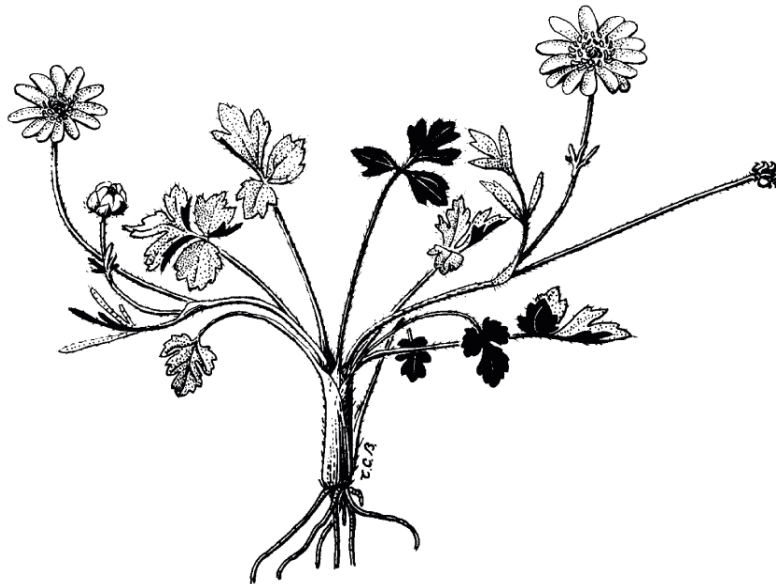


COSEWIC
Assessment and Status Report

on the

California Buttercup
Ranunculus californicus

in Canada



ENDANGERED
2008

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2008. COSEWIC assessment and status report on the California Buttercup *Ranunculus californicus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 24 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:

COSEWIC acknowledges Matt Fairbarns, Brian Klinkenberg, and Rose Klinkenberg for writing the status report on the California Buttercup, *Ranunculus californicus* in Canada. COSEWIC also gratefully acknowledges the financial support of Parks Canada for the preparation of this report. The COSEWIC report review was overseen by Erich Haber, Co-chair COSEWIC Vascular Plants Specialist Subcommittee, with input from members of COSEWIC. That review may have resulted in changes and additions to the initial version of the report.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215

Fax: 819-994-3684

E-mail: COSEWIC/COSEPAC@ec.gc.ca

<http://www.cosewic.gc.ca>

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la renoncule de Californie (*Ranunculus californicus*) au Canada.

Cover illustration:

California Buttercup — Artwork by T.C. Brayshaw, Brayshaw 1989, with permission.

©Her Majesty the Queen in Right of Canada, 2009.

Catalogue No. CW69-14/566-2009E-PDF

ISBN 978-1-100-12441-4



Recycled paper



COSEWIC Assessment Summary

Assessment Summary – November 2008

Common name

California buttercup

Scientific name

Ranunculus californicus

Status

Endangered

Reason for designation

A perennial species restricted to two small island groups adjacent to Victoria, BC. The four small confirmed populations are found within coastal meadow habitats where the extensive spread of invasive plants places the species at risk. Potential impacts on the populations include planned enlargement of communications towers at one site and unauthorized recreational visitors to the island habitats.

Occurrence

British Columbia

Status history

Designated Endangered in November 2008. Assessment based on a new status report.



COSEWIC
Executive Summary

California Buttercup
Ranunculus californicus

Species information

California Buttercup *Ranunculus californicus* is a low-growing, erect to flattened on the ground perennial species of buttercup with shiny lemon-yellow petals. It is readily distinguished from other buttercup species by its multiple petals (up to 16). Other similar species of buttercup, such as the western buttercup, typically have only 5 petals. California Buttercup readily hybridizes with the Western Buttercup, but can be easily distinguished by the curved beak on the fruitlets.

Distribution

California Buttercup is found along the west coast of North America, from islands in extreme southwestern British Columbia and adjacent Washington State to Baja California where it is widespread. In British Columbia, it is found on two small island clusters that lie to the south and east of Victoria. The Extent of Occurrence is <20 km². The actual area of habitat occupied in Canada is under 2 ha although the Index of Area of Occupancy, based on a 1 km square grid, is 4 km² and 8 km² using a 2 km square grid.

Habitat

In Canada, California Buttercup is restricted to open coastal meadows on exposed oceanic bluffs. It occurs in sites that remain open because of wind exposure along shore, summer drought stress in thin soils and winter seepage that waterlogs soils, preventing taller vegetation from dominating. It is found in areas within 50 m of the coast where frequent coastal fogs occur in the autumn and winter, and the ocean buffers against deep frosts in the winter.

Biology

California Buttercup is primarily a perennial species that can occasionally act as an annual. It is primarily bee-pollinated, although pollination may also be by thrips and flies. Seedling ecology and germination requirements are unknown. No specific information is known about dispersal in this species, although other buttercup species are eaten by voles, and are thought to be dispersed by adhesion (fur, feathers, clothing) and, for short distances, by wind. No damage from herbivores has been observed in the Canadian populations.

Investigators studying the response of coastal bluff species to temperature, light and humidity found that species in this habitat, including California Buttercup, are characterized by moderate photosynthetic abilities, and that the plants are adapted to conserve moisture during the dry summer season.

Population sizes and trends

Records from 2003 and 2005 indicate there are four confirmed populations in British Columbia and a fifth reported population on private land that requires closer inspection. There are a total of between 3,000 and 3,600 individuals in the BC populations. Detailed surveys throughout the Canadian extent of occurrence have not resulted in any new populations of the species, although some sites adjacent to known populations appear to support hybrid plants.

There is no reliable long-term information on past population sizes of this species in Canada so fluctuations and trends in the size of extant populations cannot be determined. However, potential habitat has declined over the last century as a result of development of coastal meadows for residential and recreational use. Because of limitations in dispersal, colonization and development of new populations is unlikely.

Limiting factors and threats

Limitations for the occurrence of this species in Canada include restricted availability of habitat because of direct habitat loss through past land development, and alteration of habitat resulting from grazing and the subsequent invasion of sites by alien species. Vegetation management plans for all sites are lacking, and this includes a lack of a plan for dealing with invasive species and habitat restoration.

Direct threats to our populations of California Buttercup include invasive species, land development and land use practices (Camas production), general recreational use and development in the area, and fire suppression.

Special significance of the species

Canadian populations of *Ranunculus californicus* are of scientific interest because the species' distribution suggests that it is a relict from the Hypsithermal Interval of warm, dry climate 4,000-6,000 years b.p. This is surmised from the fact that British Columbia populations are highly disjunct from the main range in California, adding to their biogeographic and genetic importance.

Existing protection or other status designations

Neither the provincial nor federal government offers legal protection at the species level, although it is a provincially red-listed species. Such species are recognized as potentially being threatened or endangered in BC. Part or all of three populations occur in Ecological Reserves, where the plants and the habitat that sustains them, are legally protected.



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 (2008)

| | |
|------------------------|--|
| 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

Canadian Wildlife
Service

Environnement
Canada

Service canadien
de la faune

Canada

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

COSEWIC Status Report

on the

California Buttercup *Ranunculus californicus*

in Canada

2008

TABLE OF CONTENTS

| | |
|--|----|
| SPECIES INFORMATION..... | 4 |
| Name and classification..... | 4 |
| Similar species | 4 |
| Taxonomic discussion | 4 |
| Description..... | 5 |
| Genetic description | 5 |
| Designatable units | 5 |
| DISTRIBUTION..... | 6 |
| Global range | 6 |
| Canadian range | 7 |
| HABITAT | 9 |
| Habitat requirements | 9 |
| Trends | 11 |
| Habitat protection/ownership | 11 |
| BIOLOGY | 12 |
| General..... | 12 |
| Reproduction | 12 |
| Germination and seedling ecology..... | 12 |
| Survival..... | 12 |
| Herbivory | 13 |
| Dispersal..... | 13 |
| Physiology | 13 |
| POPULATION SIZES AND TRENDS..... | 14 |
| Search effort | 14 |
| Abundance | 14 |
| Fluctuations and trends | 15 |
| Rescue effect..... | 16 |
| LIMITING FACTORS AND THREATS | 16 |
| Habitat loss..... | 16 |
| Threat associated with recreational activities | 16 |
| Threat associated with altered fire regimes | 16 |
| Threats associated with invasive alien plants | 17 |
| SPECIAL SIGNIFICANCE OF THE SPECIES..... | 18 |
| EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS | 18 |
| TECHNICAL SUMMARY..... | 19 |
| ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED..... | 21 |
| Authorities consulted | 21 |
| INFORMATION SOURCES | 21 |
| BIOGRAPHICAL SUMMARY OF REPORT WRITERS..... | 24 |
| COLLECTIONS EXAMINED | 24 |

List of Figures

Figure 1. Illustration of *Ranunculus californicus*..... 6
Figure 2. Global distribution of *Ranunculus californicus* 7
Figure 3. Distribution of *Ranunculus californicus* in Canada 8

List of Tables

Table 1. *Ranunculus californicus* population data 15

SPECIES INFORMATION

Name and classification

Scientific name: *Ranunculus californicus* Bentham
Synonyms: none
Common name: California Buttercup
Family: Ranunculaceae, buttercup family
Major plant group: Eudicot flowering plant

Similar species

Although hybrids can be hard to distinguish, separating *Ranunculus californicus* from *R. occidentalis* (Western Buttercup) can also be problematic. Brayshaw (1989) notes that flowers of *R. californicus* have 9-26 petals while those of the only sympatric variety of *R. occidentalis* have 5-7 petals; that the petals of *R. californicus* are narrower than those of *R. occidentalis*; that the stylar beaks of *R. californicus* are short (0.4 – 1.0 mm) and recurved while those of *R. occidentalis* are longer (1.2-1.8 mm) and straighter; and that *R. californicus* has a greater tendency to a depressed growth habit. Similar distinguishing features are provided by Wilken (1993) and Whittermore and Parfitt (1997).

Taxonomic discussion

Benson (1948) discusses the *R. occidentalis* complex, which includes *R. californicus*. He indicates that this group is “so complex that a number of nomenclatorial recombinations and some new names have been necessary in order to bring classification into harmony with the results of field studies.” A number of varieties of *R. californicus* have been described from southern Oregon and California although Whittermore and Parfitt (1997) only recognize var. *californicus* and var. *cuneatus* Greene. Brayshaw (1989) indicates that some Canadian plants conform to descriptions of var. *cuneatus* while others conform better to descriptions of var. *californicus*.

Work by Brayshaw (1989), Wilken (1993) and others indicate that this species intergrades complexly with *R. occidentalis* and *R. canus* throughout its range. *Ranunculus canus* does not occur north of southern Oregon (Wilken 1993); however, *R. occidentalis* is a common native species of coastal meadows near Canadian populations of *R. californicus* (Brayshaw 1989).

In British Columbia, *R. californicus* is capable of forming naturally occurring and artificial hybrids with *R. occidentalis* and producing hybrid swarms (Brayshaw 1989; Ceska pers. comm. 2003, Pojar pers. comm. 2003). Brayshaw (1989) provides a formal description for *Ranunculus X heimburgerae*, a hybrid of *Ranunculus occidentalis* X *californicus* T.C. Brayshaw. Brayshaw (pers. comm. 2003) is confident that the Canadian populations are good representatives of *R. californicus*. The species is also recognized as valid in the General Status of Wild Species (Wild Species 2005).

Description

California Buttercup is a low-growing, hairy herbaceous perennial that produces numerous stems from a central root crown. At least in Canada, the first basal leaves are usually pinnate and heavily toothed. During the spring it produces lobed, long-stalked basal leaves with blunter teeth, 2-8 cm long. The sprawling to erect, 15-50 cm long stems bear alternately arranged leaves on shorter stalks. The stems each tend to have several flowers in an open inflorescence. The flowers have numerous (up to 16) shiny lemon-yellow petals, unlike most species of buttercup that typically have only five petals. It is distinguished from similar buttercup species (such as the Western Buttercup) by the noticeably curved beak on the seeds. Thomas (1961) reports that “teratological forms in which all of the plants are sepaloid are fairly common.” Such genetic abnormalities have not been reported from Canadian populations and have no bearing on the status assessment of this species. Abnormal development of flowers is of relatively widespread, although sporadic occurrence, in many species of flowering plants.

Hybrids of *Ranunculus occidentalis* X *californicus* have the parental characteristics variously combined (Brayshaw 1989).

Genetic description

Ranunculus californicus has a chromosome count of $2n=28$ (Coonen 1939, Darlington and Wylie 1955). Polyploidy is reported to occur in 50 – 69% of the species in the genus *Ranunculus* (Stebbins 1950). Brayshaw (1989) indicates that while there is strong introgression with *R. occidentalis*, the hybrid plants are less fertile, with perhaps 50% of the pollen being viable, and 50% of the ovaries producing seeds. *Ranunculus californicus* is not overwhelmed by *R. occidentalis*, but rather the two seem to be in balance, perhaps because the site conditions favour *R. californicus* close to the water where salt spray is a factor.

Molecular studies have not been conducted on Canadian populations of *Ranunculus californicus*.

Designatable units

The few extant populations found in Canada occur in close proximity in one small geographical area and, therefore, comprise a single designatable unit.

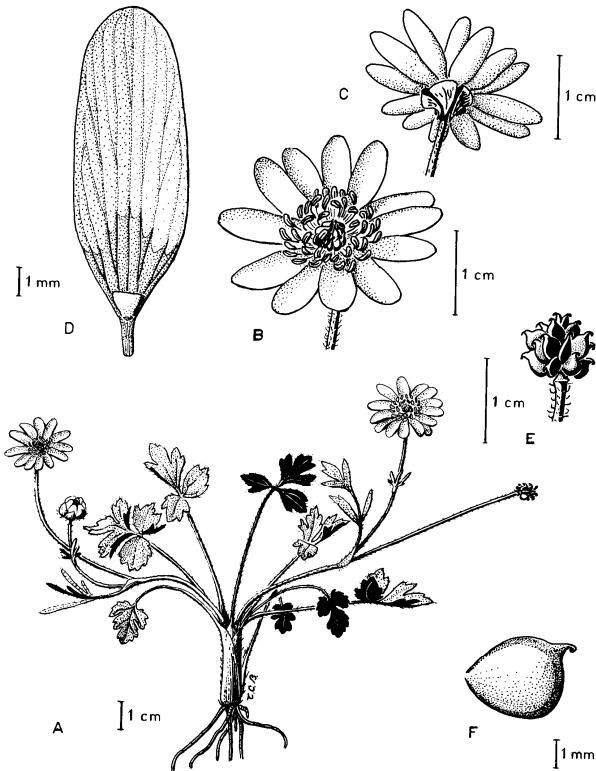


Figure 1. Illustration of *Ranunculus californicus* (artwork by T.C. Brayshaw, Brayshaw 1989, with permission).

DISTRIBUTION

Global range

Ranunculus californicus ranges from Vancouver Island south along the coast (and inland in California) to Baja California (Wilken 1993; see Figure 2).

The nearest United States record is from San Juan County in North Puget Sound, where the species is locally abundant in meadows on San Juan and Lopez Islands (Atkinson and Sharpe 1993). This site is about 15 km from the Canadian populations. It has also been reported from nearby in Skagit County (collected by M.F. Denton, accessioned WTU 266226). There are reports of a hybrid between *R. californicus* and *R. occidentalis* from the Olympic Peninsula (Buckingham *et al.* 1995), but these should be treated with caution as “extra”-petalled specimens of *R. occidentalis* are sometimes incorrectly identified as hybrids. The species has not been seen elsewhere in Washington State and the next nearest records come from the north coast of Oregon.

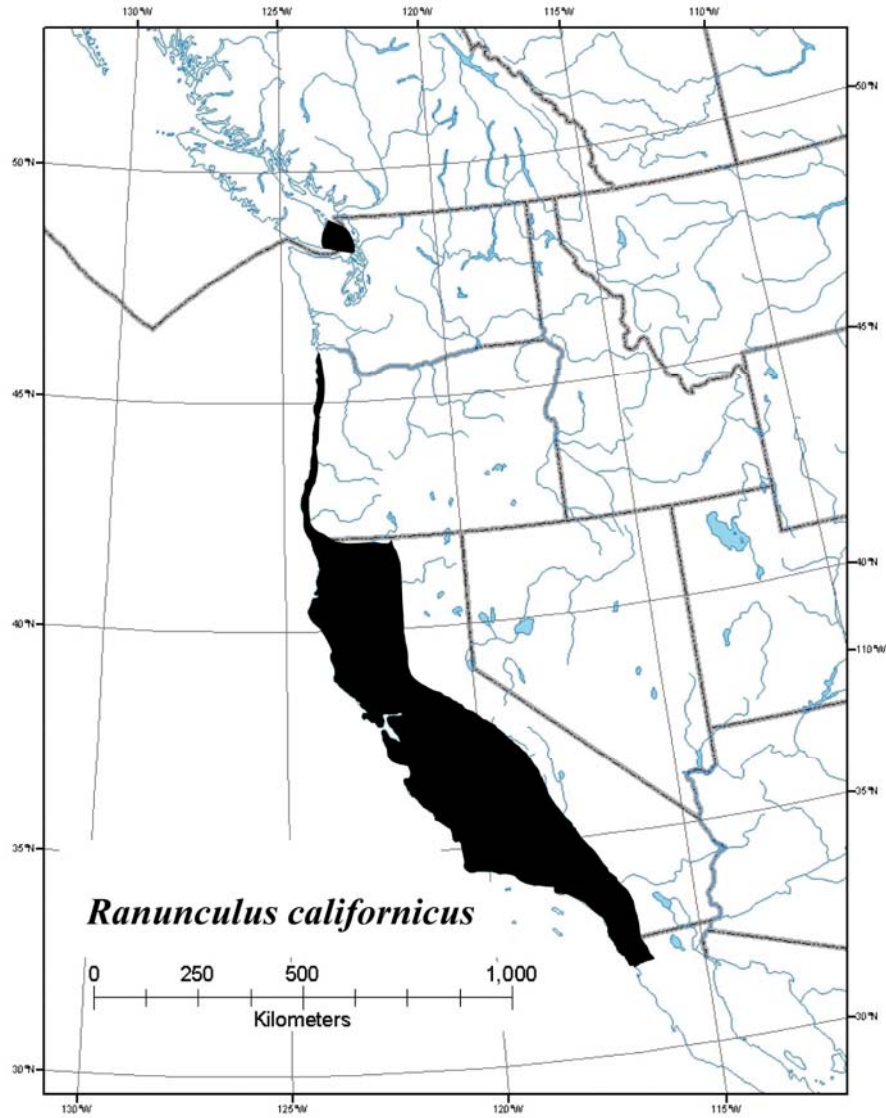


Figure 2. Global distribution of *Ranunculus californicus* (mapping by Matt Fairbarns 2005).

Canadian range

In Canada, *R. californicus* is restricted to southwestern British Columbia on small islands and islets just south and east of Victoria (Figure 3). The actual area of habitat occupied in Canada is under 2 ha (Fairbarns 2005) although Index of Area of Occupancy is 4 km² based on a 1 km square grid and 8 km² based on a 2 km square grid. The species occurs in two island clusters together representing about 700 ha based on a convex polygon. However, 80% of this area is ocean with the terrestrial portion, representing the habitable Extent of Occurrence being <200 ha (calculations determined using GIS tools). For the purpose of status assessment, a nominal value of <20 km² is here used for the Extent of Occurrence. This nominal value of EO is considerably less than 1% of the species' global range.

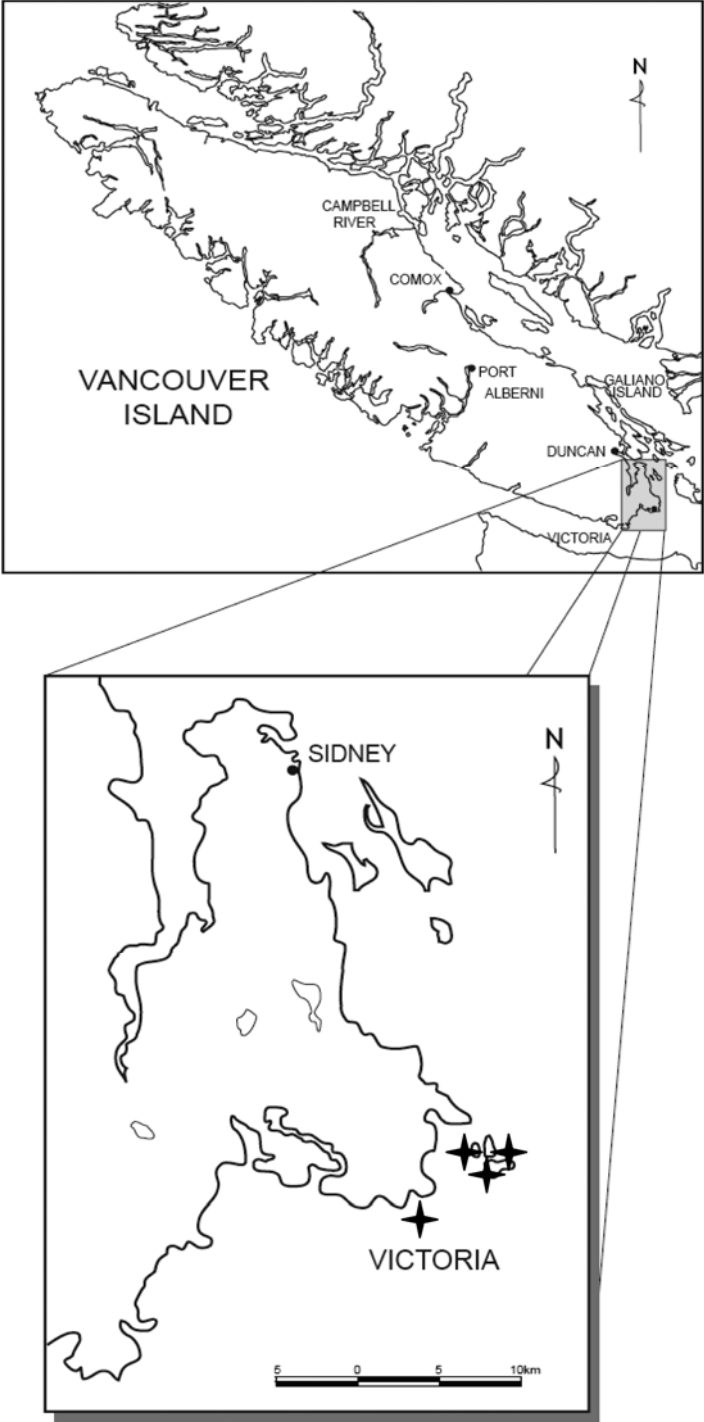


Figure 3. Distribution of *Ranunculus californicus* in Canada (mapping by Matt Fairbarns 2005)

Most individuals are found in small populations. The two island clusters where *R. californicus* occurs are approximately six km apart, and dispersal across the intervening area of ocean is very unlikely. This high degree of habitat fragmentation greatly reduces the probability of successful recolonization of suitable habitat patches if the species becomes extirpated at either island cluster.

Whittemore and Parfitt (1997) expressed doubt that the Canadian populations are native, suggesting that *R. californicus* may have been introduced by marine trade between San Francisco and Victoria. They base this argument on the fact that there are no old collections from the Victoria area, that there is a long history of marine trade between San Francisco and Victoria (which has introduced other California species into the Victoria area), and that small, isolated populations of *R. californicus* are unlikely to persist for long periods in the face of free introgression from *R. occidentalis*. Whittemore (pers. comm. 2008) clarified that the introduced species they refer to are the showy *Lupinus arboreus* (Tree Lupine) and *Eschscholtzia californica* (California Poppy). A closer examination of the following facts suggests that this hypothesis has little merit. The absence of old collections from the Victoria area is of little significance since the Canadian sites where *R. californicus* occurs do not have an extended history of collection. In fact, *R. californicus* was among the earliest species collected from each of the locations where it occurs in Canada. As well, there has been little marine traffic between Victoria and San Francisco since rail connections to Vancouver were established in 1886. *Ranunculus californicus* is absent from suitable meadow habitat near the port facilities in Victoria and only occurs on relatively remote islands. In contrast, *L. arboreus* and *E. californica* are much more closely associated with settled areas and are scarce or absent from the island groups where *R. californicus* has been found. Finally, four of the five Canadian populations of *R. californicus* show little or no evidence of hybridization with *R. occidentalis* (Fairbarns pers. obs.).

HABITAT

Habitat requirements

In Canada, *R. californicus* is restricted to coastal meadows in a small area of islands and islets just offshore of southeastern Vancouver Island. This area, which is highly correlated with the distribution of Garry Oak, has mild winters and dry, cool summers.

Winters are mild as a result of relatively warm, low-pressure areas that dominate coastal areas. The Coast Mountains impede the westward movement of cold high-pressure systems. Winter temperatures along the coast are moderated by proximity to the ocean waters immediately offshore, which are dominated by the mild Davidson Current from October to April (Peterson and Mackas 2001).

January, the coldest month, has a daily mean temperature of 4.6° C and a mean daily minimum of 2.5° C¹. Mild winter temperatures characterize the southeast coast of Vancouver Island. Southeast Vancouver Island also has drier winters than elsewhere in south coastal British Columbia. It lies in the rain-shadow of the Vancouver Island Mountains and Olympic Mountains, which intercept moisture from the prevailing systems that move in from the Pacific. December, which is also the wettest month, receives an average of 108 mm of precipitation (but little snow).

A large semi-permanent high-pressure area extends over the northeastern Pacific during the summer months, dominating the general circulation in western Canada, thereby creating cool and dry summers. The Olympic and Vancouver Island Mountains continue to intercept much of the moisture from systems moving into the region. May, June, July and August each bring less than 25 mm of mean monthly precipitation and pronounced moisture deficits develop. Temperatures are greatly mediated by proximity to the ocean and daily maximum temperatures often increase by several degrees as one moves inland on a warm summer day.

The combination of mild, relatively clear winters and dry clear summers, along with a southern location, determine that southeast Vancouver Island has the greatest annual amounts of sunshine in British Columbia. The scarcity of snow and rarity of hard frosts allows vegetation to remain green throughout the winter. Strong moisture deficits turn the meadows brown in mid-summer.

Edaphic factors strongly limit the distribution of *R. californicus* within the islets and islands where it occurs. It is restricted to coastal meadows that remain open because of: (1) wind exposure along shore, (2) summer drought stress in thin soils and (3) winter seepage that waterlogs soils preventing taller vegetation from dominating. *Ranunculus californicus* is restricted to areas within 50 m of the coast where frequent coastal fogs occur in the autumn and winter and the climate is buffered against deep frosts in the winter.

¹ All figures are 1898-1988 climatic normals for Victoria Gonzales Heights, a coastal station 69 m above sea level and close to many maritime meadows that contain species at risk. Actual climatic regimes of many maritime meadows are even milder because they are closer to the ocean and at lower elevations. Source: Climatic Normals (Environment Canada); web site accessed Sept. 2003: http://www.msc-smc.ec.gc.ca/climate/climate_normals_1990/show_normals_e.cfm?station_id=258&prov=BC

Trends

The amount of potential habitat on southeast Vancouver Island and the adjacent offshore islands has declined greatly over the past century as maritime meadows have been developed for residential and recreational use. The islands where *R. californicus* occurs have been protected from major developments due to their relatively inaccessible nature. However, approximately 30-40% of the suitable meadow habitat has been heavily modified by livestock grazing in the past and two of the four large meadow complexes have been homesteaded. Areas that have been grazed repeatedly are now dominated by a mix of invasive grasses and forbs. These appear to restrict or prevent the growth of *R. californicus*. Another meadow complex is covered, in part, by a communications lease and an electrical power right-of-way. Numerous outbuildings have been constructed on the site, four radio towers are maintained there, and there are plans to build a new dock, trails and outbuildings in the meadow area in 2009 (Kennedy, pers. comm. 2008).

Portions of at least one of the remaining meadow patches have been managed for the growth of Camas species (*Camassia* spp.), a traditional food crop among First Nations. *Ranunculus californicus* appears to be scarce or absent within the managed area despite its presence in similar habitat along its fringe.

Even those meadow areas that do not appear to have been heavily grazed by livestock, homesteaded, or managed for Camas harvest have been moderately altered as a result of invasion by alien weeds. These include shrubs: Scotch Broom (*Cytisus scoparius*, Himalayan Blackberry (*Rubus armeniacus*); several grasses: Sweet Vernal Grass (*Anthoxanthum odoratum*), Ripgut Brome (*Bromus rigidus*), Barren Brome (*Bromus sterilis*), Cheatgrass (*Bromus tectorum*), Common Velvetgrass (*Holcus lanatus*), Canada Bluegrass (*Poa compressa*), Kentucky Bluegrass (*Poa pratensis*); and several forbs: Bull Thistle (*Cirsium vulgare*), Stork's-bill (*Erodium cicutarium*), Dovefoot Geranium (*Geranium molle*), English Ivy (*Hedera helix*), Hairy Cat's-ear (*Hypochaeris radicata*), Ribwort Plantain (*Plantago lanceolata*), Sheep Sorrel (*Rumex acetosella*), Sow Thistle (*Sonchus oleraceus*), Dandelion (*Taraxacum officinale*), Little Vetch (*Vicia hirsuta*), Common Vetch (*Vicia sativa*).

Habitat protection/ownership

Three of the four verified populations of *Ranunculus californicus* lie partially or entirely within Provincial Parks or Ecological Reserves managed by B.C. Parks. The fourth population is on an Indian Reserve. None of the sites where it occurs have management plans to protect the habitat of *R. californicus* from alien invasives or succession, although B.C. Parks has prepared a proposal to control one of the invasive species (*Cytisus scoparius*) in and around populations of *R. californicus* within Ecological Reserves (J. Benning pers. comm. 2005).

BIOLOGY

There is very little published information relevant to reproduction and dispersal, germination, seedling ecology, survivorship, herbivory or physiology of *R. californicus* in Canada. The following notes include observations by the first writer of this status report.

General

Ranunculus californicus is normally a perennial species but sometimes acts as an annual in Canada (Brayshaw 1989). Plants that have been dormant during the summer drought begin to break shoot dormancy in the late summer or early fall after the first significant rains break the long summer drought. Several perennial species that occur with *R. californicus* have mixed populations, with some plants germinating in the fall and others in the spring. Fall growth allows such species to develop a substantial mass of shoots and roots that appears to lead to high fecundity. Plants that do not break dormancy until spring are less susceptible to frost damage but tend to produce fewer fruits. It is not known whether some individuals of *R. californicus* 'bet-hedge' by breaking shoot dormancy in the spring.

Reproduction

Ranunculus californicus is pollinated by bees (Dobson 1988). It, like other members of the genus, may also be pollinated by flies and thrips (Baker and Druden 1991).

No evidence of vegetative reproduction has been observed in *R. californicus*. Van Kleunan (pers. comm. 2003) wonders if it could be "that *R. californicus* reproduces vegetatively through layering of stems... It might also reproduce vegetatively from the roots; I have seen that on a few occasions in *R. reptans*." Careful examination of plants in the Canadian populations has not revealed any evidence of vegetative layering.

Germination and seedling ecology

The timing of seed germination is unknown and there is no information on the germination ecology of the species.

Survival

Survivorship curves have not been developed for *R. californicus*, nor has anything been reported that would assist in determining recruitment or conservation concerns.

Herbivory

No herbivory was observed in any of the populations. Large and small mammals appear to be scarce or absent from most of the islands and islets where it occurs, although part or all of each of the four Canadian populations has been exposed to livestock grazing in the past.

Dispersal

No information has been found for this species, although buttercups in general are eaten by voles (Noordhuis 1993), and are thought to be dispersed both by adhesion (fur, feathers, clothing) and for short distances by wind. Some species (e.g., *R. acris*) are reported to germinate after passage through animal digestive systems, and thus would be dispersed by movement of the herbivore. The scarcity or absence of mammals from the islets and island where most Canadian populations occur may limit dispersal in recent years, although one of the islands has two residences, each with dogs.

Van Kleunan (pers. comm. 2003), who has done extensive work on the conservation genetics of *Ranunculus reptans*, is not aware of any studies on seed dispersal in *Ranunculus californicus*. The Canadian populations are potentially highly fragmented since there is likely very little movement of propagules among the island populations.

Physiology

Mooney *et al.* (1983) studied photosynthetic responses of coastal bluff plants, including *R. californicus*, to temperature, light and humidity. They found that the coastal plants investigated are characterized by moderate photosynthetic capacities, and that the plants are adapted to conserve moisture during the dry summer season. Weber (1937) reports that *R. californicus* is a skin irritant. Buttercups, in general, have a glycoside compound in the above-ground structures that can cause dermatitis when the plant juice comes in contact with skin (<http://museum.gov.ns.ca/poison/?section=species&id=111>). The plant's occurrence on exposed coastal bluffs and shoreline, suggests it is tolerant of salt spray and wind.

POPULATION SIZES AND TRENDS

Search effort

Ranunculus californicus has distinctive, showy, multi-petalled flowers that attract attention and are not easily overlooked. Suitable sites have been surveyed repeatedly since the early 1980s in a series of projects designed to document the distribution of rare plants in open meadows in southeast Vancouver Island and the Gulf Islands. The principal investigators included Adolf and Oldriska Ceska, Matt Fairbarns, Hans Roemer, Jenifer Penny, Chris Brayshaw, Harvey Janszen, Frank Lomer and George Douglas, all of whom are familiar with the species. Fairbarns (2005) conducted a detailed search for *R. californicus* in forty-one meadow complexes on southeast Vancouver Island and offshore islets and islands between 2002 and 2005. The survey included detailed examination of every meadow complex within the known extent of occurrence in Canada and most meadow complexes with similar vegetation conditions within 20 km of the known extent of occurrence. Each site was visited during the flowering season and thoroughly searched on foot. No new populations were detected and some populations reported in the past (e.g., Rocky Point, Bellhouse Park, Uplands Park) were found to lack *R. californicus*, and were likely originally misidentified, although “extra”-petalled specimens of *R. occidentalis* were sometimes present. Sites close to confirmed populations of *R. californicus* (e.g., Uplands Park) sometimes contained plants that appeared to be hybrids (see above).

Abundance

Ranunculus californicus was first reported from Canada in 1952 from Trial Island but the collection label provides no information on its abundance.

Records from 2003 and 2005 indicate there are four or five populations with a total of between 3,112 and 3,542 individuals in Canada (Table 1)². Population 5, which consists of less than 50 plants and occupies an area of less than 200 m² (Janszen pers. comm. 2005), could not be visited because it occurs on private land and landowner permission could not be obtained. Brayshaw (1989) concluded that the plants in population 5 belonged to *R. californicus* but provided no information on their form, in sharp contrast to the extensive notes he provided on the morphology of the other populations of *R. californicus* he reported. Janszen (pers. comm. 2005) has observed population 5 in several different years and suggests it may be simply a population of *R. occidentalis* that has some plants with more petals than is normal for the species.

² Only plants that had all of the main identification features of *Ranunculus californicus* were counted.

Table 1. *Ranunculus californicus* population data

| Population | Observation | Extent (total area of occupancy) | Number of Mature Individuals |
|-------------------------|----------------|--|--|
| 1.1 Trial Island | Hardy 1952 | first record from the location, extent and size of the population not noted | |
| | Fairbarns 2005 | 800 m ² | 10 |
| 1.2 Lesser Trial Island | Brayshaw 1982 | first record from the location, extent and size of the population not noted | |
| | Fairbarns 2005 | 1,200 m ² | 170-180 |
| 2 Discovery Island | Brayshaw 1985 | first record from the location, extent and size of the population not noted | |
| | Fairbarns 2003 | 150 m ² | 27 |
| | Fairbarns 2005 | 350 m ² | 35 |
| 3.1 Alpha Islet | Pojar 1976 | first record from the location, extent and size of the population not noted | |
| | Brayshaw 1983 | unknown | unknown |
| | Fairbarns 2005 | 4,000 m ² | 400-600 |
| 3.2 Griffin Island | Brayshaw 1983 | first record from the location, extent and size of the population not noted | |
| | Fairbarns 2005 | 4,000 m ² | 1,900-2,100 |
| 4 West Chatham Island | Fairbarns 2005 | first record from the location | |
| | | 1,500 m ² | 570-590 |
| 5 Saturna Island | Janszen 1978 | first record from the location, extent and size of the population not noted | |
| | Janszen 2005 | < 50 Janszen indicates plants may simply be <i>R. occidentalis</i> | <200 |
| Total | | < 2 hectares | 3077-3515 [excluding the questionable pop. 5] |
| Church Hill | Ceska 1977 | Report rejected by Fairbarns, plants appear to be low-growing <i>R. occidentalis</i> with a few "extra" petals | |

Fluctuations and trends

There is no reliable long-term information on past population sizes so fluctuations and trends in the size of extant populations cannot be determined for this perennial species.

Rescue effect

Ranunculus californicus is locally abundant on San Juan and Lopez Islands in Washington State. These populations are separated from the nearest suitable habitat in Canada by almost 15 km of open ocean. In the event of catastrophic loss, the chances of re-colonization of B.C. populations by seed carried from the San Juan Islands by birds is very unlikely in any time scale relevant to present-day conservation planning (P. Arcese pers. comm. 2006). In the absence of evidence to the contrary, it appears there is little likelihood of rescue effect from Washington populations.

LIMITING FACTORS AND THREATS

Habitat loss

The loss of habitat may continue into the future if First Nations pursue opportunities for economic development in and around population 4. Portions of population 1 lie within an ecological reserve but the population extends onto unprotected lands and may be lost if plans to increase development of a communications lease are pursued. Population 5 occurs on a very valuable private waterfront property that has a high potential for development; however, this population may have been incorrectly identified as *R. californicus* and may be *R. occidentalis*. Populations 2 and 3 lie entirely within parks or ecological reserves where they and their habitat are protected by legislation.

Threat associated with recreational activities

Population 2 is threatened by recreational use and outdoor recreation development. A portion of the population occurs in the campground of a provincial marine park and has been mown repeatedly. The balance of the population occurs in the immediate vicinity of a walking trail through the marine park. Populations 1 and 3 occur in Ecological Reserves while population 4 occurs on an Indian Reserve. Recreational use is discouraged at all three sites but there is no effective enforcement. These sites are used by picnickers who arrive by boat from nearby Victoria. Boat visits are likely to increase at all of these locations as the number of people in southeast Vancouver Island increases. Species such as *R. californicus* that favour level, open meadows are at greatest risk because these are the most attractive areas for walking, picnicking and camping.

Threat associated with altered fire regimes

Pre-European fire regimes in the dry coastal belt of southeast Vancouver Island are probably more complex than is generally reported. There is no doubt that First Nations in the area used fire extensively to stimulate the growth of food species (Turner and Bell 1971)-particularly camas bulbs, which provided a storable form of starch. Fire may also have been used to improve forage for game species (elk and deer).

Frequent low-intensity burns killed young Red Alder and Douglas-fir and checked the growth of Trembling Aspen and most shrub species-notably Common Snowberry, *Symphoricarpos albus*, and Nootka Rose, *Rosa nutkana* (Fairbarns pers. obs.). The increase in light levels and decrease in competition resulting from fires favours the growth of low herbaceous plants such as *R. californicus*. Composition of the herb layer is altered following fire since many highly competitive plants decrease under a regime of frequent burning.

First Nations fire management practices also played a significant role in the development (and therefore fertility) of soils. The organic component of the upper mineral horizon was not greatly reduced by low-intensity fires because it accumulated below the surface through the *insitu* decomposition of root material. In contrast, the surface organic materials did burn, rather than accumulate, releasing nutrients. Since the main inputs of organic matter came from herbs rather than coniferous trees, the upper mineral horizon also had a relatively neutral reaction in sharp contrast to the acidic nature of soils under Douglas-fir forests (Broersma 1973). As well, the frequent fires provided a continuous supply of 'safe sites' where the small seeds of *R. californicus* may have been able to germinate and grow without the stifling influences of litter and surface organic horizons.

Most First Nations burning has ended and apart from experimental burns, fires are now suppressed throughout the range of *R. californicus*. In the absence of burning, the availability of suitable habitats has likely diminished. Even if burning programs were re-established they would now probably favour easily dispersed invasive annuals and perennials capable of pre-empting *R. californicus* on freshly exposed safe sites. This has been seen on one site, where one First Nation has burned adjacent to a *R. californicus* in order to manage camas for harvest.

Threats associated with invasive alien plants

Invasive plants pose the most striking threat in most open habitats in southwestern British Columbia. Extant populations of *R. californicus* were generally observed growing in a matrix dominated by many invasive alien shrubs, grasses and herbs. Invasive species threaten *R. californicus* in many ways. Shrubs (e.g., *Cytisus scoparius*, *Rubus armeniacus*) and tall grasses (e.g., *Anthoxanthum odoratum*, *Bromus sterilis*, *Holcus lanatus*) shade out *R. californicus*. Many alien grasses and forb species may out-compete *R. californicus* for moisture (particularly in the late spring and early summer) and nutrients. The most serious threat posed by alien annual species is their ability to pre-empt 'safe sites'-recent soil disturbances that would be favoured by *R. californicus* were it not for the ubiquity of annual invasives. Perennial aliens may have established permanent cover in sites that formerly provided a constant supply of bare mineral soil.

SPECIAL SIGNIFICANCE OF THE SPECIES

Canadian populations of *R. californicus* are of scientific interest because its distribution suggests that it is a relict from the Hypsithermal (Xerothermic) Interval, a period of warm, dry climate 4,000-6,000 years b.p. (Hebda 1983). British Columbia populations are part of a small population that extends into northwestern Washington but is highly disjunct from the main range of the species. Sharsmith (1965) reports that fruits of this species “were eaten by the California Indians”, while Calacademy (2002) reports that the seeds of this species were eaten by Native Americans, and they were “parched and beaten into a flour.” There is no evidence of First Nations use of Canadian populations.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Ranunculus californicus is not covered under the Convention on International Trade in Endangered Species (CITES), the *Endangered Species Act* (USA) and is not on the IUCN Red List. NatureServe globally ranks it as G5: secure (NatureServe 2003).

The Washington State Natural Heritage Program ranks it as S1 (critically imperiled) in their state. The Oregon Natural Heritage Information Centre and California Natural Diversity Database rank the species as SNR (status not ranked) in their jurisdictions. Major floras (Peck 1941, Hitchcock *et al.* 1964, Munz and Keck 1965, and Wilken 1993) do not indicate that *R. californicus* is rare in either Oregon or California, which suggests that the SNR designation indicates underlying rank of S4 or S5.

In British Columbia, it is currently ranked as S1 (critically imperiled). It does not occur elsewhere in Canada. The British Columbia Conservation Data Centre also places it on the provincial Red List, which is composed of species that the provincial government recognizes as potentially threatened or endangered in BC. Such a listing, however, does not provide the species with legal protection. The General Status of Wild Species in Canada recognizes this species as “May be at Risk”. British Columbia does not provide any species-level protection for *R. californicus*.

TECHNICAL SUMMARY

Ranunculus californicus

California Buttercup

Renoncule de Californie

Range of Occurrence in Canada: British Columbia

Demographic Information

| | |
|---|---------------------------------|
| Generation time (average age of parents in the population) | Unknown but perhaps several yrs |
| Observed percent reduction in total number of mature individuals over the last 10 years. | Unknown |
| Projected percent reduction in total number of mature individuals over the next 10 years. | Unknown |
| Observed percent reduction in total number of mature individuals over any 10 years period, over a time period including both the past and the future. | Unknown |
| Are the causes of the decline clearly reversible? | No |
| Are the causes of the decline understood? | Yes |
| Have the causes of the decline ceased? | No |
| Observed trend in number of populations | Stable |
| Are there extreme fluctuations in number of mature individuals? | Unknown |
| Are there extreme fluctuations in number of populations? | No |

Number of mature individuals in each population

| Population | N Mature Individuals |
|--|-----------------------------|
| 1: 180-190 2: 27-35 3: 2300-2700 4: 570-590 5: excluded since it may be <i>Ranunculus occidentalis</i> | |
| Grand Total [excluding population 5 whose identity is disputed] | 3077-3515 |

Extent and Area Information

| | |
|---|--|
| Estimated extent of occurrence (km ²) | <20 km ² |
| Observed trend in extent of occurrence | Stable |
| Are there extreme fluctuations in extent of occurrence? | No |
| Estimated area of occupancy (km ²) 8 using 2x2 grid; 4 using 1x1 grid [population 5 is excluded] | 2x2 grid = 8km ² 1x1 grid = 4km ² |
| Observed trend in area of occupancy | Unknown |
| Are there extreme fluctuations in area of occupancy? | No |
| Is the extent of occurrence or area of occupancy severely fragmented? | Unknown |
| Number of current locations Saturna Island population (#5) is excluded | 4 |
| Trend in number of locations | Stable |
| Are there extreme fluctuations in number of locations? | No |
| Observed trend in area of habitat | Stable |

Quantitative Analysis

| | |
|--|--|
| | Ex.: % probability of extinction in 50 years |
|--|--|

Threats (actual or imminent, to populations or habitats)

| |
|--|
| existing threats: recreational use, invasive species; planned development for 2009 on communications lease (pop. 1) ; potential site development on Indian Reserve (pop. 4). |
|--|

Rescue Effect (immigration from an outside source)

| | |
|--|-----------|
| Status of outside population(s)? USA: critically imperiled in WA, secure in CA, status in OR unknown | |
| Is immigration known or possible? | Unknown |
| Would immigrants be adapted to survive in Canada? | Likely |
| Is there sufficient habitat for immigrants in Canada? | Likely |
| Is rescue from outside populations likely? 15 km of ocean between San Juan Islands and the Canadian populations | No |

Current Status

| |
|--------------------------|
| COSEWIC: Endangered 2008 |
|--------------------------|

Status and Reasons for Designation

| | |
|--|--|
| Status: Endangered | Alpha-numeric code: B1ab(iii)+2ab(iii) |
| Reasons for designation: A perennial species restricted to two small island groups adjacent to Victoria, BC. The four small confirmed populations are found within coastal meadow habitats where the extensive spread of invasive plants place the species at risk. Potential impacts on the populations include planned enlargement of communications towers at one site and unauthorized recreational visitors to the island habitats. | |

Applicability of Criteria

| |
|---|
| Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Unknown total decline. |
| Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii). Extent of Occurrence and Area of Occupancy are well below thresholds for Endangered with only four extant confirmed Canadian populations. Habitat quality is declining due to the extensive presence of invasive species. |
| Criterion C (Small and Declining Number of Mature Individuals): n/a. Population size is <10,000 plants but no other subcriteria apply. |
| Criterion D (Very Small Population or Restricted Distribution): Meets Threatened D2 based on an Index of Area of Occupancy <20 km ² with the 4 confirmed populations subject to continuing impacts of the spread of invasive plants that may dominate the habitats in the near future. |
| Criterion E (Quantitative Analysis): None available. |

ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

The authors would like to acknowledge the generous assistance provided by Cheryl Bryce (Songhees Nation), Robb Bennett (B.C. Ministry of Forests), Erica Wheeler (University of Victoria), Hans Roemer (Botanist), Jenifer Penny (B.C. Conservation Data Centre), Brian Reader (Parks Canada Agency), Joe Benning and Sarah Joannis (B.C. Parks), Harvey Janszen (Botanist) and Adolf and Oluna Ceska (Ceska Geobotanical Consulting).

Authorities consulted

Achuff, Peter. National Botanist. Ecological Integrity Branch. Parks Canada. Waterton Lakes National Park, Alberta.

Caplow, Florence. Botanist, Washington Natural Heritage Program. Department of Natural Resources. PO Box 47014. Olympia, Washington.

Cunnington, David. Endangered Species Biologist. Pacific Wildlife Research Centre. Delta, British Columbia.

Donovan, Marta. Biological Information Coordinator, BC Conservation Data Centre, Ministry of Sustainable Resource Management. CDC Data Request. February 10th, 2003, February 17, 2003.

Fraser, Dave F. Endangered Species Specialist, BC Ministry of Environment, Environmental Stewardship Division, Ecosystems Branch. 2975 Jutland Road, Victoria, BC.

Goulet, Gloria Coordinator – Aboriginal Traditional Knowledge. Canadian Wildlife Service. Ottawa, Ontario.

Penny, Jenifer. Program Botanist, BC Conservation Data Centre, BC Ministry of Environment.

INFORMATION SOURCES

Atkinson, S. and F. Sharpe. 1993. *Wild Plants of the San Juan Islands* (2nd edition). The Mountaineers, Seattle. 191 pp.

Arcese, P. Pers. comm. 2006. *E-mail correspondence to M. Fairbarns*. January 2006. Professor and Co-director of the Centre for Applied Conservation Research. University of British Columbia. Vancouver, British Columbia.

Baker, James Dillon and Robert William Druden. 1991. Thrips-mediated self-pollination of two facultatively xenogamous wetland species. *American Journal of Botany* 78 (7): 959 – 963.

Benning, Joe. 2005. *Meeting with Matt Fairbarns*. November 4, 2005. Area Supervisor (Saanich and southern Gulf Islands) B.C. Parks. Victoria, British Columbia.

- Benson, Lyman. 1948. A treatise on the North American Ranunculii. *American Midland Naturalist* 40: 1-261.
- Brayshaw, T.C. 1989. Buttercups, waterlilies, and their relatives (the Order Ranales) in British Columbia, Victoria. Royal British Columbia Museum Memoir 1.
- Brayshaw, T.C. 2003. *E-mail correspondence to B. Klinkenberg*. Botanist. Vancouver, British Columbia.
- Broersma, K. 1973. Dark soils of the Victoria area, British Columbia. M.Sc. Thesis. Department of Soil Science, University of British Columbia. Vancouver. 110 pp.
- Buckingham, Nelsa M., Edward G. Schreiner, Thomas N. Kaye, Janis E. Burger, and Edward L. Tisch. 1995. *Flora of the Olympic Peninsula*. Northwest Interpretive Association, Seattle. 199 pages.
- Calacademy. 2002. Buttercup: *Ranunculus californicus* (Ranunculaceae). Web site: <http://www.calacademy.org/research/botany/wildflowers/names/202350.htm> [Accessed: February 18, 2003].
- Ceska, Adolf. 2003. *E-mail correspondence to B. Klinkenberg*. Botanist. Victoria, British Columbia.
- Coonen, L.P. 1939. The chromosomes of *Ranunculus*. *American Journal of Botany* 26: 49-58.
- Darlington, C.D. and A.P. Wylie. 1955. *Chromosome atlas of flowering plants*. George Alland & Unwin Ltd., London.
- Dobson, Heidi E.M. 1988. Survey of pollen and pollenkitt lipids: chemical cues to flower visitors. *American Journal of Botany* 75 (2): 170 –182.
- Environment Canada. 2003. Climatic normals. Web citation: http://www.msc-smc.ec.gc.ca/climate/climate_normals_1990/show_normals_e.cfm?station_id=258&prov=BC Accessed September 2003.
- Fairbarns, M. 2005. California Buttercup *Ranunculus californicus* in southwestern British Columbia. Report to the British Columbia Conservation Data Centre. 18 pp.
- Hebda, R.J. 1983. Late glacial and post glacial vegetation history at Bear Cove Bog, northeast Vancouver island. *Canadian Journal of Botany* 61: 3172-3192.
- Hitchcock, C.L., A. Cronquist, M. Ownbey and J.W. Thompson. 1964. Vascular plants of the Pacific Northwest. Part 2. University of Washington Press, Seattle, WA.
- Janszen, Harvey. 2005. *Telephone conversation with Matt Fairbarns*. Amateur botanist. Saturna Island, British Columbia.
- Kennedy, Blaine. Pers. comm. 2008. Rogers Communications. Email communication on May 28, 2008 to M. Fairbarns. Email: Blaine.Kennedy@rci.rogers.com.
- Mooney, H.A., C., C. Field, W. E. Williams, J. A. Beery and O. Bjorkman. 1983. Photosynthetic characteristics of plants of a Californian cool coastal environment. *Oecologia* 57: 38-42.

- Munz, P.A. and D.D. Keck. 1965. *A California Flora*. University of California press. Berkeley and Los Angeles. 1681 pp.
- NatureServe Explorer: An online encyclopaedia of life [web application] 2002. Version 1.6. Arlington, Virginia, USA: NatureServe. Available: <http://www.natureserve.org/explorer> (Accessed February 18, 2003).
- Noordhuis, R. 1993. Buttercups (Ranunculaceae) as food of voles (Microtidae). *Lutra* 36 (2): 71-76.
- Peck, M.E. 1941. *A manual of the higher plants of Oregon*. Binford and Mort, Portland Oregon. 866 pp.
- Petersen, W.T. and D.L. Mackas. 2001. Shifts in zooplankton abundance and species composition off central Oregon and southwestern British Columbia. *Pices Press* 9: 28-29.
- Pojar, Jim. 2003. *E-mail correspondence to R. Klinkenberg*. Botanist. Smithers, British Columbia.
- Sharsmith, Helen. 1965. *Spring Wildflowers of the San Francisco Bay Region*. University of California Press, Los Angeles.
- Stebbins, G.L. 1950. *Variation and evolution in Plants*. Columbia University Press, New York.
- Thomas, John Hunter. 1961. *Flora of the Santa Cruz Mountains: a manual of vascular plants*. Stanford University Press, Stanford.
- Turner, N.C. and M.A.M. Bell. 1971. The ethnobotany of the coast Salish Indians of Vancouver Island. *Economic Botany* 25:63-39.
- Van Kleunan, Mark. 2003. Personal communication to B. and R. Klinkenberg.
- Weber, L.F. 1937. External causes of dermatitis: a list of irritants. *Archs. Derm. Syph.* 35: 129.
- Whittermore, A.F. 2008. Personal communication to M. Fairbarns.
- Whittermore, A.F. and B.D. Parfitt. 1997. Ranunculaceae. In: *Flora of North America* Editorial Committee, eds. 1993+. *Flora of North America North of Mexico*. 12+ vols. New York and Oxford. Vol. 3, pp. 356-357.
- Wild Species. 2005. *Wild Species 2005: The General Status of Species in Canada*. <http://www.wildspecies.ca/wildspecies2005/index.cfm?lang=e>
- Wilken, D. 1993. *Ranunculus* pp. 913-928 In Hickman, J.C. (ed.) *The Jepson Manual: Higher Plants of California*. University of California Press. Berkeley. 1400 pp.

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Matt Fairbarns has a B.Sc. in Botany from the University of Guelph (1980). He has worked on rare species and ecosystem mapping, inventory and conservation in western Canada for approximately 20 years.

Brian Klinkenberg is an Associate Professor of Geography at the University of British Columbia. His research includes a focus on environmental GIS and biogeography of rare species, including rare species dispersion on the landscape. He is author or co-author of several COSEWIC status reports, and is presently project coordinator for E-Flora BC.

Rose Klinkenberg has a B.Sc. in Field Biology from the University of Toronto. She has worked on natural areas inventory and evaluation, rare and endangered species assessments, and vegetation management since 1976.

COLLECTIONS EXAMINED

The following collections were consulted:

Royal BC Museum Herbarium (V); University of Victoria Herbarium (UVIC); University of British Columbia Herbarium (UBC).