COSEWIC
Assessment and Status Report

on the

Okanagan Efferia
Efferia okanagana

in Canada

ENDANGERED
2011

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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Okanagan Efferia — Photograph by Werner Eigelsreiter.

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COSEWIC
Assessment Summary

Assessment Summary – November 2011

Common name
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.

Occurrence
British Columbia

Status history
Designated Endangered in November 2011.

COSEWIC
Executive Summary

Okanagan Efferia
Efferia okanagana

Wildlife species description and significance

Efferia okanagana Cannings (Okanagan Efferia—working common name) is a large (up to about 2 cm long), brown, bristly fly in the family Asilidae (robber flies). Both sexes have striking orange-golden bristles behind the eyes. In the male, the external genitalia at the tip of the abdomen are large and hammer-shaped; the last three visible abdominal segments are silver-white. The female has a long, sword-shaped ovipositor at the end of the abdomen. There are no subspecies known. The larva and pupa are unknown.

This robber fly is significant because it is one of the more obvious large invertebrates representative of the Antelope-brush ecosystem in Canada. Much of this habitat is threatened and, as yet, the fly is unknown from anywhere else in the world.

Distribution

The known global distribution of the fly is restricted to five locations (28 individual sites) in the Okanagan and Thompson valleys of south-central British Columbia, from Kamloops in the north, to Oliver in the south.

Habitat

The Okanagan Efferia is apparently restricted to dry grasslands growing on gravelly or sandy loam soils. Open soil is usually present, as is Bluebunch Wheatgrass. In the South Okanagan, the species has been found only in Antelope-brush steppe.

Biology

Robber flies are generalist predators of other insects, both as larvae and adults. The adults of Okanagan Efferia have been recorded capturing leafhoppers, click beetles, leafcutter and andrenid bees and ants, micromoths, flower flies, crane flies and robber flies. Prey is seized in the fly's bristly legs and the prominent proboscis is inserted in the prey's body. Paralyzing, proteolytic saliva is injected and the tissues are dissolved; the resulting fluid is sucked up by the fly. Eggs are laid in the empty glumes of the previous year's wheatgrass inflorescences. It is assumed that, like most other robber flies, larvae feed on soil invertebrates such as beetle larvae. The larval period lasts 1-2 years; pupation evidently occurs in the last spring and the adults emerge in late April or early May.

The Okanagan Efferia has been collected or photographed from 17 April to 18 June, with most records falling in the middle weeks of May.

Population sizes and trends

Population sizes have not been estimated. Populations are patchily distributed in suitable habitat at the regional scale and density is extremely variable at the site scale. In appropriate habitat, thirty-minute searches can produce catches of up to 15 specimens; usually the range is 0 to 5. There is no direct information on population trends, although declines can be inferred from trends in habitat destruction. In the southern part of the species' range, Antelope-brush steppe, the main habitat of the fly, has declined by two-thirds since European settlement.

Threats and limiting factors

Threats to the Okanagan Efferia include habitat loss or degradation (development, especially of vineyards; overgrazing by livestock; damage by vehicles), wild fires and related changes, invasive plants, climate warming, and pesticide effects.

There is no detailed information on limiting factors. There is an apparent, unmeasured correlation of the species' presence with Bluebunch Wheatgrass growing on gravelly soils. The well-drained character of these soils, or some other features, may be limiting requirements of the soil-dwelling larvae. The only oviposition sites observed are the empty glumes in the old inflorescences of this grass species. Larvae feed on subterranean insect larvae and the availability of suitable prey may be limiting. Adults are opportunistic, general predators of flying insects and locating suitable prey is likely not limiting.

Protection, status, and ranks

Okanagan Efferia has no legal protection, except for that general protection it receives when living in parks and other provincially or federally protected areas and lands owned by non-governmental conservation organizations such as the Nature Trust of BC. The most significant protected areas where the species has been recorded are the Lac du Bois Grassland Protected Area near Kamloops, Kalamalka Lake Provincial Park near Vernon (BC Parks, British Columbia *Park Act*) and Nature Trust of BC properties at Okanagan Falls and Vaseux Lake. Three of the five locations and most of the collection sites are from the southern Okanagan in Antelope-brush steppe. Government and private conservation lands there protect 15% of the remainder of this habitat in BC.

The Okanagan Efferia is not ranked by the National General Status program. It is unranked globally by NatureServe and unranked provincially by the BC Conservation Data Centre.

TECHNICAL SUMMARY

Efferia okanagana
Okanagan Efferia — Asile de l'Okanagan
Range of occurrence in Canada: BC

Demographic Information

Generation time	1-2 yrs
Is there an inferred, continuing decline in number of mature individuals? *Unknown, but probable, based on extent and decline in habitat area and condition.*	Yes. Probable small but continuing decline
Estimated percent of continuing decline in total number of mature individuals within 5 years *Unknown, but probably small declines. See **Habitat trends** section*	Unknown, but probable small decline based on recent rates of habitat loss
Inferred, or suspected percent reduction in total number of mature individuals over the last 10 years. *Habitat trends negative….Development, fires, invasive plants.*	Probable small decline
Projected or suspected percent reduction in total number of mature individuals over the next 10 years. *Habitat trends negative….Development, fires, invasive plants,*	Unknown, but probably a small decline
Inferred or suspected percent reduction in total number of mature individuals over any 10 year period, over a time period including both the past and the future. *Habitat trends negative….Development, fires, invasive plants.*	Unknown, but probably a small decline
Are the causes of the decline clearly reversible and understood and ceased?	No
Are there extreme fluctuations in number of mature individuals?	Unknown; but probably not

Extent and Occupancy Information

Estimated extent of occurrence	5865 km²
Index of area of occupancy (IAO) *Figure given is the 2 km x 2 km grid value, using a fixed grid system. The 1 km x 1 km grid value is 14 km². See **Canadian range** section*	40 km²
Is the total population severely fragmented? *Not fragmented in the South Okanagan (3 locations). The most northerly (Kamloops) is 100km distant from the central location (Vernon), which, in turn, is 94 km north of the closest southerly location (Okanagan Falls). There is apparently suitable habitat north to Vernon, but significantly less between Vernon and Kamloops.*	No
Number of locations∗	5
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	No
Is there an observed, inferred, or projected continuing decline in index of area of occupancy? *Probably stable at 2 x 2 km grid scale*	Unknown
Is there an [observed, inferred, or projected] continuing decline in number of populations? *Unknown; probably rather stable*	Unknown
Is there an inferred, or projected, continuing decline in number of locations*? *Unknown; probably rather stable*	Unknown

∗ See definition of location.

Is there an observed, continuing decline in area, extent and/or quality of habitat? *Habitat trends negative….Development, fires, invasive plants.*	Yes
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations∗?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Kamloops, Lac du Bois Grasslands Protected Area	Unknown
Vernon, Kalamalka Lake Provincial Park	Unknown
Okanagan Falls	Unknown
Vaseux Lake-Vaseux Creek	Unknown
Oliver-Fairview	Unknown
Total: total unknown, but likely less than 10,000	Unknown

Quantitative Analysis

Probability of extinction in the wild	N/A

Threats (actual or imminent, to populations or habitats)

Habitat destruction or damage by agricultural (especially vineyard development), housing and other development; wild fires; invasive plants; all-terrain vehicle use; overgrazing by livestock; climate warming; pesticides

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? *As far as is known, species is endemic to southern BC as it is not known from the United States.*	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? *Much of the grassland habitat immediately adjacent to the International Boundary in Canada is apparently unsuitable for the species; connectivity could be a problem*	No

Current Status

COSEWIC: Designated Endangered in November 2011.

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B2ab(iii)

Reasons 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.

∗ See definition of location.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Although no information is available on population sizes, there is an inferred decline based on loss of habitat over the past decade due to extensive conversion of grasslands to vineyards and extensive impact of fire, but the extent to which some of the lost habitat was occupied is unclear.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B2ab(iii) because the IAO is 40 km² (less than 500 km²), there are only 5 locations, and the area, extent and quality of habitat continues to decline.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable—no information on population sizes.
Criterion D (Very Small or Restricted Total Population): Meets D2 with 5 locations, declining habitat and a large number of threats.
Criterion E (Quantitative Analysis): Not available.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2011)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Kingdom: Animalia — animals, animaux

Phylum: Arthropoda — arthropods, arthropodes

Class: Insecta — insects, insectes

Order: Diptera — true flies

Suborder Brachycera — short-horned flies

Family: Asilidae — robber flies

Scientific name: *Efferia okanagana* Cannings — Okanagan Efferia

Efferia okanagana Cannings (Okanagan Efferia) is a true fly (Order Diptera) in the family Asilidae. The species was undescribed until 2011 (Cannings 2011).

There are no official English or French names, but the working COSEWIC name, “Okanagan Efferia”, refers to the genus and the fact that the species is known almost entirely from the Okanagan Valley in BC. However, there are no plans to submit this name for official status. No subspecies are named (Cannings 2011).

Efferia is the largest genus of robber flies in the Americas, with over 230 described species and many undescribed ones, especially south of the United States (Fisher 2009). About 100 species occur in the US and Canada (Wilcox 1966; Fisher and Wilcox 1997) although only 11 are known from Canada and 7 from British Columbia (R.A. Cannings unpublished data), including the species treated here. In North America, most species live in arid lands and grasslands in the West, where they are among the most prominent invertebrate predators.

Hine (1919) and Wilcox (1966) arranged the species of Efferia in eight species groups based mainly on differences in wing venation and setation. Artigas and Papavero (1997) elevated some of these groups to genera, but Fisher (2009) synonymized their genera, pointing to significant variability in the characters that were used to justify generic status. He emphasized the unique structure of the male and female genitalia as the best basis for recognizing a monophyletic Efferia. Fisher’s assessment is followed here. Although the species groups used by Hine and Wilcox are not based on phylogenetic analysis and are probably not all monophyletic groups (Fisher 2009), they are useful in organizing the numerous species. Therefore, this report makes reference to them, particularly the *E. arida* group, to which *E. okanagana* belongs.

Morphological description

The Okanagan Efferia is a large, brown, bristly robber fly, in both sexes ranging from about 1.2 to 2 cm in length (Cannings 2011). Like other robber flies, the eyes are separated dorsally by a deep cleft. Both sexes have striking orange-golden occipital bristles behind the eyes. The piercing proboscis is prominent at the front of the head and the strong tuft of bristles on the face is white or often pale golden at the base. The strong bristles on the legs and scutellum margin are mostly black. In the male, the external genitalia at the tip of the abdomen are large and hammer-shaped; the last three visible abdominal segments are silver-white. The female lacks this abdominal colour pattern but has a long, sword-shaped ovipositor at the end of the abdomen. The front half of the thorax bears numerous slender bristles at least as long as antennal segments 1-2. (Figures 1, 2). The larva and pupa are unknown (Cannings 2011).

Figure 1. Okanagan Efferia, male. Oliver, BC, 16 May 2009. Photo: Werner Eigelsreiter, with permission.

Figure 2. Okanagan Efferia, female. Oliver, BC, 12 May 2007. Photo: Werner Eigelsreiter, with permission.

Wilcox (1966), Bullington and Lavigne (1984), Scarbrough and Perez-Gelabert (2009) and Fisher (2009) provide information on the morphology of other *Efferia* species. Cannings (2011) describes the Okanagan Efferia in detail.

Population spatial structure and variability

Little information is available, but because they apparently prefer grasslands with gravelly soils at low elevations, populations are patchy. At certain times, populations at some localities, such as those at Cosens Bay in Kalamalka Lake Provincial Park near Vernon and near Highway 97 near the north end of Vaseux Lake were large compared to those observed at most sites (Table 1). The high number of potential sites that produced no specimens in 2009 and 2010 surveys (Table 2) illustrate the patchiness of the habitat. See **Search effort**.

Table 1. Okanagan Efferia: all known collection records.

#/ sex	Location	°N Lat	°W Long	Elev m	Date	Collector(s)	Collection
1 ♂	BC, Kamloops, Batchelor Hills, Lac du Bois Rd, SW jct Pruden Pass Rd	50.74778	120.41806	670	20.v.1984	R.A. Cannings	RBCM
1 ♀	BC, Kamloops, Batchelor Hills, Lac du Bois Rd, SE Grace L	50.76286	120.42461	780	31.v.2010	R.A. Cannings	RBCM
1 ♂	BC, Okanagan Falls, Nature Trust Thomas Ranch	49.35333	119.55889	460	28.v.1993	S.G. Cannings	RBCM
1♂	BC, Oliver*	49.18056	119.53333	340	19.v.1924	P.N. Vroom	CNC
1♂	BC, Oliver*	49.18056	119.53333	340	25.v.1924	P.N. Vroom	CNC
4♂, 1♀	BC, Oliver*	49.18056	119.53333	340	23.v.1959	R. Madge	CNC
1♂, 1♀	BC, Oliver*	49.18056	119.53333	340	23.v.1959	R. Madge	RBCM
1♂, 1♀*	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	49.18592	119.59494	513	19.v.2010	R.A. Cannings	RBCM
1♂, 1♀*	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	49.19286	119.59931	634	19.v.2010	R.A. Cannings	RBCM
4♂*, 1♀	BC, Oliver, Fairview-White Lake Rd, Oliver Mountain area	49.18749	119.58737	535	19.v.2010	R.A. Cannings	RBCM
1♂, 4♀	BC, Vaseux Lake, Oliver [exact location fide Robin Leech 2010]	49.28056	119.51667	413	23.v.1959	R.E. Leech	CNCI
1♀	BC, Vaseux Lake, E cliff base*	49.29722	119.52639	387	16.v.1980	R.A. Cannings	RBCM
1♀	BC, Vaseux Lake*	49.29667	119.52583	390	12.v.1983	S.G. Cannings	UBC
14♂, 9♀	BC, Vaseux Lake, above highway*	49.29833	119.52944	342	19.v.1983	G. Sunderland	RBCM
1♂	BC, Vaseux Lake	49.29306	119.52500	367	18.v.1984	R.A. Cannings	RBCM
1♂	BC, Vaseux Lake	49.29306	119.52500	367	18.v.1984	S.G. Cannings	UBC
2♂, 1♀	BC, Vaseux Lake	49.29306	119.52500	367	20.v.1984	R.A. Cannings	RBCM
3♂	BC, Vaseux Lake	49.29306	119.52500	367	21.v.1984	R.J. Cannings	RBCM
1♂, 4♀	BC, Vaseux Lake	49.29306	119.52500	367	01.vi.1984	R.J. Cannings	RBCM
2♂, 1♀	BC, Vaseux Lake	49.29306	119.52500	367	15.vi.1984	S.G. Cannings	UBC
1♂, 1♀	BC, Vaseux Lake, cliff tops	49.29583	119.51444	655	17.v.1987	S.G. Cannings	UBC
1♀	BC, Vaseux Lake, cliff base	49.29222	119.51833	460	20.v.1987	R.A. Cannings	RBCM
1♂, 1♀	BC, Vaseux Lake, E side below cliffs, Nature Trust property	49.29435	119.52545	365	17.v.2010	R.A. Cannings	RBCM
1 ♂	BC, Vaseux Lake, E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	49.30211	119.53054	351	17.v.2010	R.A. Cannings	RBCM
1♂	BC, Vaseux Creek, Nature Trust Kennedy property	49.25953	119.50667	470	15.v.2008	L.R. Ramsay	RBCM

#/ sex	Location	°N Lat	°W Long	Elev m	Date	Collector(s)	Collection
3♂, 1♀	BC, Vaseux Creek, Nature Trust Kennedy property	49.25774	119.50804	398	11.v.2009	R.A. Cannings	RBCM
1 ♂	BC, Vernon*	50.23333	119.28611	535	17.iv.1930	E.R. Buckell	RBCM
1 ♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	50.19928	119.26464	420	17.v.1985	C.S. Guppy	RBCM
21♂, 15♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	50.19928	119.26853	452	23.v.1987	R.A. Cannings	RBCM
1 ♂	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	50.19928	119.26853	452	24.v.1987	R.A. Cannings	RBCM
4♂, 1♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	50.19833	119.25917	415	25.v.1987	R.A. Cannings	RBCM
4♂, 2♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay	50.19833	119.25917	415	25.v.1987	R.W. Peart	RBCM
3♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland ridge to N	50.20278	119.26667	592	18.vi.1991	R.A. Cannings H. Nadel	RBCM
2♂, 1♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope*	50.20083	119.27083	484	13.v.1995	S.G. Cannings P. McAllister	RBCM
2♂	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope*	50.20083	119.27083	484	14.v.1995	S.G. Cannings	RBCM
6♂, 15♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, slope to N	50.19954	119.26981	463	12.vi.1995	R.A. Cannings H. Nadel	RBCM
1♂	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, grassland to E	50.19836	119.25991	404	16.v.2008	L.R. Ramsay	RBCM
1 ♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope to NW	50.20042	119.27083	473	30.v.2010	R.A. Cannings	RBCM
1 ♂*	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, Cosens Bay Trail to E	50.20658	119.23886	611	01.vi.2010	R.A. Cannings	RBCM

Table 2. Okanagan Efferia: localities, dates and search effort where no specimens were collected.

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Lillooet*	50.68767	121.95634	460	*Pseudoroegneria* with *Balsamorhiza sagitatta, Pinus ponderosa Cyrtopogon willistoni*	15 Jun 1917	---	M.H. Ruhmann

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Chilcotin [Riske Creek]*	51.96919	122.54117	897	*Festuca grassland* *Efferia coulei*	29 May 1920	---	E.R. Buckell
Chase, Niskonlith Lake*	50.75833	119.78504	534	*Pseudoroegneria* with *Artemisia tridentata, Balsamorhiza sagitatta, Pinus ponderosa* *Cyrtopogon willistoni*	21 May 1937	---	J.K. Jacob
Salmon Arm*	50.70926	119.27289	350	Grassland type unknown. *Efferia coulei*	26 May 1943	---	E.R. Buckell
Robson*	49.33798	117.69658	462	*Pseudoroegneria* with *Pinus ponderosa.* *Cyrtopogon willistoni*	10 Jun 1960	---	H.R. Foxlee
Penticton, Madeline L.	49.51040	119.64795	513	*Pseudoroegneria/ Festuca* grassland with *Pinus ponderosa*. *Efferia benedicti*	8 Jun 1982	3	R.A. Cannings
Okanagan Falls, White Lake, Kearns Creek	49.31410	119.62552	543	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata*, *Hesperostipa comata* *Efferia coulei*	9 Jun 1982	4	R.A. Cannings
Osoyoos, Osoyoos Lake. E side	49.05143	119.45782	278	*Purshia steppe* with *Pseudoroegneria spicata, Hesperostipa comata; Artemisia tridentata.* Sandy soils *Efferia benedicti*	11 Jun 1982	4	R.A. Cannings
Spences Bridge*	50.425370	121.34101	244	*Pseudoroegneria* with *Artemisia tridentata* *Efferia coulei*	21 May 1983	---	C.S. Guppy
Armstrong, Otter Lake*	50.40645	119.28811	666	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata*. *Stenopogon rufibarbis*	5 Jun 1983	---	C.S. Guppy
Westbank*	49.84747	119.57982	538	*Pseudoroegneria* and *Pinus ponderosa* *Stenopogon inquinatus*	30 Jun 1983	---	C.S. Guppy
Riske Creek, Rock Lake	51.97557	122.41277	947	*Festuca* grassland with *Pseudotsuga menziesii.* *Cyrtopogon willistoni*	18 Jun 1984	2	R.A. Cannings
Cache Creek, Finney Creek sage flat	50.75787	121.59109	928	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata*. *Cyrtopogon willistoni*	16 May 1989	---	C.S. Guppy
Chopaka, sage flat to E of Nighthawk Rd.	49.00509	119.66789	443	*Pseudoroegneria* grassland with *Artemisia tridentata*. *Heavily grazed* *Efferia coulei*	21 May 1986	1	R.A. Cannings
Osoyoos, Haynes Lease	49.08613	119.51575	344	*Purshia steppe* with *Pseudoroegneria spicata, Hesperostipa comata;* sandy soils *Efferia albibarbis*	19 Jun 1986	---	S.G. Cannings
Penticton, West Bench, S end	49.48877	119.62854	415	*Festuca scabrella* grassland; *Chrysothamnus* *Efferia coulei*	22 May 1987	0.5	R.A. Cannings

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Nicola, Stump Lake*	50.35088	120.40759	752	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata Stenopogon rufibarbis*	5 Jun 1987	---	R. Goward
Kimberley, Mather Creek at Hwy #95A	49.69203	115.83128	892	*Pseudoroegneria/ Festuca* grassland. *Cyrtopogon willistoni*	31 May 1988	0.5	R.A. Cannings
Wilmer, CWS Wildlife Area to N	50.55809	116.06585	828	*Pseudoroegneria* grassland *Stenopogon inquinatus*	2 Jun 1988	2	R.A. Cannings
Cranbrook, lakes 4.4 km S jct Hwys #3 and 95	49.54713	115.63872	819	*Pseudoroegneria* grassland *Stenopogon inquinatus*	3 Jun 1988	2	R.A. Cannings
Ashcroft, Bonaparte River*	50.75003	121.28378	464	*Pseudoroegneria* with *Artemisia tridentata*, *Efferia coulei*	19 May 1989	---	C.S. Guppy
Ashcroft, Basque	50.62575	121.33545	443	*Pseudoroegneria* with *Artemisia tridentata. Efferia benedicti*	13 Jun 1989	0.5	R.A. Cannings
Cache Creek, Hat Creek*	50.72063	121.58908	1073	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata Efferia benedicti*	15 Jun 1989	1	R.A. Cannings
Ashcroft, Rattlesnake Hills	50.74222	121.26236	385	*Pseudoroegneria* grassland with *Artemisia tridentata, Opuntia polyacantha. Efferia benedicti*	12 Jun 1995	---	S.G. Cannings L.R. Ramsay
Oliver, UBC Geology Camp	49.22389	119.58927	483	*Pseudoroegneria* with *Artemisia tridentata, Pinus ponderosa Efferia staminea*	30 Jun 1996	---	S.G. Cannings
Oliver, Manuel's Canyon	49.21077	119.49822	466	*Pseudoroegneria* with *Artemisia tridentata, Pinus ponderosa Efferia staminea*	30 Jun 1996	4	R.A. Cannings G. Hutchings
Osoyoos, Mt. Kobau	49.07628	119. 58741	560	*Pseudoroegneria* with *Artemisia tridentata. Machimus occidentalis*	31 May 1991	---	D. Blades C. Maier
Osoyoos, Richter Pass, International Grasslands	49.02069	119.60944	942	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata*, *Hesperostipa comata. Cyrtopogon willistoni*	31 May 2006	3	R.A. Cannings
Osoyoos, Kilpoola Lake	49.01633	119.55519	807	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata, Hesperostipa comata. Machimus occidentalis*	31 May 2006	2	R.A. Cannings
Okanagan Falls, White Lake, cliffs to S	49.29525	119.61342	637	*Pseudoroegneria/ Festuca* grassland with *Artemisia tridentata, Pinus ponderosa, Hesperostipa comata, Balsamorhiza sagitatta*. *Cyrtopogon inversus*	1 Jun 2006	3.5	R.A. Cannings
Okanagan Falls, BC Nature Trust (Schneider) property	49.33582	119.52342	550	*Pseudoroegneria/ Purshia* grassland with *Pinus pondersosa, Balsamorhiza*	20 May 2009	12	D. Marks V. Young O. Dyer

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Oliver, McIntyre Bluff	49.25284	119.54499	458	*Pseudoroegneria/ Purshia* grassland with *Pinus pondersosa*	27 May 2009	10.5	D. Marks V. Young L. Ramsay
Okanagan Falls, BC Nature Trust (Blue Mountain) property	49.32692	119.53755	478	*Pseudoroegneria/ Purshia* grassland with *Pinus pondersosa, Balsamorhiza*	29 May 2009	14	D. Marks V. Young O. Dyer L. Ramsay
Oliver, wastewater treatment facility	49.17865	119.58381	426	*Pseudoroegneria/ Purshia* grassland	2 June 2009	5	D. Marks V. Young
Grand Forks, Gilpin Grasslands Provincial Park	49.006576	118.28922	520	*Pseudoroegneria/ Festuca* grassland with *Gaillardia aristata, Eriogonum heracleoides*	22 Jun 2009	0.5	R.A. Cannings
Oliver, Secrest Hill, ridge above Sportsmens' Bowl	49.23478	119.55589	402	*Pseudoroegneria/ Purshia* grassland with *Pinus pondersosa, Balsamorhiza, Phlox longifolia. Machimus occidentalis*	17 May 2010	1	R.A. Cannings
Oliver, Secrest Hill, Park Rill area E jct Fairview-White L. Rd	49.23700	119.57661	474	*Pseudoroegneria* grassland with *Balsamorhiza, Pinus pondersosa. Cyrtopogon inversus*	17 May 2010	0.5	R.A. Cannings
Fairview, old town site, gully to east.	49.17208	119.59456	434	*Purshia steppe with Pseudoroegneria spicata, Hesperostipa comata*; weedy. Gravelly, rocky soil.	19 May 2010	0.5	R.A. Cannings
Vaseux Lake, BC Nature Trust (Emery) property	49.28583	119.51825	407	*Pseudoroegneria* grassland, *Hesperostipa comata, Bromus tectorum, o*n S-facing sandy slope	19 May 2010	0.5	R.A. Cannings
Vaseux Lake, W side, CWS Wildlife Area	49.29656	119.54097	396	*Purshia steppe* with *Pseudoroegneria spicata, Hesperostipa comata, Pinus ponderosa. Cyrtopogon montanus*	19 May 2010	0.5	R.A. Cannings
Vaseux Lake, W side, S end	49.27664	119.53033	396	*Purshia steppe* with *Pseudoroegneria spicata, Balsamorhiza, Pinus pondersosa, Pseudotsuga.*	19 May 2010	0.5	R.A. Cannings
Vaseux Lake, Allandale Rd, BC Nature Trust (Brock) property	49.32197	119.53767	430	*Purshia steppe* with *Pseudoroegneria spicata, Hesperostipa comata, Bromus tectorum, Balsmorhiza.*	19 May 2010	0.5	R.A. Cannings
Penticton, Munson's Mtn, N end	49.51711	119.57253	483	*Pseudoroegneria spicata, Hesperostipa comata, Artemisia tridentata, Chrysothamnus nauseosus* on gravelly loam (volcanic).	20 May 2010	0.5	R.A. Cannings

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Naramata, Naramata Rd near Indian Rock	49.62000	119.60289	438	*Pseudoroegneria spicata, Artemisia tridentata* with *Pinus ponderosa.* Silt bluffs below, rock outcrops above.	20 May 2010	0.5	R.A. Cannings
Penticton, West Bench, former KV Railway bed	49.48390	119.61244	354	*Purshia/ Artemisia* steppe with *Festuca scabrella, Bromus tectorum, Pseudoroegneria spicata*	20 May 2010	1	R.A. Cannings
Penticton, Sage Mesa	49.52375	119.62167	450	*Pseudoroegneria spicata, Artemisia tridentata* with *Pinus ponderosa, Amelanchier alnifolia*	20 May 2010	0.5	R.A. Cannings
Penticton, Sage Mesa, silt promontory to N	49.53008	119.61917	450	*Pseudoroegneria spicata, Artemisia tridentata, A. frigida. Efferia coulei*	20 May 2010	1	R.A. Cannings
Summerland, Giant's Head, NW slope	49.59556	119.67144	605	*Festuca scabrella grassland, Pinus ponderosa, Pseudotsuga menziesii*	20 May 2010	0.5	R.A. Cannings
Chopaka, W side of Nighthawk Road, S of Hwy #3.	49.01272	119.67653	518	*Pseudoroegneria* grassland with *Artemisia tridentata*, *Hesperostipa comata, Eriogonum niveum*. *Machimus occidentalis*	21 May 2010	0.5	R.A. Cannings
Chopaka, N side Hwy#3 near jct. Nighthawk Rd.	49.02278	119.68213	471	*Pseudoroegneria* grassland with *Artemisia tridentata*, *Hesperostipa comata, Phacelia lineata.*	21 May 2010	0.5	R.A. Cannings
Osoyoos, Richter Pass hill, grassland NE of Hwy #3	49.01086	119.55425	609	*Pseudoroegneria* grassland with *Artemisia tridentata*, *Stipa comata, Phacelia linearis, Eriogonum niveum*. *Machimus occidentalis*	21 May 2010	0.5	R.A. Cannings
Osoyoos, ridge above Strawberry Creek Rd, at base of Richter Pass Hill, Hwy#3.	49.03489	119.49503	402	*Pseudoroegneria* grassland with mixed *Purshia tridentata/ Artemisia tridentata; rocky outcrops with Selaginella*	21 May 2010	1	R.A. Cannings
Osoyoos, Hwy#3 at Veronica Lake Rd.	49.009217	119.40962	571	*Pseudoroegneria* grassland with mixed *Purshia tridentata/ Artemisia tridentata.*	21 May 2010	0.5	R.A. Cannings
Osoyoos, Osoyoos Desert Centre	49.05272	119.51742	355	*Pseudoroegneria/ Purshia tridentata/* grassland	21 May 2010	0.5	R.A. Cannings
Osoyoos, Haynes Ecological Reserve	49.09453	119.52392	352	*Pseudoroegneria/ Purshia tridentata/* grassland. Sandy soil; *Rhus glabra*	21 May 2010	0.5	R.A. Cannings

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Oliver, Black Sage Rd.	49.12236	119.56022	322	*Pseudoroegneria/ Purshia tridentata/* grassland; sandy soil	21 May 2010	0.5	R.A. Cannings
Oliver, Camp McKinney Rd.	49.16747	119.44311	798	*Pseudoroegneria* and *Pinus ponderosa* with mixed *Purshia tridentata/ Artemisia tridentata*	21 May 2010	0.5	R.A. Cannings
Vaseux Lake, BC Nature Trust (Leir) property	49.30830	119.53653	375	*Pseudoroegneria/ Purshia tridentata* grassland*. Pinus ponderosa*	22 May 2010	0.5	R.A. Cannings
Vaseux Lake, Allandale Rd, BC Nature Trust (Brock) property, W end	49.32508	119.54292	447	*Pseudoroegneria/ Purshia tridentata/* grassland*. Pinus ponderosa*	22 May 2010	0.5	R.A. Cannings
Penticton, BC Nature Trust (Skaha Estates) property	49.41606	119.56925	414	*Pseudoroegneria* grassland with *Chrysothamnus, Pinus ponderosa, Hesperostipa comata, Balsamorhiza sagitatta*.	22 May 2010	1	R.A. Cannings
Okanagan Falls, Eagle Bluff Estates	49.37447	119.55881	467	*Pseudoroegneria* grassland with *Chrysothamnus, Pinus ponderosa, Balsamorhiza sagitatta*.	22 May 2010	0.5	R.A. Cannings
Okanagan Falls Prov. Park, slope to W	49.34225	119.57989	342	*Pseudoroegneria, Purshia tridentata. Bromus tectorum.* Sandy soil; *Rhus glabra, Pinus ponderosa*	22 May 2010	0.5	R.A. Cannings
Okanagan Falls, Mahoney Lake, track thorough pine woods N of lake.	49.28997	119.58497	490	*Pseudoroegneria* grassland with *Balsamorhiza, Pinus pondersosa*. *Cyrtopogon inversus*	22 May 2010	1	R.A. Cannings
Kelowna, Black Knight Mtn, lower south-facing slopes above Hwy 33	49.85106	119.30692	775	*Pseudoroegneria* grassland	29 May 2010	0.5	R.A. Cannings
Kelowna, Okanagan Mtn. Prov. Park, trailhead S end Lakeshore Dr.	49.77997	119.59181	452	*Pseudoroegneria/ Festuca* grassland in *Pinus ponderosa* woods. *Cyrtopogon montanus*	29 May 2010	1	R.A. Cannings
Kelowna, Knox Mtn, lower S-facing slopes	49.90661	119.49042	404	*Pseudoroegneria* grassland with *Chrysothamnus nauseosus* and *Artemisia tridentata*; open *Pinus ponderosa* woods	30 May 2010	0.5	R.A. Cannings
Kelowna, Knox Mtn, middle S-facing slopes	49.90797	119.48319	509	*Pseudoroegneria/ Balsamorhiza* grassland; open *Pinus ponderosa* woods. *Cyrtopogon montanus*	30 May 2010	2	R.A. Cannings

Location	Latitude (N)	Longitude (W)	Elev. (m)	Habitat/ asilid indicator species	Date	Person-hours	Collector
Lake Country, Oyama Rd at SE corner Wood Lake	50.05194	119.38828	475	Small, steep, SW-facing *Pseudoroegneria/ Balsamorhiza* grassland	30 May 2010	0.5	R.A. Cannings
Vernon, Commonage, Allan Brooks Nature Centre.	50.24197	119.28839	558	Knoll in highly disturbed *Pseudoroegneria/ Festuca* grassland	30 May 2010	0.5	R.A. Cannings
Kamloops, Tranquille Lac du Bois grassland, Mara Loop Trail, lower grasslands	50.72731	120.50725	412	*Pseudoroegneria* with *Artemisia tridentata. Efferia benedicti.*	31 May 2010	1	R.A. Cannings
Monte Lake, S end, S of Hwy 97 and railway tracks	50.48822	119.83378	692	*Pseudoroegneria Pinus ponderosa, Pseudotsuga menziesii*	31 May 2010	0.5	R.A. Cannings
Vernon, Goose Lake, ridge above southeast corner of lake	50.31083	119.28378	530	*Pseudoroegneria* grassland with *Balsamorhiza, Lupinus, Rosa*	31 May 2010	0.5	R.A. Cannings
Vernon, Mount Middleton	50.23698	119.24982	621	E and S-facing *Pseudoroegneria* grassland adjacent to new subdivision. Disturbed. *Machimus occidentali*s	1 Jun 2010	2.5	R.A. Cannings
Vernon, Ellison Provincial Park	50.17628	119.43653	430	*Pseudoroegneria/ Festuca* grassland on E-facing ridge over lake	1 June 2010	0.5	R.A. Cannings
Kelowna, Bear Creek Prov. Park, trails to S and W above lake	49.92622	119.51256	517	*Pseudoroegneria/ Balsamorhiza/ Eriogonum heracleoides* on gravelly S-facing slope. *Stenopogon inquinatus*	3 June 2010	1.5	R.A. Cannings
Westbank, Kalamoir Regional Park	49.84475	119.54761	361	*Pseudoroegneria, Balsamorhiza*, *Chrysothamnus, Eriogonum niveum* on E-facing slope. Clay and volcanic gravels	3 June 2010	0.5	R.A. Cannings
Vernon, Rocky grassland ridge west of Recreation Complex in city	50.26772	119.28189	424	*Pseudoroegneria, Opuntia* on volcanic sands, gravels.	4 June 2010	0.5	R.A. Cannings
Vernon, Turtle Mtn, Grey Canal Trail	50.27472	119.28539	437	*Pseudoroegneria*, on volcanic sands, gravels. E-facing slope.	5 June 2010	1	R.A. Cannings
Vernon, Coldstream Estates section of Grey Canal Trail	50.23578	119.17711	603	*Pseudoroegneria/ Artemisia tridentata* on silts. *Machimus occidentalis*	5 June 2010	1.5	R.A. Cannings

There is little information on genetic variability. However, specimens of this and some other *Efferia* species were submitted to the Biodiversity Institute of Ontario, University of Guelph, for molecular diagnosis. In this analysis, 658 base pairs of the cytochrome oxidase I gene (DNA barcode) were sequenced for four individuals (ENT010-002701 - ENT010-002704) of *E. okanagana*. The DNA barcodes of the species form a distinct cluster that is approximately 7.0% divergent (uncorrected p-distance) from its most closely related sympatric congener, *E. coulei* Wilcox. However, no other members of the *E. arida* species group were barcoded because of a lack of suitable material. The allopatric *E. arida* (Williston) or *E. pinali* Wilcox from the western United States may be more closely related to *E. okanagana* than is *E. coulei*. The sequences are available from the Barcode of Life Data Systems (www.boldsystems.org; ASRMA001-10 - ASRMA004-10) and Genbank (accessions JN289678 - JN289681) (J. deWaard pers. comm. 2011).

Designatable units

All populations known are restricted to the Okanagan Valley and the adjacent Thompson Valley in south-central BC. There is one designatable unit.

Special significance

All the known range of the Okanagan Efferia lies within BC. It is a rare but top invertebrate predator in dry, low-elevation grasslands in the Okanagan and Thompson valleys, especially where the soils are gravelly. Most specimen and photograph localities lie within the Antelope-brush/ Needle-and-thread Grass plant community. This is a nationally recognized threatened habitat; among the most pressing threats is the fact that the habitat is used as an indicator of potentially high grape crop production and is therefore targeted by the wine industry for development (COSEWIC 2010). See **THREATS AND LIMITING FACTORS**. The Okanagan Efferia is one of the more distinctive and recognizable rare invertebrates representative of the ecosystem and some other grasslands in the region, which support many other rare, at-risk invertebrates (Cannings and Cannings 1995; Schluter *et al.* 1995; Cannings 2006; COSEWIC 2010). It belongs to a diverse genus, especially important in western North America, and is the rarest of seven BC species of *Efferia* at the northern limit of the distribution of the genus.

DISTRIBUTION

Global range

The Okanagan Efferia is known only from Canada (Figure 3), but the range may include at least parts of adjacent Washington State where similar habitat occurs. However, it must be rare, if it lives there. During the preparation for his taxonomic revision of *Efferia* in North America, Wilcox (1966) amassed large numbers of *Efferia* specimens from American collections. In addition, from the 1930s to the 1970s, he and his many colleagues collected extensively over much of the western US, including much of eastern Washington and Oregon, where the Okanagan Efferia might be expected to occur. It was not found; otherwise Wilcox would have described it, just as he did for 30 other *Efferia* species (Wilcox 1966). This collecting occurred, too, when Antelope-brush habitat was more abundant and widespread in the region. Eric Fisher (pers. comm. 1988) never found the species in the western US during many years of collecting robber flies.

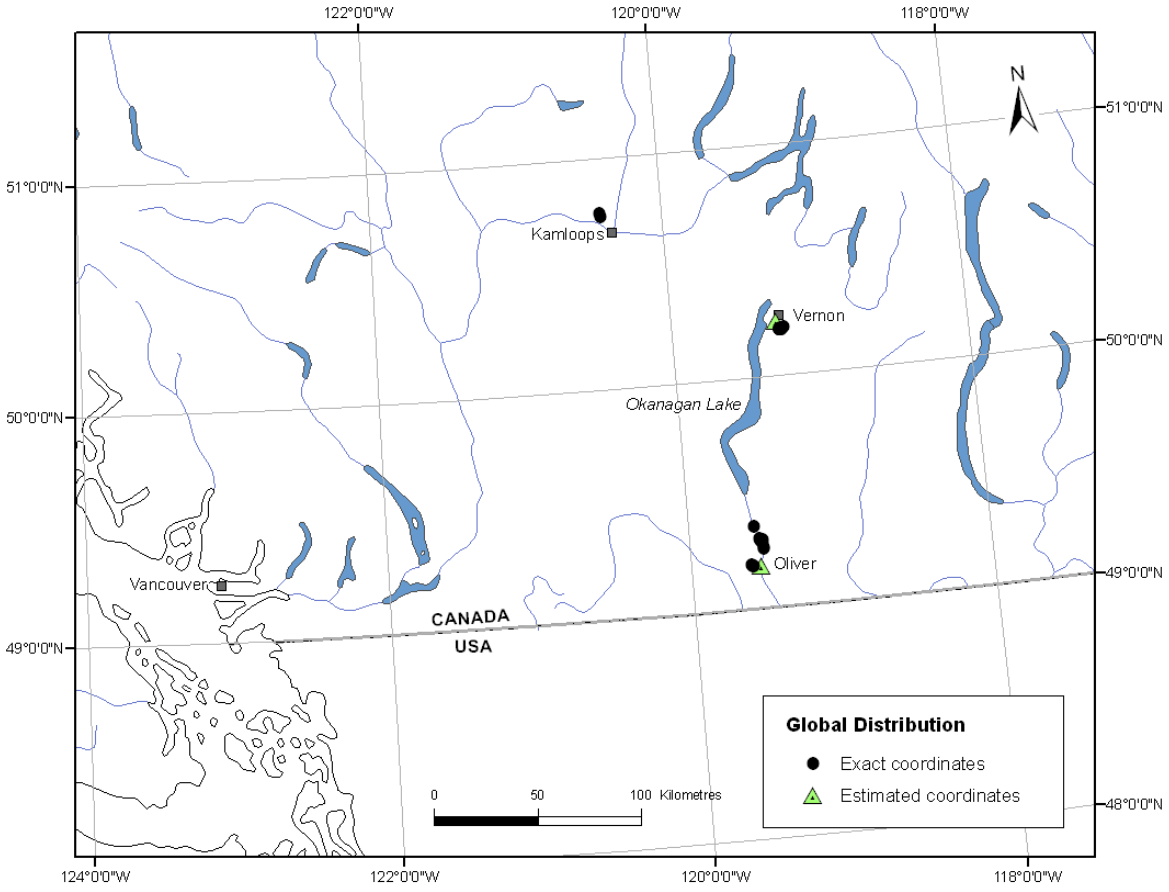

Figure 3. Global and Canadian distribution of Okanagan Efferia. The three main areas of distribution—Okanagan Falls-Oliver, Vernon and Kamloops—are mapped separately in Figures 4, 5 and 6, respectively.

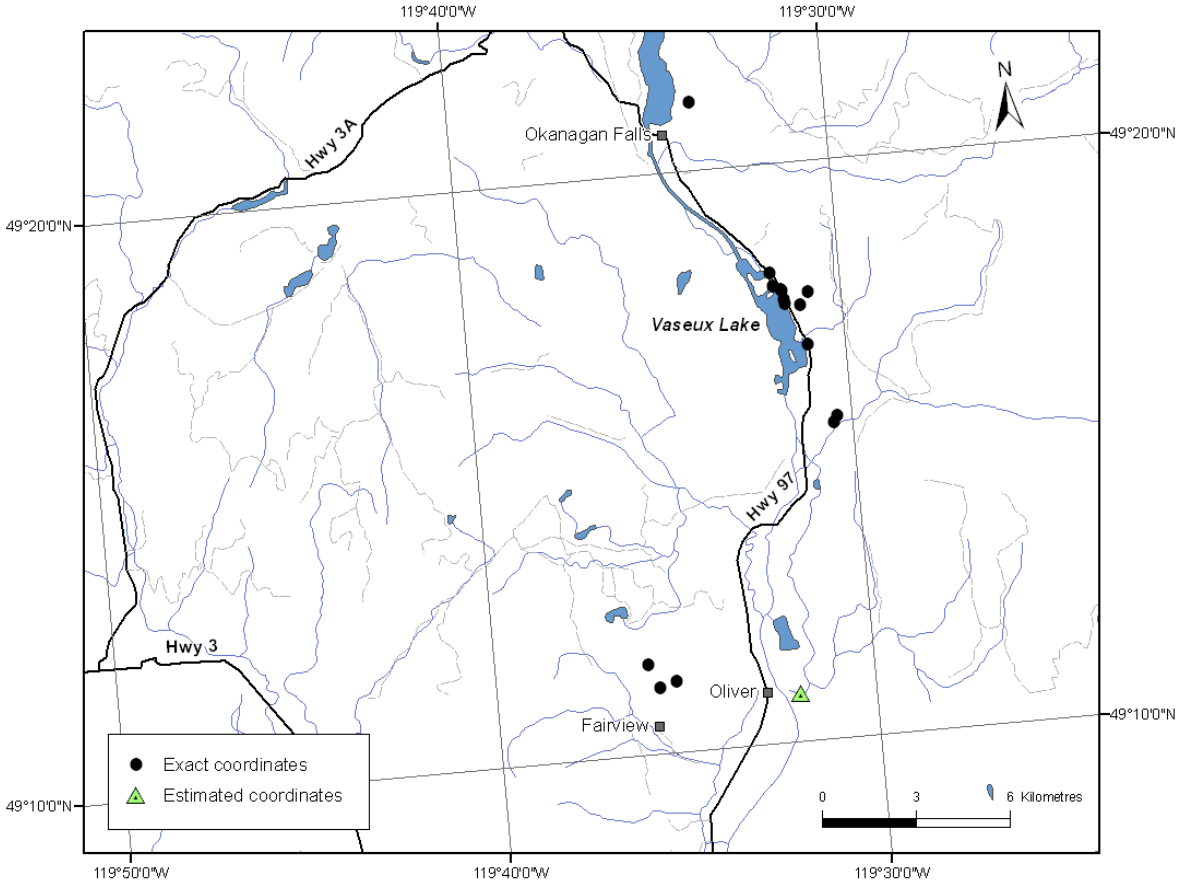

Figure 4. Known distribution of Okanagan Efferia in Canada: Okanagan Falls/Oliver, BC region.

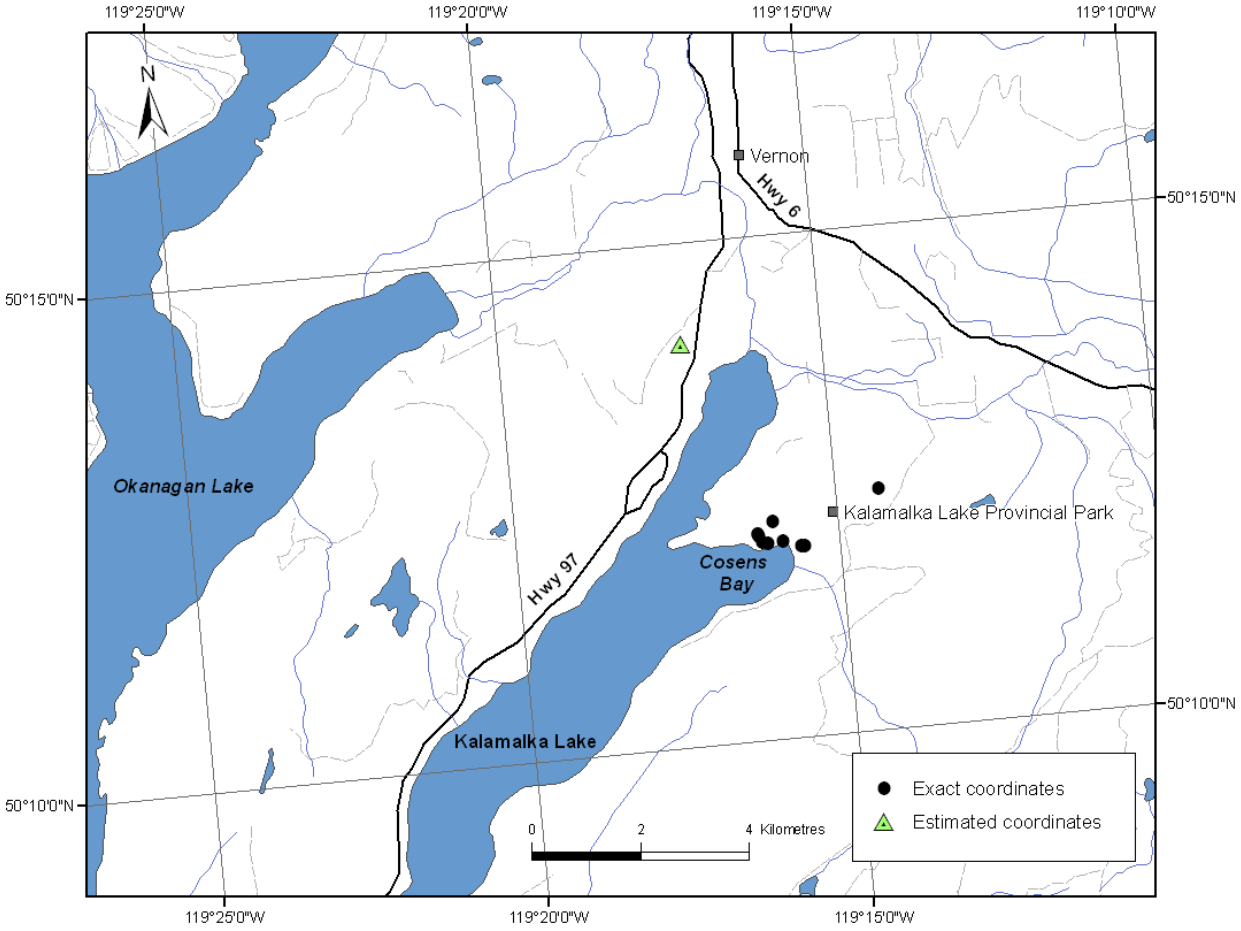

Figure 5. Known distribution of Okanagan Efferia in Canada: Vernon, BC region.

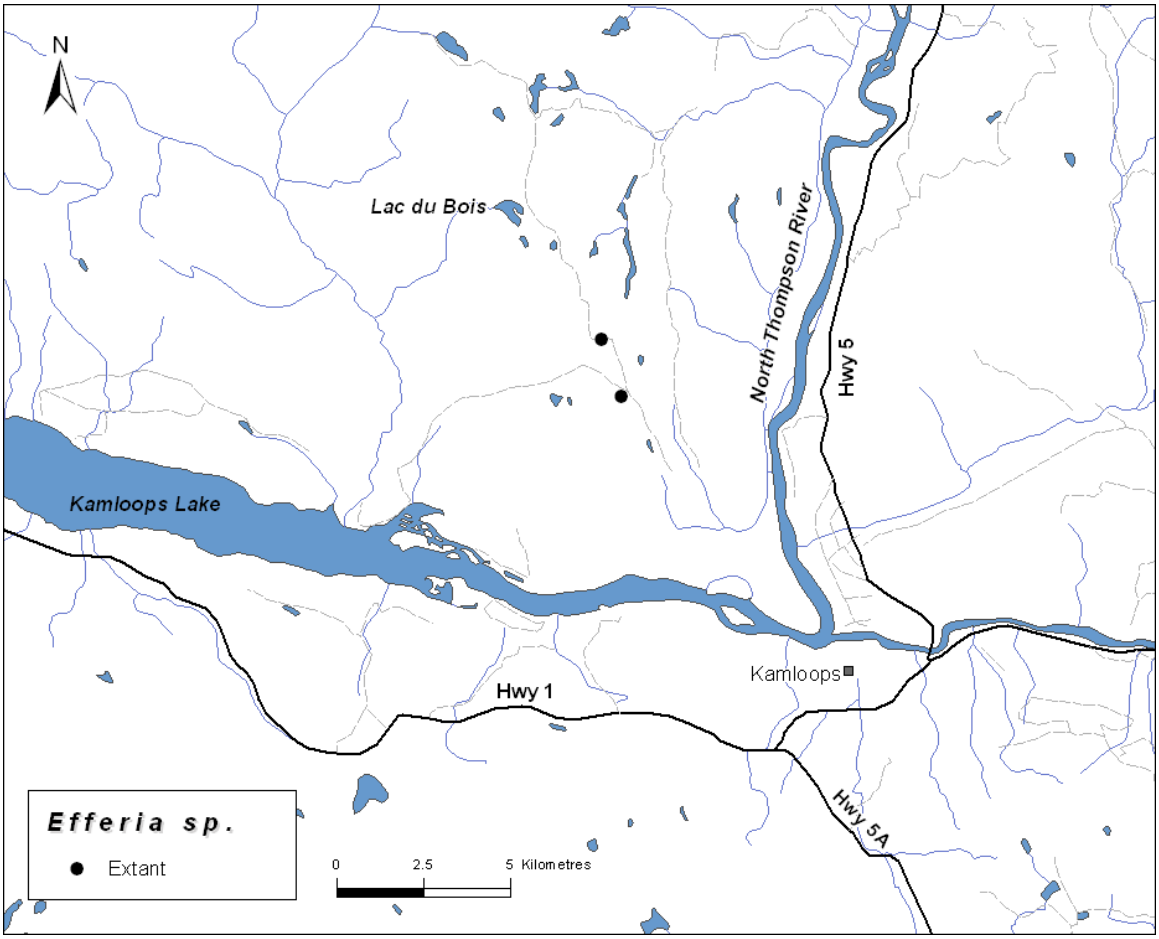

Figure 6. Known distribution of Okanagan Efferia in Canada: Kamloops, BC region.

Canadian range

The Canadian range of the Okanagan Efferia is the global range of the species. The Okanagan Efferia is recorded only from BC in the Okanagan and Thompson valleys—the Oliver, Vaseux Lake, Okanagan Falls, Vernon and Kamloops areas (Figures 3-6, Table 1). It is patchily and rarely distributed within its area of occurrence, and is apparently largely restricted to grasslands dominated by *Pseudoroegneria spicata* (Pursh) Á. Löve (Bluebunch Wheatgrass). This habitat occurs mostly at low elevations in the region but is much more widespread than the known distribution of the fly. Some grassland sites where the Okanagan Efferia has not been found during its flight period are shown in Figure 7. Most of the records are from the southern part of the fly's range, south of Penticton. These are areas where *Purshia tridentata* (Pursh) DC (Antelope-brush) is dominant in steppe associations on sandy and gravelly soils. Where the species lives north of this, as far north as the Thompson Valley at Kamloops, Antelope-brush does not grow. See also **HABITAT** section below.

A convex polygon around all known collection sites produces an extent of occurrence (EO) for the Okanagan Efferia of 5865 km². The 2 km x 2 km grid calculation gives a total of 10 grid squares and 40 km² for the index of area of occupancy (IAO), based on three areas: Kamloops (2 grid squares = 8 km²), Vernon (2 grid squares = 8 km²) and Okanagan Falls-Oliver (6 grid squares = 24 km²). A calculation using 1 km x 1 km grids gives 2 grid squares (2 km²) at Kamloops, 4 grid squares (4 km²) at Vernon and 8 grid squares (8 km²) at Okanagan falls-Oliver, for a total of 14 grid squares and 14 km². The number of grid squares in these calculations is based on a fixed grid system used by the COSEWIC Secretariat and not on the method of shifting grids to minimize grid square counts. The accuracy of a shifting grid calculation is still not established, nor is it yet approved by COSEWIC (Wu pers. comm. 2010).

The 2 km x 2 km grid squares covering the known distribution of the Okanagan Efferia mostly consist of adequate habitat for the species except for just over 1.5 km² of water at Vaseux Lake. Thus, the biological area of occupancy is probably close to the IAO.

The calculation of the number of locations in the northern part of the range poses few problems. There are two locations, separated by about 100 km of mostly unsuitable habitat. All threats except general, long-term ones such as climate warming, would act on each location independently. The two sites in the Lac du Bois Grasslands Protected Area near Kamloops (Figures 6, 8) are about 1.5 km apart in uninterrupted grassland and are considered one location. Likewise, at Kalamalka Lake Provincial Park at Vernon (Figure 9), the distance between the most westerly and easterly collections is about 2.7 km (Figure 5); the suitable habitat is continuous and the records fall within a single location. Both these locations are in provincially protected areas and presumably cannot be harmed by development of the land. Although one might expect provincial parks would protect against habitat damage by off-road vehicles, parks staff is having difficulty regulating such vehicles within parks in the range of the robber fly. Those parks should not be considered free from this threat (D. Fraser pers. comm. 2011). A single catastrophic wild fire or habitat degradation by introduced weeds could affect all the sites in each of these two locations.

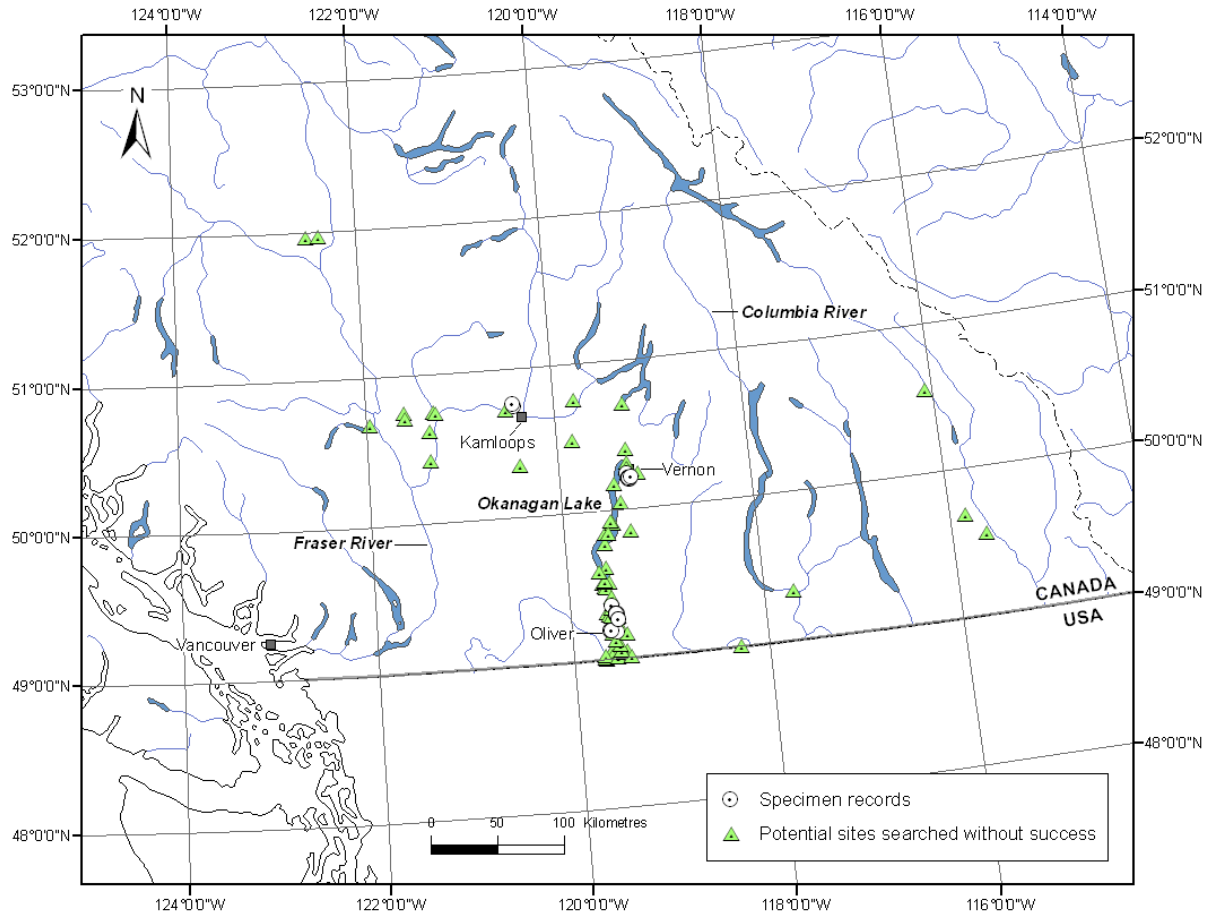

Figure 7. Distribution of Okanagan Efferia. Potential sites that have been examined but where the species has not been found are indicated (see Table 2).

Figure 8. Lac du Bois Grassland Protected Area, Kamloops, BC. View east from 50.76286ºN 120.42461ºW (780 m), 31 May 2010. *Pseudoroegneria spicata, Hesperostipa comata* and other grasses with scattered *Artemisia tridentata* shrubs. Photo: Robert A. Cannings.

Figure 9. Okanagan Efferia habitat. Kalamalka Lake Provincial Park, Vernon, BC. View southeast to Cosens Bay from 50.19936ºN 119.26883ºW (454m), 30 May 2010. *Pseudoroegneria spicata* grassland with *Balsamorhiza sagittata* (large leaves) and the invasive, introduced *Potentilla recta* (bright green). Photo: Robert A. Cannings.

The sites at Oliver (Oliver Mountain (Figure 10) and west of the Fairview-White Lake Road) are close together (centre location is 0.67 km from the eastern site and 0.8 km from the western one) and linked by mostly appropriate habitat except for the roadway that separates the two western ones from the Oliver Mountain site. This must be considered one location, but it is clearly separate from the other known sites on the east side of the Valley (Figure 4). All the latter range between Vaseux Creek (Kennedy property) and Vaseux Lake east cliffs (Figure 11) in the south and the Thomas Ranch Nature Trust property at Okanagan Falls in the north. The two southerly sites are considered one location. Both are protected areas linked over 4 km of suitable habitat by other protected areas, mainly the Vaseux-Bighorn National Wildlife Area. No threats of development pertain here, although a significant wild fire could sweep through the whole area. The Thomas property is about 6.7 km north of Vaseux lake and the two are separated by much private property, mostly cultivated as vineyards (Figure 12), as well as the suburban and industrial areas of eastern Okanagan Falls. There is some Antelope-brush steppe between the two locations, but the great extent of the intervening modified habitat suggests the threats to each are separate. In summary, the Okanagan Efferia is known from five locations (28 individual collection sites).

There is strong circumstantial evidence that Okanagan Efferia does not occupy large expanses of Bluebunch Wheatgrass habitat in BC's southern valleys where the soils are predominantly fine loams, sands and silts and where the main expanses of grassland are *Artemisia tridentata* steppe. Such grasslands occur in the White Lake basin, at Chopaka (Figure 13) and Richter Pass, on the Okanagan Lake benches, on slopes from Kelowna north to southern Kalamalka Lake, and on the sage-dominated silts in the lower South Thompson Valley west of Kamloops to Ashcroft and Cache Creek—none of these sites have produced Okanagan Efferia records despite extensive search effort. Neither have the sandy terraces east of Osoyoos Lake or the moister grasslands on the Nicola and Chilcotin plateaus. Grasslands east of the Okanagan Valley in the Boundary and Kootenay regions, although much less thoroughly collected than the Okanagan and Thompson valleys, have also not yielded specimens (Figure 7, Table 2).

At this time no Aboriginal Traditional Knowledge (ATK) is available for the Okanagan Efferia.

Search effort

The range of the Okanagan Efferia*,* especially that part in the Okanagan Valley, coincides with an area famous for its unusually diverse insect fauna. Many rare species occur here; most of these are Great Basin taxa reaching the northern extent of their range, making them special in Canada (Cannings and Cannings 1995; Cannings 2006). Thus, the area is a popular collecting ground for both professional and amateur entomologists. Robber flies have been collected and studied here for decades and the fauna of the family in the Okanagan is perhaps better known than anywhere else in the province.

General surveys of robber flies and other grassland insects have been conducted by the Royal BC Museum and the Spencer Entomological Collection (UBC) since the late 1960s, but especially since 1980. For example, Cannings (1989) studied the robber flies of a *Festuca* grassland at Pentiction (Figure 14) and Blades and Maier (1996) inventoried arthropods near Osoyoos for the South Okanagan Critical Areas Program. Much of this activity has resulted in large amounts of negative data with respect to the absence of the Okanagan Efferia from particular localities and habitat types (Figure 7). A few of these collecting events are included in Table 2, which outlines localities where the Okanagan Efferia has not been found, to help delineate the distribution pattern of the fly.

It is no surprise that the first records of the Okanagan Efferia in the South Okanagan Valley (1924-1959) were collected by entomologists (P.N. Vroom, R. Madge, R.E. Leech) hired by the Canadian National Collection in Ottawa during surveys of this special Canadian region. The specimens remained in that collection, unidentified, for several decades, where they were subsequently discovered by R.A. Cannings in the early 1980s. They were mixed with those of the similar *Efferia coulei*, a species found in the same region at the same season. The predominantly brown colouration and golden postocular bristles of these specimens contrasted with the grey colour and black bristles of *E. coulei*, making the former species stand out as different. Further examination of the specimens revealed other important diagnostic characteristics. Being familiar with one of the original collection localities of the species (Vaseux Lake), Cannings determined the fly's preferred habitat and, subsequently, more specimens were collected at Vaseux Lake and other localities.

From 1980 until 2008, several collectors searched for the Okanagan Efferia (Tables 1-3) in the Richter Pass, White Lake and other areas, but especially at Vaseux Lake and Kalamalka Lake Park. Only the latter two areas produced significant numbers of specimens. These can be considered targeted searches, although search effort was not calculated during most of them. Vaseux Lake was visited in 1980 (Rob Cannings – one visit; 1983 (Syd Cannings – 1 visit; Graham Sunderland – 1 visit); 1984 (Rob Cannings – 2 visits; Syd Cannings – 2 visits; Richard Cannings – 2 visits); 1987 (Rob Cannings – 1 visit; Syd Cannings – 1 visit). Approximately 11 person-hours were spent on these searches, if an average of one hour per visit is used. Specimens were collected at Kalamalka Lake Park in 1985 (Cris Guppy – 1 visit); 1987 (Rob Cannings – 3 visits; 1991 (Rob Cannings – 1 visit); 1995 (Rob Cannings – 1 visit; Syd Cannings – 2 visits); 2008 (Leah Ramsay –1 visit). At an estimated average of three hours per visit, these searches totaled roughly 27 person-hours. Between 1980 and 2006, in the White Lake, Richter Pass, Osoyoos Lake and other areas (Table 2), 43 person-hours (based on an estimate of one hour per visit) failed to find any specimens.

In 2009, Dawn Marks and Vicky Young of the BC Conservation Corps undertook a few surveys as part of their summer work (Marks and Young 2009). Along with Orville Dyer and Leah Ramsay (BC Ministry of Environment), from 15 May to 12 June they examined four sites from Okanagan Falls to Oliver (Table 2), looking for several species, including the Okanagan Efferia. Although the person-hour totals (41.5) are high, these biologists were also searching for other targeted species of vertebrates and invertebrates and were not spending all the time focused on the Okanagan Efferia. They found no specimens of the species. However, Marks and Young, along with Rob Cannings, collected specimens of Okanagan Efferia during a survey at Vaseux Creek on 11 May 2009.

In 2010, from 17-22 May (Okanagan Falls, Vaseux Lake, Oliver, Chopaka and Penticton areas) and 30 May-5 June (Westbank, Kelowna, Vernon and Kamloops regions), Rob Cannings made targeted searches for the Okanagan Efferia. Sampling site selection for these surveys was based on historical records of the Okanagan Efferia and other robber flies with similar habitat preferences and flight periods—*Cyrtopogon inversus* Curran, *C. montanus* Loew and *C. willistoni* Curran), *Efferia albibarbis* (Macquart), *E. benedicti* (Bromley), *E. coulei* Wilcox, *E. staminea* (Williston), *Machimus occidentalis* (Hine), *Stenopogon inquinatus* Loew, *S. rufibarbis* Bromley. In addition, an examination was made of potential habitat in the field and on Google Earth within the fly's assumed range that appeared to have similar characteristics to known occupied sites. Sites were chosen for both assumed positive (e.g., rocky, gravelly sites with or without *Purshia* or *Balsamorhiza*) (Figures 9, 10, 15) and negative (e.g., fine loam/ silt or fine sand soils, *Artemisia* or *Purshia* dominant sites) (Figures 13, 16) attributes. Negative data, although not proof of absence of the species, help create and support useful assumptions about distribution limits.

During the 2010 surveys, Cannings was unable to get permission to collect on Indian reserves in the Okanagan. Reserves may still contain potential sites for the Okanagan Efferia, especially in the Osoyoos (Inkameep), Penticton and Vernon Reserves, but these are declining due to conversion to wineries. None of the present locations fall within the reserves.

The 2010 surveys found the target species at eight sites. One person sampling for seven hours collected 15 specimens (Table 3). Flies were not found at 44 sites after 32 person-hours of searching.

Table 3. Okanagan Efferia: successful 2010 collections with sampling effort.

#/ sex	Location	°N Lat	°W Long	Elev m	Date	Collector(s)	Person-hours
1 ♀	BC, Kamloops, Batchelor Hills, Lac du Bois Rd, SE Grace L	50.76286	120.42461	780	31.v.2010	R.A. Cannings	0.5
1♂, 1♀*	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	49.18592	119.59494	513	19.v.2010	R.A. Cannings	0.5
1♂, 1♀*	BC, Oliver, Fairview-White Lake Rd, 1.3 km N Fairview jct.	49.19286	119.59931	634	19.v.2010	R.A. Cannings	0.5
4♂*, 1♀	BC, Oliver, Fairview-White Lake Rd, Oliver Mountain area	49.18749	119.58737	535	19.v.2010	R.A. Cannings	0.5
1♂, 1♀	BC, Vaseux Lake, E side below cliffs, Nature Trust property	49.29435	119.52545	365	17.v.2010	R.A. Cannings	2.0
1 ♂	BC, Vaseux Lake, E side below cliffs, N of McIntyre Cr Rd, Nature Trust property	49.30211	119.53054	351	17.v.2010	R.A. Cannings	0.5
1 ♀	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, S-facing slope to NW	50.20042	119.27083	473	30.v.2010	R.A. Cannings	1.5
1 ♂*	BC, Vernon, Kalamalka Lake Prov. Park, Cosens Bay, Cosens Bay Trail to E	50.20658	119.23886	611	01.vi.2010	R.A. Cannings	1.0

In summary, the Okanagan Efferia is recorded from 28 separate sites with different geographical coordinates. These coalesce into five locations when threats and connectivity are examined. The amount of potential habitat is large. The main habitat for the Okanagan Efferia, and the only habitat in which the species has been found in the South Okanagan—the *Purshia tridentata–Hesperostipa comata* ecosystem—consisted of 3217 ha in 2008 (COSEWIC 2010, Iverson 2010). This is mostly not to be considered potential habitat because of its poor condition and because Okanagan Efferia is absent from much what appears to be likely habitat. In the Central and North Okanagan and Thompson regions where *Purshia tridentata* does not occur, the fly is known at only two sites in a large area of Big Sagebrush shrub-steppe and other types of grasslands, the extent and suitability of which is difficult to quantify. In the South Okanagan and Similkameen, however, there were 8266 ha of this habitat remaining in 2003 (Lea 2008). Although less than 1% of this ecosystem in the South Okanagan and Similkameen valleys has been examined, no Okanagan Efferia specimens have ever been collected there and the fly is thought to be absent from this habitat. The Okanagan Efferia may occur at more places in its range, but no more than 0-5 would be anticipated and these would likely be on reserve lands which have not been accessible for the last decade and which are experiencing loss of natural habitat.

HABITAT

Habitat requirements

All of the seven species of *Efferia* known in British Columbia live in Intermontane grasslands of the region, the Pacific Northwest Bunchgrass type of Tisdale (1982). The character and composition of these grasslands vary considerably with soil, altitude and aspect. The Okanagan Efferia is an inhabitant primarily of the Lower Grasslands as described by Nicholson (1982) and Tisdale (1982), normally dominated by Bluebunch Wheatgrass and Big Sagebrush (*Artemisia tridentata* (Nutt.)) (Figure 13).

However, most of the known localities of the Okanagan Efferia are in the southern Okanagan Valley south of Penticton on gravelly and sandy soils where these Lower Grasslands are represented by a shrub steppe dominated by Antelope-brush rather than *Artemisia* (the dominant community here is *Purshia tridentata–Hesperostipa comata* (Antelope-brush–Needle-and-thread Grass) (Figures 10, 16). Antelope-brush plant communities mainly occur in the low elevation valley bottoms (280-760 m) in xeric sites of the driest variant of the Bunchgrass Biogeoclimatic Zone, BGxh1 (Very Hot Dry Bunchgrass). Some Antelope-brush plant communities also occur at the margins of the Ponderosa Pine Biogeoclimatic zone, PPxh1subzone (Very Hot Dry Ponderosa Pine). *Artemisia* typically predominates in sites that have a capping of very fine sands and silts; these are considered a different ecosystem (Iverson 2010).

Figure 10. Okanagan Efferia habitat. Oliver, BC. View south from 49.18778ºN 119.58611ºW (535 m), 19 May 2010. *Purshia tridentata / Pseudoroegneria spicata* habitat; *Pinus ponderosa* stand in middle distance. Photo: Robert A. Cannings.

The *Purshia tridentata–Hesperostipa comata* community characteristically has a 10-30% cover of Antelope-brush, with lesser amounts of Big Sagebrush (*Artemisia tridentata*) and Rabbitbrush (*Ericameria nauseosa* (Pall. ex Pursh) G.L. Nesom & Baird). The herb layer is variable but is typically dominated by the grasses *Hesperostipa comata* and *Sporobolus cryptandrus* (Torr.) A. Gray. The moss layer may contain a low percent cover of the moss *Tortula ruralis* (Hedw.) Gaertn. Meyer, & Scherb. The climax community normally has a moderate cover of the grasses *Pseudoroegneria spicata* and *Koeleria macrantha* (Ledeb.) Schult. (Lloyd *et al.* 2000) and the cryptogam crust should consist of a variety of lichen and moss species, be well developed, and provide moderate to continuous ground cover. Lloyd *et al.* (2000) and Dyer and Lea (2003) provide more information on this habitat in the Okanagan.

The low-elevation grassland on the east side of Vaseux Lake is an example of the *Purshia tridentata–Hesperostipa comata* community. One site where the Okanagan Efferia occurs (Figure 15) has a scattered shrub layer dominated by *Purshia tridentata* with *Rhus glabra* L., *Philadelphus lewisii* Pursh and *Amelanchier alnifolia* Nutt. The herb layer is predominantly *Pseudoroegneria spicata* and *Aristida purpurea* Nutt., with lesser amounts of *Erigeron glabellus* Nutt., *Selaginella wallacei* Hieron., *Hesperostipa comata* (Trin. & Rupr.) Barkw, *Panicum scribnerianum* Nash and *Agoseris glauca* (Pursh) Raf. There are considerable numbers of weedy species such as *Centaurea* sp., *Bromus tectorum* L. and *Vulpia octoflora* (Walt.) Rydb. The bryophyte and lichen layer is absent. Typical species present here but absent from the Penticton stand (see below), in addition to those listed above, include *Gaillardia aristata* Pursh, *Astragalus purshii* Dougl. and *Crepis atrabarba* Heller.

In this region, on many grasslands with finer soils, where *Pseudoroegneria* and *Artemisia tridentata* predominate, the Okanagan Efferia is absent. Extensive grasslands around White Lake, Chopaka (Figure 13) and Richter Pass, the Okanagan Lake benches from Penticton to Kelowna, grasslands north of Kelowna and the sage-dominated silts in the lower South Thompson Valley west of Kamloops to Ashcroft and Cache Creek have not produced any specimens. These habitats are the home of *Efferia benedicti* Bromley from June to August and *E. harveyi* Hine from August to October. Interestingly, there are also no records from the sandy *Purshia tridentata* steppe on the east side of Osoyoos Lake (Figure 16), despite considerable fly collecting there over many years. The typical species there is *E. albibarbis* (Macquart). The grasslands of the Rocky Mountain Trench (upper Kootenay and Columbia River valleys), dominated by *Pseudoroegneria spicata* and *Festuca* species with *Purshia* steppe in many southern sites, support *E. frewingi* Wilcox, a western Great Plains species at the northern edge of its range.

Records of the Okanagan Efferia at the northern edge of its range at Kamloops (Figure 17) and Vernon come from *Pseudoroegneria* habitat, but *Purshia* does not grow this far north. At Cosens Bay, Kalamalka Lake Park sites (Figure 9), *Pseudoroegneria* predominates but other grasses include *Stipa nelsonii* Scribn., *Koeleria macrantha* (Ledeb.) Schult., *Poa canbyi* (Scribn.) Howell and *Bromus tectorum* L. Forbs such as *Balsamorhiza sagitatta* (Pursh) Nutt. and the invasive *Potentilla recta* L. are common. Big Sagebrush can be uncommon or absent in the northern sites where the Okanagan Efferia has been found.

In contrast, the other *E. arida* group species in the region, *E. coulei*, is much more widespread, occurring as far north as the Chilcotin Plateau (about 52°N, 200 km NW of Kamloops). This species also is a spring flier, but prefers grassland types classed as Middle Grasslands (characterized by grasses such as *Festuca campestris* Rydb. which are, in general, more extensive in BC than the Lower Grasslands and occupy somewhat cooler, moister situations (Nicholson *et al.* 1982, Tisdale 1982). On the West Bench, Penticton (Figure 14), where *E. coulei* is common and the only *Efferia* in spring (Cannings 1989), the herb layer is dominated by *Festuca campestris* and a low coverage of Rabbitbrush. Secondary species are *Vulpia octoflora*, *Bromus tectorum*, *Sporobolus cryptandrus* (Torr.) Gray, and *Phlox longifolia* Nutt. There is a well-developed bryophyte and lichen layer consisting primarily of *Cladonia, Peltigera* and *Pohlia*. Species here but absent from the Vaseux Lake site where the Okanagan Efferia is found include *Lewisia rediviva* Pursh, *Fritillaria pudica* (Pursh) Spreng., *Ranunculus glaberrimus* Hook. and *Geum triflorum* Pursh. This habitat is apparently not suitable for the Okanagan Efferia.

Efferia larvae live in the soil (Lavigne and Holland 1969). The Vaseux Lake site habitat of Okanagan Efferia is an alluvial terrace at the foot of metamorphic cliffs; the subsoil is a stony, gravelly alluvium (Figures 11, 15). The surface soil is coarser and with a higher percentage of organics and salts and with a lower moisture-holding capability than the Penticton site (*E. coulei*), which is a deep, medium-textured soil (Figure 14). Thus, soil consistency may be a factor in the presence or absence of the Okanagan Efferia 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 Park (sandy to heavy loam, 8-17% gravel). The species is absent from sites where gravels are less common—West Bench, Penticton (loam to fine sandy loam, 0-1%), Chopaka (heavy sandy loam and clay, 5%) and Haynes Lease, Osoyoos (loamy sand, 3%) (B. Maxwell pers. comm. 1989). Soil types in the Okanagan Valley are extremely diverse and patchy (Wittneben 1986). This variability may play a role in the patchiness of the distribution of the Okanagan Efferia.

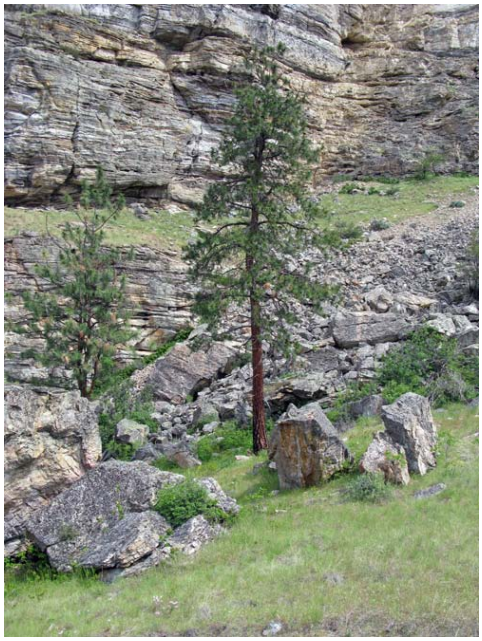

Figure 11. Okanagan Efferia habitat, Vaseux Lake, BC. View east to metamorphic cliffs east of lake from 49.30236ºN 119.52956ºW (351 m), 17 May 2010. *Pseudoroegneria spicata, Hesperostipa comata, Sporobolus cryptandrus* and *Phlox longifolia* are common. *Pinus ponderosa* tree in centre; most bright green shrubs are *Philadelphus lewisii*. Photo: Robert A. Cannings.

Habitat trends

The grasslands that support the Okanagan Efferia are limited in area and have been, and continue to be, degraded. They have received intense attention from conservation programs. In the Okanagan Valley 33% of the sagebrush steppe ecosystem has been destroyed in historical times for agriculture or development (Figures 12, 17). This ecosystem, which provides habitat for 23 federally listed species, is a priority 1 under goal 1. This means that it is considered of global importance and is given the highest priority for conservation efforts based on its vulnerable conservation status, trends in habitat loss, the threats it faces, and other factors (BC Conservation Framework 2009). The Antelope-brush–Needle-and-thread Grass ecosystem in the South Okanagan, where most of the sites for the Okanagan Efferia occur, is assigned the highest priority under the provincial Conservation Framework goal with a G2 Global status and S1 Provincial status. The ecosystem supports one of the highest densities of species at risk for any ecosystem in BC (Dyer and Lea 2003, Iverson 2010); 22% of all the province's endangered and threatened vertebrates live here (Schluter *et al.* 1995). Perhaps the best known invertebrate in this habitat, the Behr's Hairstreak (*Satyrium behrii* W.H. Edwards) serves as a model for tracking changes in the environment (COSEWIC 2010). Other terrestrial arthropods, however, such as the flies *Apiocera barri* Cazier (Apioceridae) and *Nemomydas pantherinus* (Gerstãcker) (Mydidae) are extremely rare inhabitants of the same grasslands that the Okanagan Efferia occupies, and are even more poorly known (Cannings 2006).

Figure 12. Vineyards, Okanagan Falls, BC. View south to Vaseux Lake from about 49.5205ºN 119. 5333ºW (440 m), 19 May 2010. Agricultural development, especially wine production, is probably the greatest present threat to Okanagan Efferia habitat. Until recently, this view looked over Antelope-brush steppe. Photo: Robert A. Cannings.

Figure 13. *Artemisia tridentata* (Big Sage) steppe, Chopaka, BC. View north up Similkameen Valley toward Keremeos from 49.01272°N 119.67653°W (518 m), 21 May 2010. Okanagan Efferia is not recorded in this type of habitat in the South Okanagan–Similkameen. Photo: Robert A. Cannings.

Figure 14. Penticton Indian Reserve, West Bench, Penticton, BC. View southeast from 49.49001ºN 119.62699ºW (420 m), 18 May 2010. Badly overgrazed *Festuca campestris* grassland with *Bromus tectorum*, *Sporobolus cryptandrus* and *Phlox longifolia*; the grey shrubs are *Ericameria nauseosa.* Okanagan Efferia does not occur here, but at the same time of year that it flies elsewhere, the closely related *Efferia coulei* is common in this habitat. Photo: Robert A. Cannings.

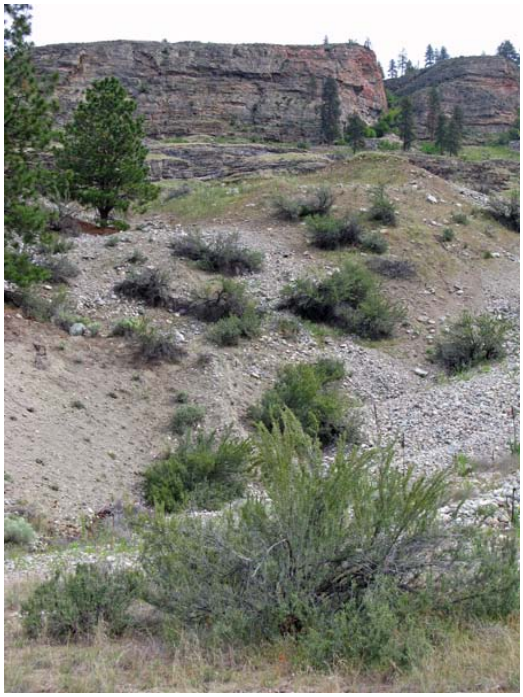

Figure 15. Okanagan Efferia habitat, Vaseux Lake, BC. View north from 49.29417ºN 119.52422ºW (360 m), 17 May 2010. Disturbed *Pseudoroegneria spicata/ Hesperostipa comata* grassland with *Purshia tridentata* shrubs on gravelly soil, a substrate often present at sites supporting Okanagan Efferia. Much of this site was burned in 2003. Photo: Robert A. Cannings.

Despite attempts, some successful, to conserve them, many BC grassland areas have been eliminated or reduced in area and condition by an expanding human population. Most habitat reduction is owing to agricultural (Figure 12), housing (Figure 17), recreational and industrial development; changing fire regimes; disturbance by livestock; and the introduction and spread of invasive plants (Figure 9) (Dyer and Lea 2003, Cannings 2006, Lea 2008, Iverson 2010). Iverson (2010) derived condition classes (excellent, good, fair, poor) from these habitat threats and reported that of 3217 ha of the *Purshia tridentata–Hesperostipa comata* ecosystem remaining in BC in 2008, only about 7.1% remains in good to excellent condition and 71.3% is only in fair condition. Trends in extent of the ecosystem show continued loss: 1800 (9863 ha), 1938 (7235 ha), 1995 (4376 ha), 2003 (3299 ha) and 2008 (3217 ha)—a loss of 67.5% of the original area and 40.7% since 1938 (Iverson 2010). From 1995-2003, 1077 ha of *Purshia tridentata–Hesperostipa comata* habitat was lost to habitat conversion at an average rate of 134.6 ha/year (Iverson 2010) and the rate peaked at 220 ha per year between 2001 and 2002 (COSEWIC 2010) during a period of extensive vineyard development by the Osoyoos Indian Band. Development slowed from 2003 to 2008 when 82 ha of habitat were lost to cultivation (Iverson 2010). These data show the latest known 10-year trend (1998-2008) to be a decline of 21%. Of the 3217 ha remaining in 2008, about 17.4% of the ecosystem is protected; 56.2% is on Indian reserves, 20.0% is in private hands and 6.4% is on unprotected provincial land (Iverson 2010).

Forest and grassland fires are natural ecosystem processes in the southern BC Interior, but fire suppression in grassland habitats since European settlement has reduced the natural effects of fires in the environment. The resulting fuel build-up and the increase in young trees in grasslands mean that the effects of present and future fires are probably more severe than they were historically (Iverson 2010). The extensive fires in the Okanagan Valley in 2003 burned 61,776 ha (COSEWIC 2010). Much of the grassland along the cliffs on the northeast side of Vaseux Lake was burned and the population of Okanagan Efferia there may have been affected. The population still survives but the data are not sufficient to indicate the state of the population's health in this degraded habitat. See **Fluctuations and trends.**

Grasslands inhabited by the Okanagan Efferia are, in many places, impacted by introduced invasive plants that change the character of the environment. For example, the Vaseux Lake site has extensive populations of *Bromus tectorum* L. (Cheatgrass), *Centaurea diffusa* Lam. (Diffuse Knapweed) and Dalmatian Toadflax (*Linaria genistifolia* ssp. *dalmatica* (L.) Maire & Petitm.). The South Okanagan–Similkameen Invasive Plant Committee now tracks over 45 species of invasive alien plants (Lea 2008). Cheatgrass was first recorded in Interior grasslands at Summerland in 1912 and is now the most widespread weed in the South Okanagan (Lea 2008). It predominates the grass-forb communities of more than half the sagebrush region in the western United States, replacing native bunchgrasses (Rich 1996).

Disturbance of the soil by cattle or all-terrain vehicles encourages the spread of these plants. The accumulated plant debris increases the fuel load in grasslands and helps support severe fires (Iverson 2010) that may destroy robber fly larvae and pupae, prey insects, native plants required for oviposition, and their seeds. Cheatgrass often creates a more continuous ground cover that is denser than that of native bunchgrasses and can more readily spread fire (Lea 2008). Even in the absence of cattle grazing and other significant disturbance, the Sulphur Cinquefoil has expanded considerably in the bare spaces between the bunches of Bluebunch Wheatgrass supporting the Okanagan Efferia in Kalamalka Lake Park near Vernon (R.A. Cannings, pers. obs.), the type locality of the fly (Cannings 2011) (Figure 9). Although grazing and motorized vehicle (but not bicycle) use in the grasslands of this park has been absent for several decades, the cryptogamic (microbiotic) crust of lichens, mosses and algae has been damaged in many places and has not recovered. This promotes erosion and weed influx (Schluter *et al.* 1995, Iverson 2004).

It is to be noted that impacts on habitat have an influence on the buffer surrounding all five known locations as well as the conditions within some of those sites.

BIOLOGY

Robber fly larvae and adults are generalist predators of other insects. Prey is grabbed in the adult fly's bristly legs and the prominent proboscis is inserted in the prey's body. Paralyzing, proteolytic saliva is injected and the tissues are dissolved; the resulting fluid is sucked up by the fly.

Little is known about the biology of *Efferia* species in general and the Okanagan Efferia in particular. Most literature on biology of *Efferia* deals with foraging, prey selection and mating behaviour, e.g., Lavigne and Holland (1969) and Dennis *et al*. (1986). Much of the limited information on the biology and ecological relationships within BC of the seven *Efferia* species recorded in the province comes from the experience of the report writer (Cannings 1989, Cannings 2011).

Life cycle and reproduction

Phenology

Thirty-five collection events recording flying Okanagan Efferia adults range from 17 April (1930, Vernon) to 18 June (1991, Vernon, Kalamalka Lake Park). Thirty-one records are from May and two-thirds of all records fall between 15 and 25 May. Both the mean and the mode of the May records are 19 May. Seventeen photographs of different individual flies taken at Oliver by Werner Eigelsreiter (pers. comm. 2010) fall between 24 April (2001) and 30 May (2007); the median date is 16 May.

This flight period is early relative to most other sympatric species of *Efferia* in southern BC grasslands. It flies at about the same time as its *E. arida* group relative, *E. coulei*. These two spring species are replaced in about mid-June by the *E. staminea* group species, *E. benedicti* (Bromley) and *E. staminea* (Williston) and the *E. albibarbis* group species, *E. albibarbis* (Macquart), which are the typical summer species in the region. The two *E. pogonias* group species, *Efferia harveyi* (Hine) and *Efferia frewingi* Wilcox, fly later, from August onwards. The former, the only true autumn species in BC, flies until late October. In BC the latter mostly flies in August; it is typically a Great Plains species and in BC is known only from the Rocky Mountain Trench.

Oviposition

The ovipositor is strongly flattened laterally (Figure 2). *Efferia* species with this type of ovipositor lay their eggs in or on vegetation; those with cylindrical ovipositors lay eggs directly in the soil (Dennis *et al.* 1986). In the Okanagan, at least two species (*E. benedicti* and *E. harveyi*) oviposit in the soil or in cracks in dried cow dung, but Okanagan Efferia females likely do not lay eggs in these places (R.A. Cannings pers. obs.).

On 23 May 1987, at Kalamalka Lake Park, Vernon, females laid eggs in the empty glumes of the previous year's Bluebunch Wheatgrass florets (R.A. Cannings pers. obs.). As far as is known, the fly has never been collected at a site where this grass is absent (Cannings 2011). A reduction in the abundance of this or other grass species with suitable glumes for oviposition may negatively affect the species in a particular location.

Larval development and behaviour

After hatching, the tiny larvae drop from the grass to the soil and begin burrowing. Unlike the wood-dwelling robber fly larvae of species of *Laphria* and *Andrenosoma*, which live in the burrows and eat the larvae and pupae of wood-boring beetles (Wood 1981), *Efferia* larvae presumably make their own burrows as they move through the soil searching for prey. The length of the average burrow is unknown and probably depends upon the distance a larva must travel to find prey.

Like the larvae of the few other soil-dwelling asilids studied (Wood 1981), *Efferia* larvae probably mostly feed on the larvae and pupae of beetles, especially Scarabaeidae. Other recorded prey of asilid larvae include larvae of other Coleoptera families, Hymenoptera and Diptera (including cannibalism) as well as eggs of Orthoptera eggs (Wood 1981). The larvae of two species of *Mallophora* (a genus in the same subfamily as *Efferia*) have been recorded as ectoparasitoids of larval Scarabaeidae (Knutson 1972). In cases of parasitoidism, the robber fly larva likely feeds on a single suitable host larva throughout its development and would not continue to burrow once it settles on a host. In these situations, the burrow of these larval flies would be even more circumscribed than usual.

The larval life of robber flies normally lasts 1 to 2 years. There is no information on *Efferia* development time. Pupation in the Okanagan Efferia would occur in the last spring of development; adults emerge in late April or early May. Adults disappear around mid-June, indicating that life after the larval stage lasts no more than about two months, and probably less.

Foraging

In grasslands, collectors most easily find robber fly species that hunt from the ground along trails or dirt tracks. Not only do such tracks offer the flies clear views of potential flying prey, they provide them maximum exposure to the sun. Most collections of adult Okanagan Efferia have been made in such situations; when disturbed, they fly from the ground with a strong buzzing of wings and land a few metres away and, if they land again on the path, are usually readily located. Where there are no trails, flies are most easily seen when they sit on rocks or pieces of wood. For many species of *Efferia*, foraging flights for prey cover distances of up to 5 metres, but most prey is caught within 1 to 2 metres of a perch (Dennis *et al.* 1986). At the latitude of southern BC in western North America, *Efferia* species evidently always forage for prey or fly after mates from the ground or from objects lying on the ground. Farther south, many species hunt from perches at different levels on vegetation (Dennis *et al*. 1986). This behaviour can be attributed to species partitioning the habitat to avoid competition or, in many hot habitats, to the avoidance of high ground surface temperatures (Dennis *et al.* 1986). See **Physiology and adaptability**.

The adults of Okanagan Efferia have been recorded capturing planthoppers, click beetles, leafcutter and andrenid bees and ants, micromoths, flower flies crane flies and robber flies. See **Interspecific interactions**.

Physiology and adaptability

There are no specific data on the physiology of the Okanagan Efferia.

The Okanagan Efferia is a spring species and probably has a higher tolerance to cool weather than many robber flies that fly in mid-summer. It is more active in the sun than in cloudy conditions, but it flies in cloudy weather if the cover is not heavy and persistent and especially if it is warm. On sunny warm days the flies are active from at least 10:00 to 18:00 PDT. Temperature is perhaps more important than cloud cover. The lowest temperature recorded in collection data for flying activity is 14ºC and the highest is 24ºC at Kalamalka Lake Park on 18 June 1991, the latest date in the season for an observation of the species. By late June adults are no longer present. Activity probably increases with increasing temperature, but the data do not allow a definite statement about this. An upper limit for activity is unknown, but *Efferia* species, in general, are adapted to handle high temperatures. Dennis *et al*. (1986) note that all species of *Efferia* studied by them in Wyoming that forage from the ground moved to vegetation to perch and hunt when the surface temperature reached 40 to 49ºC. These soil surface temperatures probably are seldom, if ever, reached in the range of the Okanagan Efferia.

In discussing the temperature regulation of *Efferia helenae* (Bromley) in Wyoming, Lavigne and Holland (1969) state: “In the early morning, soon after the sun strikes an asilid in its nocturnal location, the asilid warms enough to crawl into an open sunny spot between grass clumps. It flattens against the warm (24-30ºC) ground to gain heat and it presents a full broadside to the sun’s rays. Foraging may begin any time thereafter, depending on the availability of prey.” This behaviour is seen in Okanagan Efferia in Figure 18.

As in many groups of robber flies, the size variation in individuals of both sexes is considerable. In the Okanagan Efferia, body length ranges from about 12 to 20 mm. This is probably owing to differences in individual nutrition as much as genetic variability.

Dispersal and migration

No information is available on dispersal. Significant passive dispersal in the Okanagan Efferia is unlikely. This and other BC species of *Efferia* usually disappear into the lower parts of grass clumps when the wind increases to levels where they have trouble controlling flight and although some may be picked up by the wind, they probably would not be blown any great distance. Anthropogenic dispersal is unlikely as the species is not attracted to, or associated with, humans. Active dispersal is likely over short distances, but despite its size, the Okanagan Efferia usually does not fly far (often only 2 or 3 metres) when it is disturbed from a perch.

For many species of *Efferia*, foraging flights cover distances of up to 5 metres, but most prey is caught within 1 to 2 metres of a perch (Dennis *et al.* 1986). Males of most species studied search for females by making short flights, low to the ground, of up to 6 or 7 metres.

There are no data on how frequently adults might leave a particular patch of habitat or how far they might fly. See **Rescue effect** below.

The known Kamloops population of Okanagan Efferia is about 100 km northwest of the closest population in Vernon (Figure 3). There is little suitable grassland habitat scattered among the forests and mountains that lie between the Thompson and Okanagan valleys. Unless connectivity is improved with grassland expansion because of climate warming, this fragmented distribution probably results in almost no dispersal between these areas. On the other hand, it is easy to believe that the species does live between Okanagan Falls and Vernon, despite present evidence to the contrary. Much grassland habitat between the North and South Okanagan is not suitable for the Okanagan Efferia but some locations seem adequate. The south slopes of Knox Mountain in Kelowna (Figure 19) and the south-facing ridges at Bear Creek across Okanagan Lake are such places. Suitable grasslands in the Okanagan north of Okanagan Falls may not pose as fragmented a picture to Okanagan Efferia as the present data suggest.

Interspecific interactions

Most information regarding the Okanagan Efferia's interactions with other species deals with prey species. Only one specimen of the fly has been captured with prey, a male at Vaseux Lake on 17 May 1987. It had killed a winged *Formica* ant. However, at Oliver, BC, Werner Eigelsreiter (pers. comm. 2010) has photographed them feeding on a variety of prey in five insect orders: a click beetle (Elateridae); a leafhopper (*Errhomus calvus* Oman, Cicadellidae) (A. Hamilton pers. comm. 2010); bees (*Andrena* sp., Andrenidae; *Hoplitis* sp., Megachilidae) (L. Best pers. comm. 2010); a micromoth (*Lampronia* sp. probably *L. aenescens* (Walsingham), Prodoxidae) (G. Pohl pers. comm. 2010); a flower fly (*Syrphus opinator* Osten Sacken, Syrphidae) (C. Thompson, J. Skevington pers. comm. 2010); a robber fly (*Machimus* sp., Asilidae); a crane fly (*Tipula* sp., Tipulidae) (Figure 20) (F. Brodo pers. comm. 2010). Although it is not an interspecific interaction, cannibalism is common in *Efferia* species. Eigelsreiter (pers. comm. 2010) photographed a female eating another female at Oliver (Figure 21). In normal environments, prey is apparently abundant and food availability is unlikely to be a limiting resource for the survival of adult Okanagan Efferia.

Figure 16. *Purshia tridentata* (Antelope-brush) steppe, Ecological Reserve 100, north end of Osoyoos Lake. View northwest from 49.09502ºN 119.52309ºW (361 m), 21 May 2010. *Rhus glabra* L. (smooth sumac) in foreground; *Pinus ponderosa* trees in middle distance. The soil is mostly fine sand. This area has been heavily collected for several decades without producing specimens of Okanagan Efferia. Photo: Robert A. Cannings.

Figure 17. Mount Middleton, Vernon, BC. View northeast from about 50.22249ºN 119.25917ºW (423 m), 30 May 2010. Suburban development encroaches here on potential Okanagan Efferia grassland habitat. Photo: Robert A. Cannings.

Figure 18. Okanagan Efferia male warming in the morning by lying on a sunny rock and tilting broadside to the sun's rays. Oliver, BC, 9 May 2010. Photo: Werner Eigelsreiter, with permission.

Figure 19. Knox Mountain, Kelowna. View south to Kelowna and Okanagan Lake from about 49.90622º N 119.48189ºW (451 m). 30 May 2010. *Pseudoroegneria spicata* (Bluebunch Wheatgrass) grassland with *Balsamorhiza sagittata* (large leaves) and *Ericameria nauseosa* (grey shrub). Okanagan Efferia was not found at this site despite two visits to this apparently suitable habitat. Photo: Robert A. Cannings.

Figure 20. Okanagan Efferia male feeding on a crane fly (*Tipula* sp.). Oliver, BC, 16 May 2009. Photo: Werner Eigelsreiter, with permission.

Figure 21. Okanagan Efferia female feeding on another female of the same species. Cannibalism is frequent in robber flies. Oliver, BC, 23 May 2009. Photo: Werner Eigelsreiter, with permission.

The larva of Okanagan Efferia has not been discovered and, of course, neither has its prey. Soil dwelling asilids feed on insect larvae and pupae (Wood 1981) and it is likely that the Okanagan Efferia is an opportunistic predator of beetle larvae and pupae in, among other taxa, common grassland families such as Scarabaeidae and Tenebrionidae or the cutworm larvae of noctuid moths.

There are no records of other predatory species killing the Okanagan Efferia, although there is one incident of cannibalism (see above). Although the larvae of parasitic mites (Acari: Parasitengona) have not been found on Okanagan Efferia, they have been recorded on close relatives (e.g., *Efferia harveyi*) in the Okanagan (R.A. Cannings, unpublished data).

The only known oviposition sites used by the Okanagan Efferia are the glumes of Bluebunch Wheatgrass. See **Life cycle and reproduction**.

POPULATION SIZES AND TRENDS

Sampling effort and methods

Grassland sites sampled specifically for the Okanagan Efferia were chosen for both assumed positive (e.g., rocky, gravelly sites with or without *Purshia* or *Balsamorhiza*) and negative (e.g., fine soils, *Artemisia* dominant sites) attributes. Negative data, although not proof of absence of the species, helps create and support useful assumptions about distribution limits. Sites were sampled by walking in a meandering line through potential grassland habitat in favourable weather for at least 30 minutes in 30-minute increments between 09:30 and 17:00 PDT. In almost all situations, all *Efferia* specimens seen were captured. Favourable weather is defined as at least 15°C, sunny or light overcast, calm to moderate winds and no rain (although light rain may not always be a detriment—a female *E. benedicti* was captured at Kamloops in rain at 18°C (31 May 2010) (Table 2). Flies were caught with standard 18- or 21-inch aerial insect nets. Time at start and end of sampling was recorded, as was air temperature, cloud cover, a rough estimate of wind speed, dominant plants and general soil consistency. Where Okanagan Efferia is present, it is usually easy to detect.

In 2006 and again in 2010, Malaise traps were tested (Figure 22) a few times in sampling Okanagan Efferias, even though experience had shown that *Efferia* species were not readily captured in these traps (R.A. Cannings pers. obs.), perhaps because the flies are so geophilic and do not climb up into the trap's collecting jar, even if they land on the netting inside the trap. The traps again did not catch any *Efferia* specimens and their use was discontinued for most of the 2010 survey.

Figure 22. Malaise trap set on south-facing slope to catch flying Okanagan Efferia, Nature Trust of BC (Leir property), Okanagan Falls, BC. *Purshia tridentata* and *Pinus ponderosa* habitat. View northeast from 49.30200ºN 119.53533ºW (365 m), 19 May 2010. Photo: Robert A. Cannings

Abundance

Population sizes of Okanagan Efferia are difficult to estimate with the data at hand and estimates have not been calculated. Populations are patchily distributed in suitable habitat at the regional scale and density is extremely variable at the site scale. In 2010, in appropriate habitat, thirty-minute searches produced catches of up to 5 specimens; usually the range is 0 to 2 (Table 3). Densities can be higher, however. At the Oliver Mountain site (Figure 10) on 19 May 2010, during a five-minute walk along a dirt track (11:25-11:30), 12 flies were seen but not collected. At Cosens Bay, Vernon, on 23 May 1987, Rob Cannings collected 21 males and 15 females (Table 1). No attempt to collect systematically was made and the time spent at the site was not recorded. The site visit probably lasted about five hours and was certainly not completely focused on collecting this single species. It is likely, too, that after so many specimens were captured, collecting was halted. The same Kalamalka Lake Park site has been sampled several times since, most times without search effort recorded. There is general search effort information for a few collection events there, however. On 18 June 1991, two collectors recorded 3 female specimens in 5 hours; this is at the end of the species' flight period and no males were observed. On 12 June 1995, 21 specimens were collected (Table 1) in 2.5 hours by two collectors. On 30 May 2010, in 1.5 person-hours (15:15-16:45), only a single female was collected. Based on what is known about other Robber Flies with similar occurrence, it is estimated that there are less than 10,000 mature individuals.

The patchy distribution of the fly is emphasized by the amount of negative data. This may or may not show an absence of the fly, of course, but in the 2010 surveys, only 8 of 52 sites produced specimens.

Fluctuations and trends

There is no direct information on population trends, although declines can be inferred from trends in habitat destruction. In the southern part of the species' range, Antelope-brush steppe, the main habitat of the fly, has declined by two-thirds since European settlement (Schluter *et al*. 1995).

The extensive fires in the Okanagan Valley in 2003 burned 61,776 ha (COSEWIC 2010). At least the Vaseux Lake population of Okanagan Efferia was affected by one of these fires. Much of the grassland along the cliffs on the northeast side of the lake was burned; in the 1980s specimens were collected at seven separate sites there (Table 1). Searches totalling 2 person-hours in 2010 produced a total of three specimens at two different coordinates (Table 1). The population still survives. The data are insufficient to indicate the state of the fly's health in this degraded habitat; however, a decline may be suggested. See **Habitat trends**.

Rescue effect

Despite frequent robber fly collections in the Osoyoos Lake (Figure 16, International Grasslands (Richter Pass) and Chopaka areas adjacent to the International Boundary since the 1970s, no Okanagan Efferia have ever been recorded south of Oliver (Figure 4). Although there is no evidence of a US population across the border in Okanogan County, Washington State, the species may occur there. If it does, the rescue effect would likely be minimal because the grassland habitat in BC near the International Boundary, in the main, appears to be unsuitable for Okanagan Efferia. In the unlikely event of immigration into suitable Canadian habitat, however, the immigrants would probably be adapted to survive in Canada.

THREATS AND LIMITING FACTORS

The "Threats Assessment Worksheet" was used to determine overall threat considering only the five existing locations. Fire and invasives were treated as high threats and agriculture, pesticide drift and ATV use were treated as "low" threats. The overall threat impact was "very high" when scope and severity were taken into account.

The range of the Okanagan Efferia lies in the valleys of the Thompson-Okanagan region, an area of rapid human population growth and increasing land development. In particular, the population of the Okanagan Valley itself has tripled every 30 to 40 years since 1940, reaching 300,000 in 2002 (Jensen and Epp 2002). Coincident with this growth is the considerable alteration, degradation and loss of the natural grassland ecosystems of the region that support diverse invertebrate communities. The increasingly intensive and extensive imprint of humans on the landscape is the basis of most of the threats to Okanagan Efferia populations in the region

The primary limiting factor for the Okanagan Efferia is the presence of appropriate, reasonably intact natural habitat. Threats to the species include development of its habitat for agriculture, housing and other uses (Figures 12, 17); overgrazing by livestock; damage by vehicles; wild fires and related changes; invasive plants (Figure 9); climate warming; and pesticide effects. In the South Okanagan, the Okanagan Efferia shares parts of the Antelope-brush steppe with the Behr's Hairstreak and, although the fly is not as closely tied ecologically to the shrub as is the butterfly, many of the threats to the two species are similar. COSEWIC (2010) discusses these threats in detail. Threats to Behr's Hairstreak populations and the Antelope-brush habitat are outlined by the Southern Interior Invertebrates Recovery Team (2008). Threats to the predominant Antelope-brush habitat, the *Purshia tridentata–Hesperostipa comata* (Antelope-brush/Needle-and-thread Grass) ecosystem, are discussed in Iverson (2010).

Habitat loss and degradation

The two locations in the northern part of the Okanagan Efferia's range are in protected areas and are thus under less stress, at least with respect to agricultural, housing and other similar development, than some of the areas to the south, especially the Antelope-brush steppe, where all the southern records are found. However, some habitat now in the Lac du Bois Protected Area (Kamloops, Figure 8) was damaged in the past by all-terrain vehicles and has now recovered to some degree. The main, authorized ATV use area is now outside the protected area at a lower elevation and degradation there likely does not greatly affect the fly's habitat. However, BC Parks staff is having difficulty regulating such vehicles within parks in the range of the robber fly and those parks should not be considered free from this threat (D. Fraser pers. comm. 2011). Vehicle damage to BC grasslands is a problem wherever lands are not protected. It disturbs or kills insect larvae directly or by compacting the soil. At the Kalamalka Lake Park location near Vernon (Figure 9) invasive plants have proliferated in the last 10 or 20 years despite the fact that cattle no longer graze the land. See **Invasive plants** below.

The integrity of the Antelope-brush steppe communities continues to be eroded and threatened by development, damage, and resulting fragmentation (Iverson 2010). About 67% of the major component of these communities, the Antelope-brush/Needle-and-thread Grass plant association has been destroyed by agricultural, housing and other development since the arrival of European settlers. In 2008, assessment of remaining Antelope-brush/Needle-and-thread Grass habitats showed 7.1% (228.4 ha) in good or excellent condition and 71.3% (2988.6 ha) in fair condition (Iverson 2010). See **Habitat trends**.

Antelope-brush steppe, with its gravelly/sandy, well-drained soil, is used as an indicator of potentially high grape crop production and, therefore, is targeted by the wine industry for development (COSEWIC 2010). This is the greatest ongoing developmental threat to the habitat (Figure 12).

Urban expansion is also expected to have an impact at some locations, not only in the southern Okanagan but also in grasslands between the Okanagan Falls and Kalamalka Lake Park locations, where the Okanagan Efferia has not been found, but could possibly occur. Development appears continuous at the margins of all the population centres in the range of the fly (Figure 17).

Wild fires

The natural fire regime in Intermontane grasslands has been altered over the past century and a half by fire suppression. 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 2010). Changes to fire regimes and the concomitant spread of invasive plants may also modify the structure and composition of Antelope-brush plant communities. Fires are probably a threat to Okanagan Efferia populations depending on the season, intensity, and the proportion of the habitat affected. Wild fires have increased in frequency in the past decade and have severely damaged some *Efferia* habitat (e.g. Vaseux Lake (Figure 15); Ecological Reserve 100 (Figure 16)); these recent fires tend to burn much hotter than the fires of long ago and may kill *Efferia* larvae in the soil as well as destroying above-ground habitat, including ovposition sites in grasses, and affecting prey species. However, the Vaseux Lake population is still present in the area that produced specimens in the 1980s despite a severe fire in 2003. See **Habitat trends** and **Fluctuations and trends.**

Invasive plants

Many introduced and invasive plants grow throughout the range of the Okanagan Efferia. Many probably have little effect on the fly or its ecosystems, but others certainly change the nature of the habitat. Cheatgrass, Sulphur Cinquefoil, Diffuse Knapweed, and Dalmatian Toadflax have significant adverse impacts. For example, Sulphur Cinquefoil (Figure 9) or other weeds can form monospecific stands and may eventually out-compete native plants that may be necessary Okanagan Efferia oviposition sites, shelter sites, or be important to prey species. Weeds especially proliferate after damage to the plants and soil by vehicles or by livestock grazing and trampling. Both cause erosion and compaction of soil, usually increasing the competitive advantages of invasive species over native ones (Iverson 2010). See **Habitat trends**.

Climate warming

As for other species, climate warming is a potential, but poorly understood, threat to the Okanagan Efferia in BC's southern Interior grasslands, mainly owing to the modifications that any change might bring to grassland environments. The Okanagan Efferia is a spring-flying species, presumably adapted to the cooler temperatures of that season, compared to some other species of the genus (e.g., *E. benedicti*) that are at home in the higher temperatures of grasslands in summer. Any significant increase in average temperatures may adversely affect the species' life history or increase competition with other robber fly species. An increase in the intensity of summer drought may change rain patterns during the larval period, increasing soil desiccation and potentially reducing juvenile survival.

Climate suitable for Antelope-brush steppe and other grassland types might expand as a result of warming. Wilson and Hebda (2008) show that the climate impact model for Behr's Hairstreak shows the occurrence of suitable climate for grassland in northern BC by 2080. However, current rates of habitat loss and fragmentation within the present range of grassland suitable for the Okanagan Efferia, combined with the natural dispersal capabilities of grassland ecosystems and the fly itself, may prevent natural expansion (J. Heron pers. comm. 2010).

Overgrazing

Overgrazing by cattle can encourage weeds that may form monospecific stands and may eventually out-compete native plants that may be Okanagan Efferia's oviposition sites, shelter sites, or be important to prey species. Livestock grazing and trampling may reduce the grasses that provide oviposition sites. Erosion and compaction of soil may disrupt larval burrowing and developmental success. See **Invasive plants**.

Pesticides

Robber fly habitats bordering agricultural lands, especially in the Okanagan part of the range, may be affected by pesticide drift. Individual adult flies may be killed through direct contact with sprays or by eating affected prey. Herbicide treatments against weeds may affect non-target grasses required by the flies for shelter or oviposition. There are no data to support these suppositions.

Limiting factors

There is no detailed information on limiting factors. There is an apparent, unmeasured correlation based on observation of the species' presence with Bluebunch Wheatgrass growing on gravelly soils. The well-drained character of these soils, or some other features, may be limiting requirements of the soil-dwelling larvae. The only oviposition sites observed are the empty glumes in the old inflorescences of this grass species. Larvae feed on subterranean insect larvae and the availability of suitable prey may be limiting. Adults are opportunistic, general predators of flying insects and locating suitable prey is likely not limiting.

PROTECTION, STATUS, AND RANKS

Legal protection and status

The Okanagan Efferia is not protected under the federal *Species at Risk Act.* It is protected in National Wildlife Areas under the *Canada Wildlife Act* (Vaseux Bighorn National Wildlife Area). The British Columbia *Park Act* gives general protection to organisms within parks and provincially protected areas, even if they are not ranked on the provincial red or blue lists; the Okanagan Efferia is not provincially listed as threatened or endangered.

Non-government conservation organizations, such as the Nature Trust of BC include protection measures for at-risk species in their plans. The Nature Trust manages three sites where the Okanagan Efferia has been recorded.

Okanagan Efferia may be recommended for listing as Identified Wildlife under the provincial *Forest and Range Practices Act* (FRPA) once the fly is named and scientifically described and after it is assessed by COSEWIC. If listed under this act, the fly's recorded sites and habitats within Wildlife Habitat Areas on provincial Crown land will be protected (J. Heron pers. comm. 2010). Some protection may already be afforded through the protection of habitat of Behr's Hairstreak which is listed under FRPA.

Invertebrates listed by COSEWIC as threatened, endangered or extirpated will be protected through the British Columbia *Wildlife Act* and *Wildlife Amendment Act* once the regulations listing these species are completed (COSEWIC 2010).

Non-legal status and ranks

The Okanagan Efferia is not ranked by the National General Status program. It is unranked globally by NatureServe and unranked provincially by the BC Conservation Data Centre. The fly has not yet been assessed by the BC Conservation Framework (see www.env.gov.bc.ca/conservationframework/) in its program to maintain the diversity of native species and ecosystems.

Habitat protection and ownership

The most significant protected areas where the Okanagan Efferia has been recorded in the northern part of its range are the Lac du Bois Grassland Protected Area near Kamloops (Figure 8) and Kalamalka Lake Provincial Park (Figure 9) near Vernon. These are administered by BC Parks (BC Ministry of Environment) under the British Columbia *Park Act.*

Three of the five locations and most of the collection sites for the species are from the southern Okanagan in Antelope-brush steppe. Government and private conservation lands there protect 17.5% of the remainder of this habitat in BC. The Nature Trust of BC properties at Okanagan Falls (Thomas Ranch), Vaseux Lake (Figure 11) and Vaseux Creek (Kennedy property) support recorded populations. One site lies within Vaseux Lake Provincial Park and another is in the Vaseux-Bighorn National Wildlife Area, managed by the Canadian Wildlife Service. The three productive sites at Oliver are on Crown Land. The one at Oliver Mountain (Figure 10) is being examined as a potential protected area. It is a proposed goal 2 protected area from the Okanagan-Shuswap LRMP (Land and Resource Management Plan) process. Any change in its status depends partly on the results of a study examining the feasibility of creating a national park in the grasslands of the South Okanagan–Similkameen. There also are wildlife reserves under the *Land Act* on some of the parcels at Oliver Mountain (O. Dyer pers. comm. 2010).

Antelope-brush plant communities probably represent the best habitat resources for the Okanagan Efferia. In the southern Okanagan Valley, the control of remaining habitat in 2008 (3217 ha) is as follows: Indian Reserves - 56.2%, unprotected private land - 20%, private conservation land - 8.3%, provincial government protected areas - 5.7%, provincial Crown land (unprotected) - 6.4%, and federal government land (Canadian Wildlife Service) - 3.5% (COSEWIC 2010).

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BIOGRAPHICAL SUMMARY OF REPORT WRITER

Rob Cannings has worked since 1980 as Curator of Entomology at the Royal British Columbia Museum in Victoria, BC. From 1987 to 1996 he also led the Natural History Section there. He has been active on the Scientific Committee of the Biological Survey of Canada (Terrestrial Arthropods), the British Columbia Invertebrate Recovery Team and the Entomological Societies of British Columbia and Canada. He is a member of the Arthropod Subcommittee of COSEWIC. In former lives, Rob was a biologist and nature interpreter for BC Parks and the Canadian Wildlife Service and served as a lecturer and museum curator at the University of BC. His BSc and MSc are from the University of BC; his PhD comes from the University of Guelph. Rob studies insect systematics, especially the taxonomy, evolution and biogeography of dragonflies (Odonata) and robber flies (Diptera: Asilidae). However, he has published on groups in all the major orders of insects. He has authored several books, including The Dragonflies of British Columbia (1977), Introducing the Dragonflies of British Columbia and the Yukon (2002) and The Systematics of *Lasiopogon* (Diptera: Asilidae) (2002). Rob and his brothers, Syd and Richard, were made Honorary Fellows of Okanagan College in 2008. In 2009 Rob won the Bruce Naylor Award from the Alliance of Natural History Museums of Canada for outstanding contributions to museum-based natural history studies in Canada.

COLLECTIONS EXAMINED

All known specimens of the Okanagan Efferia were examined (Cannings 2011) and come from the following collections:

CNC: Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, K.W. Neatby Building, Central Experimental Farm, 960 Carling Ave., Ottawa, ON, K1A 0C6, Canada (J. M. Cumming).

RBCM: Royal British Columbia Museum, 675 Belleville Street, Victoria, BC V8W 9W2, Canada (R.A. Cannings)

UBC: Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, 2212 Main Mall, Vancouver, BC, V6T 1Z4, Canada (K.M. Needham).

No specimens of the Okanagan Efferia were found in the large *Efferia* collection (much of it the Joseph Wilcox Collection) at the California Academy of Sciences, 55 Music Concourse Drive, San Francisco, CA 94118, USA (CAS) or the Eric M. Fisher Collection, Sacramento, CA , USA (EMF). Specimens are not likely to be housed in the collections examined by Wilcox (1966), including the USNM (Smithsonian Institution, National Museum of Natural History, 10th St. & Constitution Avenue, NW, Washington, DC 20560-0165, USA.

Table 1 lists all known specimens of *Efferia okanagana*. All are included in the type series. The holotype is deposited in the CNC; paratypes are deposited in the above collections (Cannings 2011).