber Fly) follows the naming conventions of the B.C. Conservation Data Centre, which in this case is different from the name reported by COSEWIC.

*** 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

Okanagan Robber Fly^a			
Legal Designation:			
FRPA: ^b No		B.C. <i>Wildlife Act:</i> ^c No	SARA: ^d No schedule, No Status
OGAA: ^b No			
Conservation Status^e			
B.C. List: Red	B.C. Rank: S2 (2012)	National Rank: N2 (2012)	Global Rank: G2 (2012)

^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 No = not designated as wildlife under the B.C. *Wildlife Act* (Province of British Columbia 1982).

^d No = not on any Schedules under the *Species at Risk Act* (SARA; Government of Canada 2002). The COSEWIC assessment will be reviewed by the Governor in Council who may, on the recommendation of the Minister, amend the List to include this species on Schedule 1 of SARA.

^e S = subnational; N = national; G = global; X = presumed extirpated; H = possibly extirpated; 1 = critically imperilled; 2 = imperilled; 3 = special concern, vulnerable to extirpation or extinction; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure; NA = not applicable; NR = unranked; U = unrankable.

3 SPECIES INFORMATION

3.1 Species Description

Okanagan Robber Fly (*Efferia okanagana*) is a true fly (order Diptera) within the robber fly family (Asilidae). Globally, there are eleven species in the genus *Efferia*, with seven occurring within British Columbia (COSEWIC 2011). Okanagan Robber Fly was recently scientifically described (Cannings 2011a).

Okanagan Robber Fly has four life stages. The adults are large, brown, bristly robber flies approximately 1.2–2 cm in length. Morphological features distinct to the adults (in both sexes) include striking orange-golden occipital bristles, or “eyebrows,” around the upper rim of the eyes (as shown on Figures 1 and 2) and a tuft of white bristles on the face which are often pale golden at the base. The last three abdominal segments in males are silver white; females do not have this feature. The males have hammer-shaped genitalia and females have a long, sword-shaped ovipositor (organ used by insects to lay eggs). The egg, larva, and pupa are unknown and undescribed (Cannings 2011a). A full morphological description of the adult fly is detailed in Cannings (2011) and COSEWIC (2011).



Figure 1. Okanagan Robber Fly male. Note the characteristic row of orange occipital bristles (eyebrows) around the upper rim of the eye and a tuft of white bristles on the face that is also often pale golden at the base (Photo by Werner Eigelsreiter).



Figure 2. Okanagan Robber Fly female. Note the characteristic row of orange occipital bristles (eyebrows) around the upper rim of the eye and a tuft of white bristles on the face that is also often pale golden at the base (Photo by Werner Eigelsreiter).

The adult flight period for Okanagan Robber Fly is from April to June, peaking from May 15 to 25 (see Table 1; B.C. Conservation Data Centre 2015). During the flight period, mating and oviposition (egg-laying) occurs. Although the specific microhabitats selected for oviposition are not fully known, there has been one observation of oviposition within the empty glumes (the thin, dry, scaly bracts that surround a ripe grass seed) of the previous years' bluebunch wheatgrass (*Pseudoroegneria spicata*) florets (small flowers that make up a composite flower head) (COSEWIC 2011). The time from oviposition to larval hatching is unknown. As in other

Asilids, hatched larvae fall from the grass and burrow into the soil. The length of time Okanagan Robber Fly larvae spend in the soil is unknown, although flies in the genus *Efferia* generally spend 1–2 years in the larval life stage. Robber flies are predators, and based on the feeding preferences of other robber flies, Okanagan Robber Fly larvae likely feed on the larvae and pupae of Coleoptera (beetles), Hymenoptera (bees, ants, and wasps), and Diptera (flies), as well as Orthopteran (grasshoppers and crickets) eggs (Wood 1981). Some research shows larval growth of other Asilidae is accelerated in warmer regions and that many species live only 1 year (Theodor 1980). It is likely Okanagan Robber Fly pupation occurs at the soil surface in early spring (e.g., March to early April). The adult life span is likely less than 2 months (Cannings 2011a; COSEWIC 2011).

3.2 Populations and Distribution

The Okanagan Robber Fly is a Canadian endemic—100% of its global range is in Canada. The global and Canadian range of the species is restricted to the Okanagan and Thompson valleys of British Columbia with a maximum range extent of 5865 km² (Figure 3). It may range into adjacent Washington State, although there are no records despite extensive search effort (see COSEWIC 2011; R. Cannings, pers. comm., 2015).

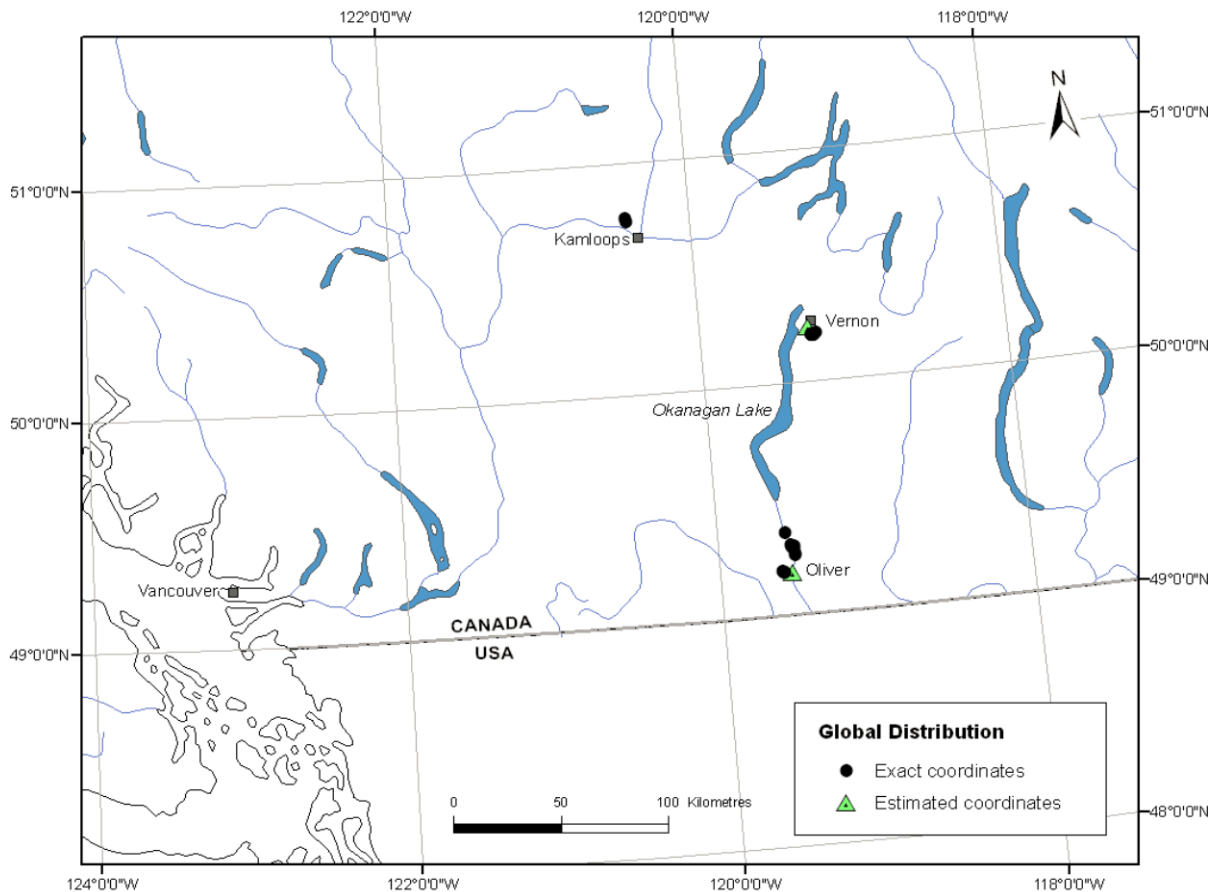


Figure 3. The Okanagan Robber Fly distribution showing the 26 extant sites grouped into five discrete populations (COSEWIC 2011). Note the map scale is too large to delineate separate dots for each collection site.

Okanagan Robber Fly is patchily distributed within the low-elevation (280–760 m), open grassland habitats dominated by bluebunch wheatgrass in the Okanagan and Thompson valleys. However, this habitat is much more extensive than the known records and distribution of the fly (see Section 3.3), and therefore other unknown factors contribute to its presence within these habitats. Plant community composition, other than the presence of bluebunch wheatgrass, is not always a good indicator of fly habitat. The species appears to be associated with coarse gravel and sandy loam soils with more than 10% gravel (COSEWIC 2011). The soil types of the Okanagan are diverse and patchy (Wittneben 1986) and may play a role in the patchy distribution of Okanagan Robber Fly (COSEWIC 2011) (see Section 3.3).

Okanagan Robber Fly records date from 1924 to 2016 (see Table 1), with the species recorded in 26 extant sites grouped into five populations (referred to as “Element Occurrences” [EOs] by the B.C. Conservation Data Centre). Two additional sites have historical collection information (one site at Vernon and one site at Oliver, bringing the total of extant and historical sites to 28), however the locality information is unknown and these sites are not included in the extant tally.

The EOs listed in this recovery plan follow the population and occurrence delineation standards set and mapped by the B.C. Conservation Data Centre (2015). In summary, a population is based on some evidence of historical or current presence of breeding, which includes oviposition, the presence of immature life stages (although none have been found for Okanagan Robber Fly), the shed pupal exoskeleton remaining after adult emergence (although none have been found for Okanagan Robber Fly), teneral adults (newly emerged adults with an exoskeleton not fully sclerotized), and potential habitat (see Section 3.3). Should there be a large distance of unsuitable habitat between sites, the EO is deemed separate. For robber flies, the separation distance between two populations is set at a minimum of 3 km of what is considered unsuitable habitat (B.C. Conservation Data Centre 2015).

The five populations named by the B.C. Conservation Data Centre (2015) are (north to south): (1) Kamloops, (2) Vernon, (3) Okanagan Falls, (4) Vaseux Lake, and (5) Oliver (Figures 4–6).

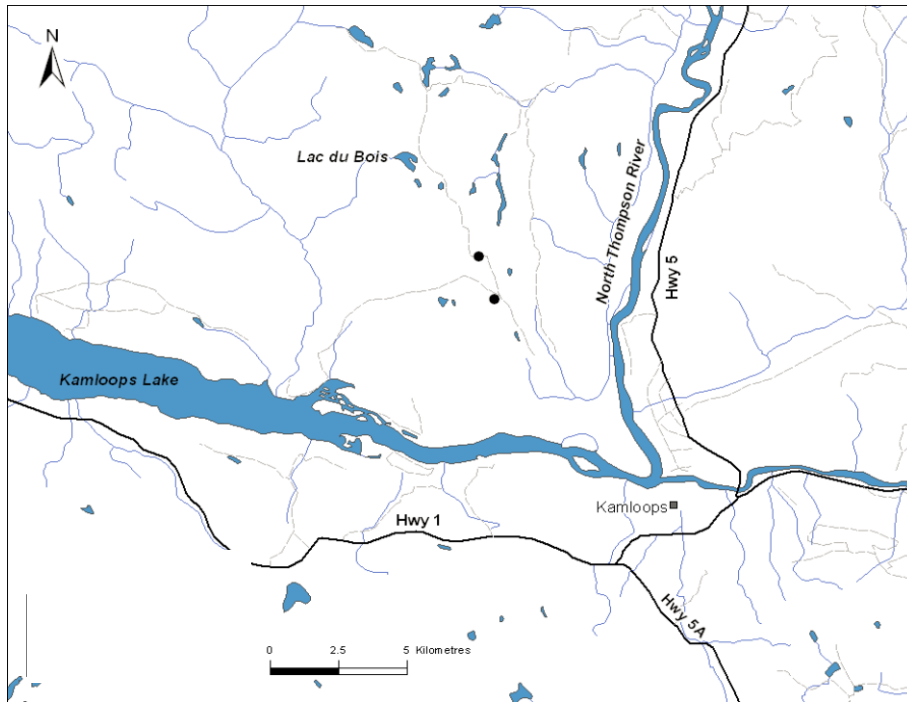


Figure 4. Okanagan Robber Fly population in the Kamloops area (two extant sites) (COSEWIC 2011).

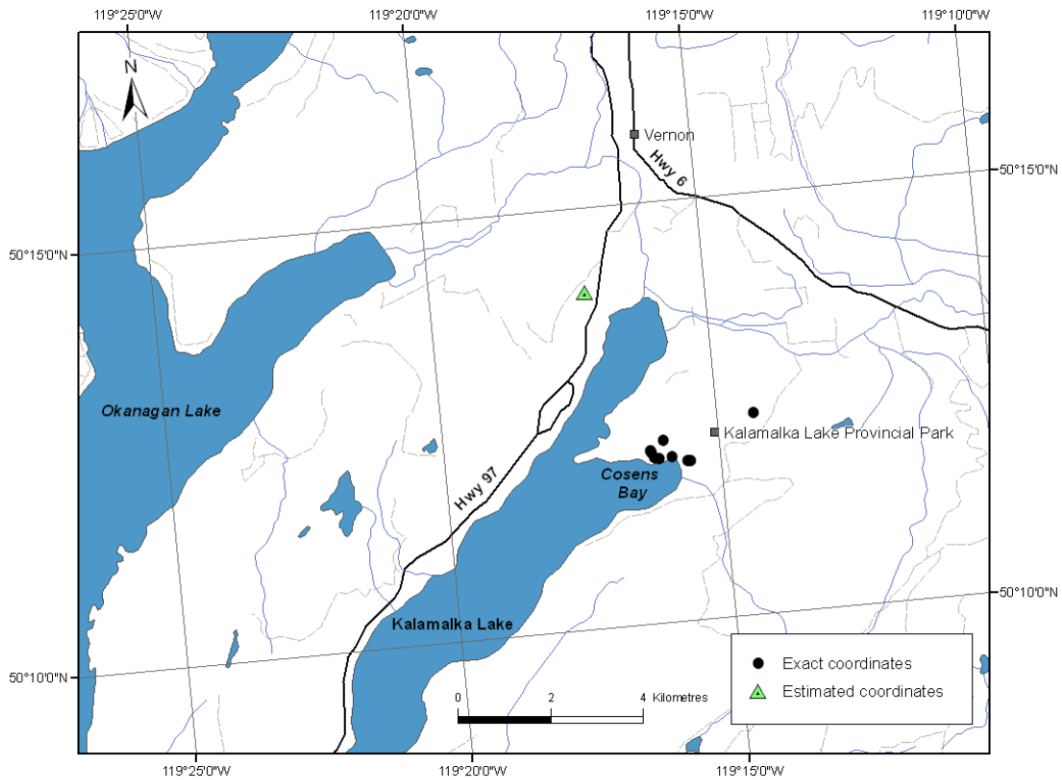


Figure 5. Okanagan Robber Fly population in the Vernon area (12 extant sites) (COSEWIC 2011). Note the map scale is too large to delineate separate dots for each of the 12 sites.

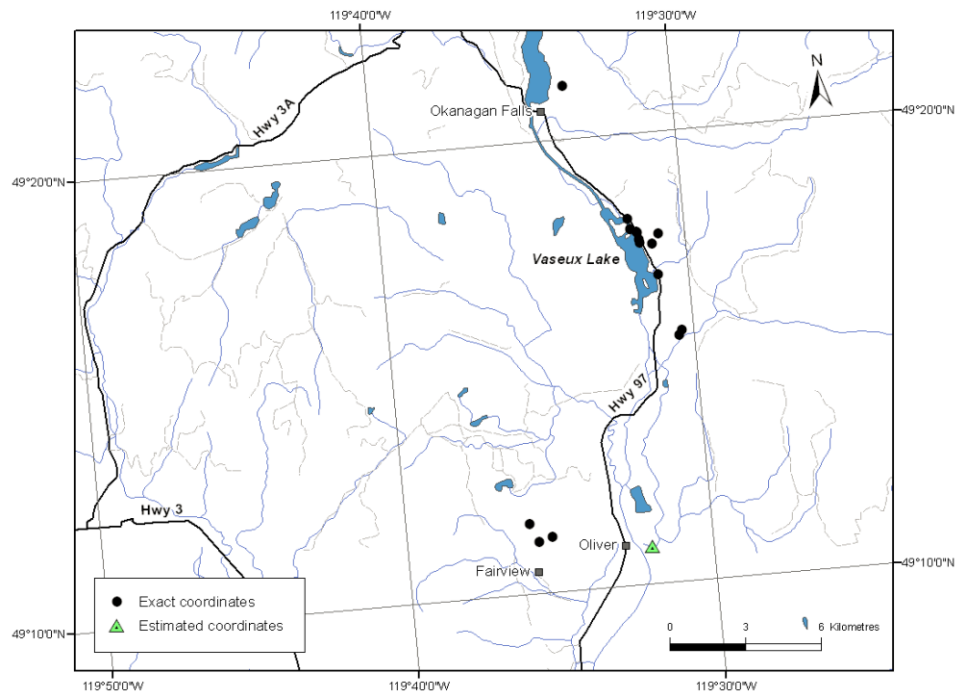


Figure 6. Okanagan Robber Fly populations in the Okanagan Falls area (one extant site), Oliver area (three extant sites), and Vaseux Lake area (eight extant sites, based on land ownership), with more than one specimen collected at some sites (COSEWIC 2011).

Table 1. Status and description of the Okanagan Robber Fly populations and sites (26 extant sites and two unknown geographic location sites) in British Columbia.

Population	Status, description and collection dates	Land tenure
1. Kamloops	Extant ^a . Two sites (1994 and 2010) in the Kamloops area. The sites are within 3 km ^b of one another and linked by good condition bluebunch wheatgrass habitat.	Crown; Lac du Bois Grassland Protected Area
2. Vernon	Extant. Twelve extant (1985–2010) in the Vernon area are within good condition bluebunch wheatgrass habitat. Another collection date (1930) has no specific geographic location details and may or may not be in the same area as the 12 extant sites (e.g., land tenure is “unknown” and the site is not included in the final tally).	Crown (provincial park); Kalamalka Lake Provincial Park, Cosens Bay (12 sites) Unknown land tenure (1 site) and not included in extant tally.
3. Okanagan Falls	Extant. One extant site (1933) within good condition bluebunch wheatgrass habitat.	Private conservation land; Nature Trust Thompson property

Population	Status, description and collection dates	Land tenure
4. Vaseux Lake	<p>Extant.</p> <p>Eight extant sites are within the Vaseux Lake area and span numerous properties and landowners. There are sixteen collection dates from 1959 and 2010.</p> <p>The extant sites are within 3 km^b of one another and the habitat is good condition bluebunch wheatgrass habitat.</p>	<ul style="list-style-type: none"> • Private conservation land; The Nature Trust, Kennedy property, Sublot 15 property • Crown; Vaseux Lake Provincial Park • Crown; Vaseux Protected Area • Federal (Environment and Climate Change Canada – Canadian Wildlife Service); Vaseux-Bighorn National Wildlife Area • Private, non-conservation land
5. Oliver	<p>Extant.</p> <p>Three extant sites in the Oliver area (three specimens collected in 2010). The sites are within 3 km^b of one another and the habitat is good condition bluebunch wheatgrass habitat.</p> <p>Four older collection dates (1924 [two specimens] and 1959 [two specimens]) have no specific geographic site collection details and are not considered sites in the tally; these sites may or may not be within the same area as the other two known sites (hence land tenure is “unknown”).</p>	<ul style="list-style-type: none"> • Crown^c; Oliver Fairview White Lake Road, 1.3 km N Fairview Junction • Crown (<i>Land Act Reserves</i>; unclassified); Oliver, Fairview White Lake Road, Oliver Mountain area • Unknown; older records do not have accurate site collection data; it is not possible to determine the geographic location of collection site.

^a Extant: occurrence has been recently verified as still existing

^b Delineation standard set by the B.C. Conservation Data Centre.

^c This property is within a proposed provincial protected area however a recent government decision has approved a dirt bike track within a portion of this proposed provincial park and overlaps the known Okanagan Robber Fly site ;

3.3 Habitat and Biological Needs of the Okanagan Robber Fly

The habitat and biological needs of Okanagan Robber Fly are summarized from the COSEWIC (2011) status report, recent observations and general information about robber flies (Cannings 2011b; Cannings 2014). Table 2 provides a summary of essential functions and features of Okanagan Robber Fly habitat in British Columbia.

3.3.1 General Okanagan Robber Fly habitat

Okanagan Robber Fly inhabits low-elevation (280–760 m) grasslands dominated by bluebunch wheatgrass plant communities growing on gravelly and sandy soils. In general, Okanagan Robber Fly habitats in the northern parts of its range (i.e., Kamloops and Vernon areas) are dominated by big sagebrush (*Artemisia tridentata*) plant communities; habitats in the southern parts of its range (i.e., south of Penticton at Okanagan Falls, Vaseux Lake, and Oliver areas) are dominated by antelope-brush (*Purshia tridentata*) plant communities. Scattered ponderosa pine (*Pinus ponderosa*) and interior Douglas-fir (*Pseudotsuga menziesii*) also occur at some collection sites.

A terrestrial ecosystem mapping (TEM) exercise that overlaid the 26 extant Okanagan Robber Fly sites with the ecological community data for the Okanagan Valley was completed in 2015. Terrestrial ecosystem mapping is defined by ecological standards set by the B.C. Ministry of Forests and Range ecosystem classification system (2010). Where TEM data intersected the 26 Okanagan Robber Fly sites, the habitat polygon was selected. The polygons are mapped such that they may contain up to three different ecological communities, although some may not support Okanagan Robber Fly. Ecological communities without the presence of bluebunch wheatgrass and coarse sand and gravel were considered unsuitable habitats and removed. These habitats included exposed soil, talus slopes, cliffs, road surfaces, and three unsuitable ecological communities (i.e., Baltic rush–common silverweed; saskatoon–mock orange talus; trembling aspen/common snowberry/Kentucky bluegrass). Cliff, road surface, and duplicates were also removed. The mapping result was 18 TEM polygons that included nine potential ecological communities, which may contain Okanagan Robber Fly habitat.

The following TEM communities may support Okanagan Robber Fly, if suitable soil and plant species are present.

1. antelope-brush/needle-and-thread grass
2. bluebunch wheatgrass–compact selaginella
3. bluebunch wheatgrass–arrowleaf balsamroot
4. Idaho fescue–bluebunch wheatgrass
5. big sagebrush/bluebunch wheatgrass–arrowleaf balsamroot
6. ponderosa pine/bluebunch wheatgrass
7. ponderosa pine/red three-awn
8. Douglas-fir–ponderosa pine/bluebunch wheatgrass
9. Douglas-fir–ponderosa pine/bluebunch wheatgrass–pinegrass

Having such a wide range of plant communities makes it difficult to identify specific habitat attributes and/or map potential habitat. Nevertheless, in all parts of its range, Okanagan Robber Fly appears to inhabit plant communities that grow on coarse sand and gravel; it is not found in plant communities that grow primarily on finer-grained soils of loam, sand, and silt. Even when bluebunch wheatgrass is present at a site, the fly is not present if the soils are finer.

The nine ecological communities in which Okanagan Robber Fly has been recorded are part of three biogeoclimatic zones (B.C. Ministry of Forests and Range 2010): (1) the Bunchgrass (BGxh1–Okanagan Very Hot Dry variant; BGxw1–Nicola Very Dry Warm variant); (2) the Ponderosa Pine (PPxh1–Okanagan Very Hot Dry); and (3) the Interior Douglas-fir (IDFxh1–Okanagan Very Hot Dry variant).

3.3.2 Oviposition and egg development habitat

Bluebunch wheatgrass may play a significant role in the life cycle of Okanagan Robber Fly. One female has been observed ovipositing in the empty glumes of the previous year's bluebunch wheatgrass florets (COSEWIC 2011). There may be other similar habitat and vegetation features that have yet to be recorded, so it is noted that this may not be an obligate association. In other

Efferia species, the eggs will hatch within the vegetation and larvae will drop to the soil where they burrow and seek shelter. Some other *Efferia* larvae are reported to live in the soil (Lavigne and Holland 1969) for 1–2 years and are mobile although likely do not disperse far from the initial oviposition site.

3.3.3 Dispersal, forage, and mating habitat

There is no information on the dispersal of Okanagan Robber Fly. The species likely does not disperse long distances. Typical adult behaviour (when disturbed) is to fly 2–3 m before landing again on vegetation or soil, and foraging up to 5 m, but most prey is caught 1–2 m from their perch (Dennis *et al.* 1986). Males search for females, low to the ground, at up to 6–7 m from the original perch point.

3.3.4 Pupal development habitat

The COSEWIC (2011) report provides detailed soil information for one site at Vaseux Lake: “... alluvial terrace at the foot of metamorphic cliffs; the subsoil is a stony, gravelly alluvium . . . The surface soil is coarser and with a higher percentage of organics and salts and with a lower moisture-holding capability . . .”. Thus, soil consistency may be a factor in the presence or absence of the Okanagan Robber Fly as a relatively high percentage (> about 10%) of gravel in the soils is an indication of sites where the fly occurs—Vaseux Lake, east bench (sandy loam, 45% gravel); Kalamalka Lake Provincial Park (sandy to heavy loam, 8–17% gravel)” (page 31).

Okanagan Robber Fly is active from approximately 10 am to 6 pm on warm sunny days (R. Cannings, pers. comm., April 2015). Robber flies generally need perching and resting sites from which to forage for invertebrate prey, as well as to patrol and seek females. Some robber flies exhibit diurnal activity patterns, showing activity at different times of the day that is often similar with other robber flies at a site. It is unknown whether Okanagan Robber Fly exhibits these temporal patterns (COSEWIC 2011).

Table 2. Summary of essential functions and features of Okanagan Robber Fly habitat in British Columbia.^a

Life stage	Function ^b	Feature(s) ^c
Egg	Incubation	Bluebunch wheatgrass may be important as an egg incubation site based on one observation of oviposition on bluebunch wheatgrass glumes. Note the range of plant species and/or features used for egg-laying is not yet known. There may be additional and/or other important plants or habitat features used as oviposition sites.
Larvae	Burrow and refuge	Other robber fly larvae burrow into the substrate to take cover during this part of their life cycle. The substrates where Okanagan Robber Fly adults have been observed are within stony, gravelly alluvium, sandy loam with more than 10% gravel.
Pupae	Pupation	Unknown where pupation occurs, although likely within the same coarse gravel and sandy loam soils with more than 10% gravel.

Life stage	Function ^b	Feature(s) ^c
Adult	Oviposition	There is one observation of a female ovipositing on the dried glumes of bluebunch wheatgrass. This plant is present at all known Okanagan Robber Fly sites.
	Perching	Vegetation, rocks, and bare ground are used for perching and basking (to raise internal body temperature).
	Hunting	Habitat with a variety of arthropods as prey items.
	Mating	Unknown. In general, robber fly males establish patrolling territories within which to find potential mates.

^a Note: Little information is available upon which to base these functions and features; more research is needed.

^b Function: a life-cycle process of the species (e.g., breeding, rearing, feeding/foraging).

^c Feature: the essential structural components of the habitat required by the species.

3.4 Ecological Role

Okanagan Robber Fly is a top arthropod predator. Adults are opportunistic; they hunt and consume a wide variety of prey that includes flies, bees, wasps, grasshoppers, dragonflies, and some spiders (COSEWIC 2011). Robber fly larvae are also predatory, and consume the immature stages of many arthropods, including grasshopper eggs, and beetle and fly larvae. Robber flies are thought to help maintain balanced arthropod populations within an ecosystem (Shurovnekov 1962; Joern and Rudd 1982).

3.5 Limiting Factors

Limiting factors are generally not human induced and include characteristics that make the species less likely to respond to recovery and conservation efforts. It is presumed that Okanagan Robber Flies are currently present in high enough numbers for breeding and recruitment and that sufficient habitat is currently available to support existing populations. However, several limiting factors for Okanagan Robber Fly make them more vulnerable to future impacts; these include specific habitat requirements, low dispersal ability, and low population density.

3.5.1 Specific habitat requirements

Although Okanagan Robber Fly has been recorded within nine plant communities the specific microhabitat requirements within these plant communities are unknown. The fly is not recorded in large numbers, and may itself be at low abundance, making it difficult to observe natural history related to its specific habitat requirements. There are likely factors at these sites, whether they be structural, functional or species specific, that limit the presence of the robber fly.

- *Bluebunch wheatgrass presence* – There is one observation of a female ovipositing in the empty glumes of the previous year's florets of bluebunch wheatgrass, suggesting the plant may provide oviposition sites. Bluebunch wheatgrass is not evenly distributed throughout the landscape, with some areas having higher density and abundance than other areas. This factor, combined with other unknown factors, may limit oviposition sites.

- *Coarse gravelly and sandy soils* – Most of the known sites are on gravel and sandy loam soils with greater than 10% gravel. This may be a factor in larval development, given that the larvae spend up to 2 years in the soil. They need to be able to burrow, move around, predate on other arthropods and take cover. This factor, combined with other unknown factors, may limit successful completion of the life cycle.
- *Appropriate flight temperatures* – The previous year’s weather greatly influences the population abundance in the following year. In addition, insects are dependent on ambient temperature for their activity; warm temperatures are required for foraging, mating, and oviposition. Cool temperatures and rainy weather limit this activity, and when combined with stochastic events or site-specific threats, populations can be adversely affected.

3.5.2 Low dispersal ability

- The dispersal ability of Okanagan Robber Fly is likely poor. Adults are focused on mating and oviposition and the species is not widespread within what would otherwise appear to be suitable habitat. The spatial area (habitat) required to sustain a population has not been measured or defined for this species. Individual home ranges are unknown but likely limited based on the known territories of males (7–8 m). The likely poor dispersal ability of the species, combined with the heavily fragmented low-elevation bluebunch wheatgrass plant communities of the Okanagan and Thompson valleys, may limit natural dispersal.

3.5.3 Low population density

- Okanagan Robber Fly surveys indicate the species occurs at low densities (as shown by inventory and search effort summarized in COSEWIC 2011) and thus may have low reproductive potential even within optimal habitats. Some species survive in habitats at low populations, and do not reach high population densities. Low densities, when combined with stochastic events or site-specific threats, may cause significant population declines.

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).

For the most part, threats are related to human activities, but they can also be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., introduction of invasive species). Effects of natural phenomena (e.g., fire) may be especially important when the species is concentrated in one location or has few occurrences, which may be a result of human activity (Master *et al.* 2012). As such, natural phenomena are included in the definition of a threat, though they should be considered cautiously. These stochastic events should only be considered a threat if a species or habitat is damaged from other threats and has lost its resilience. In such cases, the effect on the population would be disproportionately large compared to the effect experienced historically (Salafsky *et al.* 2008).

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 or ecosystem 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 Okanagan Robber Fly were assessed for the entire province (Table 3). Note that the threats presented below have been updated since the COSEWIC (2011) status report and have changed in some of the categories.

Table 3. Threat classification table for Okanagan Robber Fly in British Columbia.

Threat # ^a	Threat description	Impact ^b	Scope ^c	Severity ^d	Timing ^e	Sites ^f
1	Residential & commercial development	Low	Small	Extreme	High	Possible at 3a, 3b, 4g. Also possible within unchecked habitats.
1.1	Housing & urban areas	Negligible	Negligible	Extreme	Unknown	3, 4g
1.2	Commercial & industrial areas	Negligible	Negligible	Extreme	Unknown	3, 4g
1.3	Tourism & recreation areas	Low	Small	Extreme	High	3, 4g
2	Agriculture & aquaculture	Medium - Low	Restricted - Small	Extreme	High	
2.1	Annual & perennial non-timber crops	Low	Small	Extreme	High	Possible at 3, 4g
2.3	Livestock farming & ranching	Unknown	Restricted	Unknown	High	Confirmed at 1a; 1b; 2; 3; 4f;
6	Human intrusions & disturbance	Medium	Restricted	Serious	High	
6.1	Recreational activities	Medium	Restricted	Serious	High	1ab; 2; 3; 4bcdefh; 5ab
7	Natural system modifications	Unknown	Small	Unknown	High	
7.1	Fire & fire suppression	Unknown	Small	Unknown	High	All sites
8	Invasive & other problematic species & genes	Unknown	Pervasive	Unknown	High	
8.1	Invasive non-native/alien species	Unknown	Pervasive	Unknown	High	All sites

Threat # ^a	Threat description	Impact ^b	Scope ^c	Severity ^d	Timing ^e	Sites ^f
9	Pollution	Unknown	Restricted	Unknown	High	
9.3	Agricultural & forestry effluents	Unknown	Restricted	Unknown	High	Possible in areas adjacent to 3; and confirmed at 4gh
11	Climate change & severe weather	Unknown	Unknown	Unknown	High	
11.1	Habitat shifting & alteration	Unknown	Unknown	Unknown	High	All sites
11.2	Droughts	Unknown	Unknown	Unknown	High	All sites

^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 or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), 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. 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 Okanagan Robber Fly, a 10-year time frame was used. 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.

^f Geographic location numbers: (1) Kamloops, (2) Vernon, (3) Okanagan Falls, (4) Vaseux Lake, and (5) Oliver. Refer to Appendix 1 for geographic location numbers and Appendix 2 for specific threats associated with each site.

4.2 Description of Threats

The overall province-wide Threat Impact for this species is Medium.⁴ This overall threat considers the cumulative impacts of multiple threats (Table 3). Details are discussed below under the Threat Level 1 headings. The threats applicable to each of the five populations and associated sites are detailed in Appendix 2.

Potential unchecked Okanagan Robber Fly habitat was not considered when determining the scoring for each of the threats presented; however, threats thought to be present in unchecked habitat have been noted under the relevant threat heading below. Numbers mentioned below refer to the five Okanagan Robber Fly populations and sites: (1) Kamloops, (2) Vernon, (3) Okanagan Falls, (4) Vaseux Lake, and (5) Oliver (see Appendix 2 for details).

4.2.1 Threat 1. Residential & commercial development

1.1 Housing & urban areas and 1.2 Commercial & industrial areas

These threats apply directly to populations in the Vaseux Lake (4g) and Oliver (5a and 5b) areas, where they occur on provincial Crown land that does not fall within specific land tenure (i.e., “undesigned”). Although some of these undesigned lands are proposed as provincial protected area, there is still pressure from the municipal governments to convert a portion of these areas for urban or commercial development and expand the town limits. Okanagan Robber Fly has also been collected from undesigned provincial Crown land west of Oliver Mountain (5); however, this property (5a and 5b) has a Section 16⁵ agreement for conservation under the *Land Act*. If development was to occur at these properties, with destruction of bluebunch wheatgrass habitat within a housing or commercial development, Okanagan Robber Fly would not likely survive.

1.3 Tourism & recreation areas

The threat of land development for tourism and recreation only applies to developments at elevations less than 760 m (elevation limit of fly habitat). There is an approved off-road vehicle motor-cross track at Oliver Mountain (5a and 5b). This affects two of the 26 known sites (approximately 8% of the global range). Additional threats from tourism and recreational developments primarily apply to unchecked potential Okanagan Robber Fly habitat throughout the species’ range; recovery actions for this threat are proposed under Objective 2 in the recovery actions table (Table 5).

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, which included 1 Medium, 1 Medium-low, and 1 Low (Table 2). The overall threat impact considers the cumulative impacts of multiple threats.

⁵ A Section 16 agreement (Temporary Withdrawal or Map reserve) is a legal mechanism of the provincial *Land Act* (Province of British Columbia 1996) available to limit certain uses of the land for a specified period of time.

4.2.2 Threat 2. Agriculture & aquaculture

2.1 Annual & perennial non-timber crops

There is little threat of agricultural land conversion at known sites primarily because most sites are within protected areas. Conversion is possible at one site (4g) (approximately 4% of global range extent). Within the Okanagan Valley, grassland habitats are primarily converted to vineyards, although the site with the potential for development (4g) is quite rocky. Rocky sites are less likely to be developed owing to the costs associated with clearing the land; rocky soils are also less productive for vineyard success. This site is on developed private land; the owner has irrigated a portion, and the possibility of further development exists.

The threat of agricultural vineyard development applies to much of the unchecked potential Okanagan Robber Fly habitat within the low-elevation, private land and undesignated provincial Crown land within the Okanagan and Thompson valleys.

2.3 Livestock farming & ranching

Livestock grazing applies to seven of the 26 known Okanagan Robber Fly sites (approximately 25% of global range extent). Sites at Kamloops (1a and 1b), Okanagan Falls (3), Vaseux Lake (4g and 4h), and Oliver (5a and 5b) are subject to livestock grazing, at variable intensity and severity. Grazing may remove bluebunch wheatgrass clumps, trample and compact the soil (which then affects pupation sites), trample sites where pupae are overwintering, as well as consume eggs or larvae hidden within bluebunch wheatgrass clumps or other oviposition sites. The importance of bluebunch wheatgrass needs further study before concluding how significant it is to Okanagan Robber Fly. The long-term impact is unknown and requires further study. Past grazing is evident at most extant Okanagan Robber Fly sites. Historical overgrazing of some habitats has compacted the soil and severely impacted the native vegetation; regrowth in these habitats has been slow.

4.2.3 Threat 6. Human intrusions & disturbance

6.1 Recreational activities

Recreational activities may result in the physical damage, or destruction, of bluebunch wheatgrass and other oviposition sites, leading to the compaction or disturbance of the soil near these sites. These impacts affect egg laying, larval feeding, larval refuge and hibernation, and pupation, as well as adult feeding, perching, and refuge sites.

The threat of all-terrain vehicle (ATV) use is present at two of the 26 known sites, both at Oliver Mountain (5a and 5b) (approximately 8% of the global range). Vehicle laneways (i.e. the cumulative width of vehicles driving the same route, over time) can be 1.5–4.5 m wide, compact the soil, and tend to be in a set route that may widen and change over the course of a few years. Longer-term ATV use compacts the soil and makes the site unsuitable for larval burrow sites. Constant vehicle traffic would directly harm or kill larvae that are present within the site.

The Lac du Bois Grasslands Protected Area (1a and 1b) is protected under the *Park Act*, but recreational vehicle use is often difficult to enforce. The threat appears to have ceased at some sites in the park, but the threat is ongoing at others. The threat is also present at Oliver Mountain;

although this site is within a proposed provincial park, there are no laws preventing ATV use at the site.

Mountain bike use was a previous threat within habitat at Kalamalka Lake Provincial Park (2) but is no longer considered a threat (O. Dyer pers. comm., 2015; K. Safford pers. comm., 2015). A few sites have extensive mountain bike trails, although most are well defined and recreational users stay within these trails.

All-terrain vehicle use is ongoing in unchecked potential Okanagan Robber Fly habitats. The scope, severity, and timing are unknown.

4.2.4 Threat 7. Natural system modifications

7.1 Fire & fire suppression

The threat of intensive and severe wildfires applies to all Okanagan Robber Fly sites. Periodic wildfires were once part of the natural ecosystem processes occurring in Okanagan Robber Fly habitat. Fire suppression has been ongoing for the past 100 years, altering the natural plant communities and shrub composition throughout the grasslands in the Okanagan and Thompson valleys. Fire suppression promotes extensive, stand-replacing fires rather than small, localized, and less intense surface fires that usually leave patches of antelope-brush steppe intact (COSEWIC 2011). As a result, the majority of present-day fires occurring within the range of the fly are more intensive and severe than historical fires. Intense fire damages or removes the plants necessary for the fly's life cycle, such that the survival of local populations is affected.

In the past decade, relatively intense wild fires at Vaseux Lake have severely damaged Okanagan Robber Fly habitat and may have caused direct mortality to larva and pupae. Wildfires are likely to affect 3–5 ha over the 10-year span, based on fires at sites over the past 10–20 years.

4.2.5 Threat 8. Invasive & other problematic species & genes

8.1 Invasive non-native/alien species

Invasive non-native plants, such as cheatgrass (*Bromus tectorum*), sulphur cinquefoil (*Potentilla recta*), diffuse knapweed (*Centaurea diffusa*), and Dalmatian toadflax (*Linaria genistifolia* ssp. *dalmatica*), have the potential to outcompete bluebunch wheatgrass recruitment and result in the loss or degradation of bluebunch wheatgrass and the surrounding substrate. Some plants, such as sulphur cinquefoil or other weeds can form monospecific stands and may eventually out-compete native plants that may be necessary biophysical attributes for Okanagan Robber Fly (e.g., as oviposition sites for egg laying, shelter sites for larval refuge, hibernation, and pupation, or to support prey species) (COSEWIC 2011). The overall threat impact is unknown.

4.2.6 Threat 9. Pollution

9.3 Agriculture & forestry effluents

Agricultural pesticides are widely used throughout the Okanagan and Thompson valleys. The extent of this use within agricultural areas adjacent to Okanagan Robber Fly sites is unknown; however, pesticide application adjacent to known sites may be present at five of the 26 known sites (4d, 4g, and 4h; 5a and 5b). Okanagan Robber Fly habitats border agricultural lands and may be affected by pesticide drift, especially in the Vaseux Lake (4d, 4g, and 4h) and Oliver (5a and 5b) populations. Widespread use of herbicides to treat invasive grasses may also affect bluebunch wheatgrass abundance and damage fly habitat.

The impacts of pesticide application on Okanagan Robber Fly are speculative and unknown. Pesticide application may directly kill adults or larvae through direct contact with sprays or if the fly was to consume affected prey. Some pesticides can remain within the soil and the cumulative long-term impacts of pesticide may affect larval development sites. Further research into the pesticides used in the Okanagan and Thompson valleys and the effects on Okanagan Robber fly is needed.

4.2.7 Threat 11. Climate change & severe weather

11.1 Habitat shifting & alteration

Habitat shifting and alteration is a potential, but poorly understood, threat to the Okanagan Robber Fly. The species is presumably adapted to cooler spring temperatures because it can pupate as early as mid-April and is active throughout the early spring months. Nevertheless, as climate warms, it is possible that the fly could begin to emerge sooner in the spring and that the timing of its life cycle could change with the changing climate. In some insects, the males and females differ in their diapause timing (length of time they overwinter). Although the length of diapause is unknown in Okanagan Robber Fly, shifting temperature regimes are most likely to affect the species emergence dates. If the timing of male and female emergence widens, and emergence is not paired, successful mating and oviposition will decline. Limiting factors and threats to the species could compound, if the seasonality of the fly's life cycle changes. The overall threat is unknown.

11.2 Droughts

Changes in rain patterns may lead to summer drought and soil desiccation, potentially affecting larval development patterns and reducing juvenile survival (COSEWIC 2011).

5 RECOVERY GOAL AND OBJECTIVES

5.1 Recovery (Population and Distribution) Goal

The recovery (population and distribution) goal is to maintain the abundance and distribution of all extant Okanagan Robber Fly populations (as represented by extant sites) within British Columbia, including any additional populations that may be identified in the future.

5.2 Rationale for the Recovery (Population and Distribution) Goal

Okanagan Robber Fly is a Canadian endemic with a small global range. This species is currently known from 26 extant sites grouped into five populations in the lower-elevation grassland habitats of the Okanagan and Thompson valleys. These records are the result of both targeted searches and incidental collection (i.e., random-chance collections when surveying for other species) over many years. Existing habitat information suggests the species is associated with bluebunch wheatgrass habitats on coarse gravelly and sandy soils; however, complete information on the proportion and types of vegetation and habitat attributes used by Okanagan Robber Fly is not available. There is no evidence that this species was more widely distributed.

Because of knowledge gaps (e.g., population abundance, dispersal and re-colonization capabilities, habitat requirements, and threats to the species), the recovery goal for Okanagan Robber Fly cannot be quantified. Population information on Okanagan Robber Fly is limited to abundance counts during surveys; a full understanding of lifespan, dispersal distance, and other information is unavailable. Fulfilling these knowledge gaps will provide important information to help maintain the population abundance at known sites, and allow the recovery goal to be quantified in the future.

5.3 Recovery Objectives

The recovery objectives for Okanagan Robber Fly are:

1. to secure protection⁶ for the known extant sites of Okanagan Robber Fly with no loss or degradation of occupied habitat;
2. to confirm the distribution of Okanagan Robber Fly within its range in British Columbia;
3. to assess the extent of threats to each of the known extant sites and reduce their impacts; and
4. to address knowledge gaps (e.g., habitat requirements for each life stage, natural history information, dispersal, etc.).

6 APPROACHES TO MEET RECOVERY OBJECTIVES

6.1 Actions Already Completed or Underway

The following actions have been categorized by the action groups of the B.C. Conservation Framework (B.C. Ministry of Environment 2010). Status of the action group for this species is given in parentheses.

Compile Status Report (complete)

- COSEWIC report completed (COSEWIC 2011). Update due 2021.

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

Send to COSEWIC (complete)

- Okanagan Robber Fly assessed as Endangered (COSEWIC 2011). Re-assessment due 2021.

Planning (completed)

- B.C. Recovery Strategy completed (this document, 2016).

Inventory (in progress)

- Inventory prior to 2011 is summarized in the COSEWIC (2011) status report.
- Surveys in early May 2015, for 1 hour at the Nature Trust Thompson Property (Vaseux Lake population), confirmed the species presence at this site.
- Surveys on May 28, 2015, recorded three female Okanagan Robber Fly at the known site on the east side of Vaseux Lake.

Habitat Protection, Habitat Restoration and Private Land Stewardship (in progress)

- The Nature Trust is aware of and includes Okanagan Robber Fly in management planning decisions on their lands in Oliver (Kennedy property) and Okanagan Falls (Thompson property).

Table 4. Existing mechanisms that afford habitat protection for Okanagan Robber Fly.

Existing mechanisms that afford habitat protection	Threat^a or concern addressed	Site no. and name
B.C. <i>Park Act</i>	All (human-related) impacts	1. Kamloops (Lac du Bois Grasslands Protected Area). 2. Vernon (Kalamalka Lake Provincial Park). 4. Vaseux Lake (Vaseux Lake Provincial Park)
Canadian Wildlife Act – Wildlife Area Regulations	All (human-related)	4. Vaseux Lake (Vaseux-Bighorn Wildlife Area)

^a Threat numbers according to the IUCN–CMP classification (see Table 3 for details).

6.2 Recovery Planning Table

Recovery planning for Okanagan Robber Fly is concurrent with recovery planning approaches for similar species under the South Okanagan–Similkameen Conservation Program and other grassland conservation initiatives in the Thompson River valley. Because of the extensive knowledge gaps for this fly, most of the recovery planning activities listed in Table 5 focus on inventory, gathering natural history and habitat information, habitat mapping, and threat clarification. These activities will help prioritize areas for future surveys and inform habitat protection efforts. A combined approach to recovery also includes engaging all levels of government (municipal, regional, First Nations, provincial, and federal), academic, naturalist, and stewardship communities in recovery projects for the species, including inventory, natural history, and habitat information gathering.

Table 5. Recovery actions for Okanagan Robber Fly.

Objective	Actions to meet objectives	Threat ^a or concern addressed	Priority ^b
1	<p>Protect extant sites</p> <ol style="list-style-type: none"> 1. Work with landowners to determine appropriate measures to protect Okanagan Robber Fly habitat at each of the known sites. 2. At undesignated provincial Crown sites, establish Section 16 notation of interest under the <i>Land Act</i>, such that future development interests know species-at-risk habitat exists at the site. 3. On private land sites, including private conservation land, work with landowners to develop Best Management Practices guidelines to mitigate site-specific threats and restore habitat for the Okanagan Robber Fly. 4. Within provincial parks and protected areas sites, integrate mapping and protection measures into existing Park Master Plans and other relevant park planning documents. 5. Map and delineate the known Okanagan Robber Fly sites within provincial parks and protected areas. This action will be ongoing and overlaps with recovery action 11 – 13. 6. Recommend Okanagan Robber Fly be a priority for listing in the category “Species at Risk” under the provincial <i>Forest and Range Practices Act</i> and <i>Oil and Gas Activities Act</i>. 	All threats	Essential
3, 4	<p>Address knowledge gaps</p> <ol style="list-style-type: none"> 7. <i>Clarify habitat:</i> Develop standard protocol for gathering habitat information at extant sites, including attributes for soil type, percent bare soil, plant diversity and abundance, slope, aspect, ambient temperature, and abiotic and biotic data. Complete data gathering at a representative number of extant Okanagan Robber Fly sites, and an equal number of sites where Okanagan Robber Fly has not been recorded (e.g., null sites). 8. <i>Clarify threats:</i> Develop protocols for measuring, comparing between sites, and monitoring site-specific threats. Gather this information at a representative number of extant Okanagan Robber Fly sites, and an equal number of sites where Okanagan Robber Fly has not been recorded (e.g., null sites). Develop a habitat monitoring project at known sites (e.g., photographic monitoring) to monitor threats over time. 9. <i>Clarify larval habitat requirements:</i> Attempt to find larval burrow sites, and explore the feasibility of monitoring these sites to obtain information on the life history, movements, habitat use, and population biology of the species. This will enable a better understanding of habitat requirements for each life stage, and the potential dispersal to adjacent habitats. 10. <i>Clarify how limiting factors may limit fly populations:</i> Attempt to document the thermal requirements for Okanagan Robber Fly; the temperature thresholds for flight and foraging habits and daily activity patterns, perching, and mating habits. Attempt to complete population monitoring at sites to determine the abundance of the fly and whether the populations are low across sites. Attempt to determine whether bluebunch wheatgrass is a primary oviposition site. Develop a list of additional studies that address how limiting factors may affect fly populations when cumulative threats are applied. 	All threats; knowledge gaps	Essential
4	Determine specific habitat characteristics at extant sites	Knowledge	Essential

Objective	Actions to meet objectives	Threat^a or concern addressed	Priority^b
	11. Develop a habitat model for Okanagan Robber Fly. Spatially define habitat polygons at each Okanagan Robber Fly site using established mapping techniques (e.g., terrestrial ecosystem mapping, soil mapping, etc.), plant community classification, and other resources for describing habitat attributes. 12. Complete surveys at these mapped polygons to confirm species presence within the mapped polygons. Adjust habitat mapping model according to habitat attributes collected during surveys. 13. Survey Crown properties adjacent and/or near extant sites to better determine habitat that could be prioritized for inventory and the potential extent of known sites.	Gaps	
2	Determine range extent (potential sites) 14. Use the habitat information obtained from the habitat model (above) to prioritize survey sites in unchecked potential habitat in the Okanagan and Thompson valleys. 15. Prioritize survey sites based on habitat mapping and develop a 10-year survey schedule and landowner contact strategy. 16. Work with landowners on private lands, provincial parks and other land tenures, to identify potential Okanagan Robber Fly habitat and survey priority sites.	All threats; knowledge gaps	Essential
4	Increase profile of Okanagan Robber Fly 17. Increase public awareness of the existence, conservation value, importance of robber flies in controlling other arthropod populations, threats, and harm reduction measures for Okanagan Robber Fly. 18. Engage local stewardship and conservation groups through the development and delivery of public education and outreach materials concerning Okanagan Robber Fly.	All threats	Beneficial

7 SPECIES SURVIVAL AND 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 formerly occurred on and has the potential to be reintroduced.

7.1 Biophysical Description of the Species' Survival/Recovery Habitat

A description of the known biophysical features and their attributes of the species' habitat that are required to support these life-cycle processes (functions) are provided in Section 3.3. Additional work required to fulfill habitat knowledge gaps is included in the Recovery Actions Table.

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 meet the recovery goal. Although no maps are included with this document, it is recommended that locations of survival/recovery habitat be described on the landscape to mitigate habitat threats and to facilitate the actions for meeting the recovery (population and distribution) goals. Our knowledge of the specific habitat details for Okanagan Robber Fly is incomplete. Until these microhabitat features are better understood, the ability to map and spatially define the habitat for this species is limited. Nevertheless, as the recovery goal focuses on maintaining all extant populations of Okanagan Robber Fly, these sites should be included as survival habitat, when possible. As new sites are recorded, or as the spatial habitat at extant sites is quantified, our understanding of habitat information will be refined and the threats to these habitats better understood. Survival and recovery habitat should include new and/or confirmed sites.

8 MEASURING PROGRESS

The successful implementation of recovery actions for Okanagan Robber Fly will be shown through monitoring extant populations and further inventory within potential habitats. The Okanagan Robber Fly lifespan is thought to be 2–3 years, from egg to adult. Population monitoring will allow for an indication of possible abundance trends, changes in area of extent at known sites, and determination of whether the abundance and distribution of each extant population is being maintained. The recovery plan will be reviewed in 5 years to assess progress and to identify additional approaches or changes that may be required to achieve recovery.

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution goal and recovery objectives. Performance measures are listed below for each objective.

Measurables for Objective 1

- Recommend Okanagan Robber Fly be a priority for listing as a “Species at Risk” under the provincial *Forest and Range Practices Act* and *Oil and Gas Activities Act* by 2016. Create a written draft of an *Identified Wildlife Species Account* for Okanagan Robber Fly. Complete by 2020.
- Establish habitat polygon maps for Okanagan Robber Fly sites on provincial Crown land and establish a Section 16 notation of interest under the *Land Act* at these sites (Site 3 in Appendix 1). Complete by 2020.
- Work on stewardship agreements and/or covenants for known (and any new) Okanagan Robber Fly sites on private conservation lands, regional district and municipal lands by 2020.

Measurables for Objective 2

- Complete habitat mapping by 2020.
- Identify and continue to inventory additional potential habitat within the species' range and refine habitat model (ongoing).

Measurables for Objective 3

- Develop protocols for comparing and measuring site-specific threats and complete site-specific assessments at half of known sites by 2020.

Measurables for Objective 4

- Initiate natural history studies to observe oviposition and find larva at known sites by 2016.

9 EFFECTS ON OTHER SPECIES

Detailed information is lacking on species at risk that co-occur with Okanagan Robber Fly at known sites throughout its range. However, many provincially and federally listed species occur in the Okanagan and Thompson River valleys, and some amount of overlap with one or more of the nine ecological communities occupied by Okanagan Robber Fly is likely. Protection for Okanagan Robber Fly habitat will likely indirectly benefit any co-occurring species at risk. Recovery planning activities for Okanagan Robber Fly will be implemented with consideration for any identified and/or potentially co-occurring species at risk, such that no negative impacts result to these species or their habitats. Conservation strategies are concurrent with South Okanagan–Similkameen Conservation Program and other programs in the Thompson River valley.

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Appendix 1. All known collection records of Okanagan Robber Fly (COSEWIC 2011).

Population #	Site #	Collection site	Elev. (m)	#/ sex	Date	Land tenure	Collector	Collection
1	1	BC, Kamloops, Batchelor Hills, Lac du Bois Rd, SW jct Pruden Pass Rd	670	1 ♂	20.v.1984	Confirmed extant site. Crown (provincial park).	R.A. Cannings	RBCM
1	2	BC, Kamloops, Batchelor Hills, Lac du Bois Rd, SE Grace L	780	1 ♀	31.v.2010	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings	RBCM
2	unknown	BC, Vernon	535	1 ♂	17.iv.1930	Unknown	E.R. Buckell	RBCM
2	3	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	420	1 ♀	17.v.1985	Confirmed extant site. Crown, Provincial Park.	C.S. Guppy	RBCM
2	4	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	452	21♂, 15♀	23.v.1987	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings	RBCM
2	4	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	452	1 ♂	24.v.1987	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings	RBCM
2	4	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	415	4♂, 1♀	25.v.1987	Confirmed extant site. Crown, Provincial Park	R.A. Cannings	RBCM
2	5	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	415	4♂, 2♀	25.v.1987	Confirmed extant site. Crown, Provincial Park.	R.W. Peart	RBCM
2	6	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland ridge to N	592	3♀	18.vi.1991	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings H. Nadel	RBCM
2	7	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope*	484	2♂, 1♀	13.v.1995	Confirmed extant site. Crown, Provincial Park.	S.G. Cannings P. McAllister	RBCM
2	8	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope	484	2♂	14.v.1995	Confirmed extant site. Crown, Provincial Park.	S.G. Cannings	RBCM
2	9	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, slope to N	463	6♂, 15♀	12.vi.1995	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings H. Nadel	RBCM
2	10	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland to E	404	1♂	16.v.2008	Confirmed extant site. Crown, Provincial Park.	L.R. Ramsay	RBCM
2	11	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope to NW	473	1 ♀	30.v.2010	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings	RBCM
2	12	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, Cosens Bay Trail to E	611	1 ♂	01.vi.2010	Confirmed extant site. Crown, Provincial Park.	R.A. Cannings	RBCM
3	13	BC, Okanagan Falls, Nature Trust Thomas Ranch	460	1 ♂	28.v.1993	Confirmed extant site. Private conservation land.	S.G. Cannings	RBCM
4a	14	BC, Vaseux Lake, Oliver [exact location fide Robin Leech 2010]	413	1♂, 4♀	23.v.1959	Unknown	R.E. Leech	CNC

Population #	Site #	Collection site	Elev. (m)	#/ sex	Date	Land tenure	Collector	Collection
4b	15	BC, Vaseux Lake, E cliff base	387	1♀	16.v.1980	Private conservation land (The Nature Trust Sublot 15)	R.A. Cannings	RBCM
4c	16	BC, Vaseux Lake	390	1♀	12.v.1983	Private conservation land (The Nature Trust Sublot 15)	S.G. Cannings	UBC
4d	17	BC, Vaseux Lake, above highway	342	14♂, 9♀	19.v.1983	Crown (provincial park)	G. Sunderland	RBCM
4e	18	BC, Vaseux Lake	367	1♂	18.v.1984	Private conservation land (The Nature Trust Sublot 15)	R.A. Cannings	RBCM
4e	18	BC, Vaseux Lake	367	1♂	18.v.1984	Private conservation land (The Nature Trust Sublot 15)	S.G. Cannings	UBC
4e	18	BC, Vaseux Lake	367	2♂, 1♀	20.v.1984	Private conservation land (The Nature Trust Sublot 15)	R.A. Cannings	RBCM
4e	18	BC, Vaseux Lake	367	3♂	21.v.1984	Private conservation land (The Nature Trust Sublot 15)	R.J. Cannings	RBCM
4e	18	BC, Vaseux Lake	367	1♂, 4♀	01.vi.1984	Private conservation land (The Nature Trust Sublot 15)	R.J. Cannings	RBCM
4e	18	BC, Vaseux Lake	367	2♂, 1♀	15.vi.1984	Private conservation land (The Nature Trust Sublot 15)	S.G. Cannings	UBC
4f	19	BC, Vaseux Lake, cliff tops	655	1♂, 1♀	17.v.1987	Crown, Provincial Park.	S.G. Cannings	UBC
4g	20	BC, Vaseux Lake, cliff base	460	1♀	20.v.1987	Private	R.A. Cannings	RBCM
4h	21	BC, Vaseux Lake, E side below cliffs, Nature Trust property	365	1♂, 1♀	17.v.2010	Confirmed extant site. Private conservation land.	R.A. Cannings	RBCM
4h	21	BC, Vaseux Lake, E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	351	1♂	17.v.2010	Confirmed extant site. Private conservation land.	R.A. Cannings	RBCM
4h	21	BC, Vaseux Lake, E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	351	unknown	16.v.2010	Confirmed extant site. Private conservation land.	J. Heron; C. Dawson	Sight records
4h	22	BC, Vaseux Creek, Nature Trust Kennedy property	470	1♂	15.v.2008	Confirmed extant site. Private conservation land.	L.R. Ramsay	RBCM
4h	23	BC, Vaseux Creek, Nature Trust Kennedy property	398	3♂, 1♀	11.v.2009	Confirmed extant site. Private conservation land	R.A. Cannings	RBCM
5	unknown	BC, Oliver	340	1♂	19.v.1924	unknown	P.N.Vroom	CNC
5	unknown	BC, Oliver	340	1♂	25.v.1924	unknown	P.N.Vroom	CNC
5	unknown	BC, Oliver	340	4♂, 1♀	23.v.1959	unknown	R. Madge	CNC
5	unknown	BC, Oliver	340	1♂, 1♀	23.v.1959	unknown	R. Madge	RBCM
5a	24	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	513	1♂, 1♀	19.v.2010	Crown (undesigned)	R.A. Cannings	RBCM
5a	24	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	634	1♂, 1♀	19.v.2010	Crown (undesigned)	R.A. Cannings	RBCM
5b	25	BC, Oliver, Fairview-White Lake Rd, Oliver Mountain area	535	4♂, 1♀	19.v.2010	Crown (unprotected but recommended as provincial)	R.A. Cannings	RBCM

Population #	Site #	Collection site	Elev. (m)	#/ sex	Date	Land tenure	Collector	Collection
						park)		

Appendix 2. Population number, site, and associated level 2 threats from the IUCN–CMP threat classification (see Table 3).

Pop. #	Site ^a	Date	Land tenure	Level 2 threats (Table 3)												
				1.1	1.2	1.3	2.1	2.3	4.1	4.2	6.1	7.1	8.1	9.3	11.1	11.2
1a	BC, Kamloops, Batchelor Hills, Lac du Bois Grasslands Protected Area, Lac du Bois Rd, SW jct Pruden Pass Rd.	20.v.1984	Crown (provincial park)	No	No	No	No	Yes, most is grazed by cattle.	No	No	Hiking, walking - mostly on trails; no ATV use in park; there are roads through the park that people can drive ATVs; occasional illegal ATV use in the park in some areas but not widespread.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
1b	BC, Kamloops, Lac du Bois Grasslands Protected Area, Batchelor Hills, Lac du Bois Rd, SE Grace L.	31.v.2010	Crown (provincial park)	No	No	No	No	Yes, most is grazed by cattle.	No	No	Hiking, walking - mostly on trails; no ATV use in park; there are roads through the park that people can drive ATVs; occasional illegal ATV use in the park in some areas but not widespread.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon*	17.iv.1930	U	U	U	U	U	U	U	U	U	Yes, both	Yes, but unknown impacts.	Unknown	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	17.v.1985	Crown, Provincial Park	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	23.v.1987	Crown, Provincial Park	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	24.v.1987	Crown, Provincial Park	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	25.v.1987	Crown, Provincial Park	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.

Pop. #	Site ^a	Date	Land tenure	Level 2 threats (Table 3)													
				1.1	1.2	1.3	2.1	2.3	4.1	4.2	6.1	7.1	8.1	9.3	11.1	11.2	
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	25.v.1987	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland ridge to N	18.vi.1991	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope*	13.v.1995	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope*	14.v.1995	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, slope to N	12.vi.1995	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland to E	16.v.2008	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope to NW	30.v.2010	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
2	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, Cosens Bay Trail to E	01.vi.2010	Crown, Provincial Park	No	No	No	No	No	No	No	No	Hiking, walking; no ATV use; mountain biking on trails but not impacting Robber Fly habitat.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.

Pop. #	Site ^a	Date	Land tenure	Level 2 threats (Table 3)												
				1.1	1.2	1.3	2.1	2.3	4.1	4.2	6.1	7.1	8.1	9.3	11.1	11.2
3	BC, Okanagan Falls, Nature Trust Thomas Ranch	28.v.1993	Private conservation land	No	No	No	No	Yes, lightly grazed by cattle.	No	No	Hiking, walking - mostly on trails. ATV use unlikely.	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
4a	BC, Vaseux Lake, Oliver [exact location fide Robin Leech 2010]	23.v.1959	U	U	U	U	U	U	U	U	U	Yes, both	Yes, but unknown impacts.	Unknown	Yes, but unknown impacts.	Yes, but unknown impacts.
4b	BC, Vaseux Lake, E cliff base*	16.v.1980	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4c	BC, Vaseux Lake*	12.v.1983	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4d	BC, Vaseux Lake Provincial Park, above highway*	19.v.1983	Crown (provincial park)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Possible adjacent landowners may spray herbicides; not close to agricultural areas.	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	18.v.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	18.v.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	20.v.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	21.v.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	01.vi.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.
4e	BC, Vaseux Lake	15.vi.1984	Private conservation land (The Nature Trust Sublot 15)	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Unlikely	Yes, but unknown impacts.	Yes, but unknown impacts.

Pop. #	Site ^a	Date	Land tenure	Level 2 threats (Table 3)												
				1.1	1.2	1.3	2.1	2.3	4.1	4.2	6.1	7.1	8.1	9.3	11.1	11.2
4f	BC, Vaseux Protected Area (BC Parks), cliff tops	17.v.1987	Crown (provincial park)	No	No	No	No	Yes, grazed by cattle.	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
4g	BC, Vaseux Lake, cliff base	20.v.1987	Private	Unlikely	No	Unlikely	Possible	Yes, grazed by cattle.	No	No	No	Yes, both	Yes, but unknown impacts.	Yes, possible.	Yes, but unknown impacts.	Yes, but unknown impacts.
4h	BC, Vaseux Lake, E side below cliffs, Nature Trust property	17.v.2010	Private conservation land	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	Yes, adjacent properties have agricultural crops that use pesticides that could drift onto the property and/or impact prey.	Yes, but unknown impacts.	Yes, but unknown impacts.
4h	BC, Vaseux Lake, Vaseux Bighorn National Wildlife Area (Canadian Wildlife Service); E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	17.v.2010	Federal	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
4h	BC, Vaseux Creek, Nature Trust Kennedy property	15.v.2008	Private conservation land	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
4h	BC, Vaseux Creek, Nature Trust Kennedy property	11.v.2009	Private conservation land	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
4h	BC, Vaseux Lake, Vaseux Bighorn National Wildlife Area (Canadian Wildlife Service); E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	16.v.2016	Private conservation land	No	No	No	No	No	No	No	Hiking, walking; no ATV use	Yes, both	Yes, but unknown impacts.	No agricultural areas immediately adjacent to protected area.	Yes, but unknown impacts.	Yes, but unknown impacts.
5	BC, Oliver	19.v.1924	U	U	U	U	U	U	U	U	U	Yes, both	Yes, but unknown	Unknown	Yes, but unknown	Yes, but unknown

