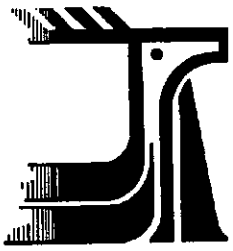

COMMITTEE ON THE
STATUS OF ENDANGERED
WILDLIFE IN CANADA

OTTAWA, ONT. K1A 0H3
(819) 997-4991

COMITÉ SUR LE STATUT
DES ESPÈCES MENACÉES
DE DISPARITION AU
CANADA

OTTAWA (ONT.) K1A 0H3
(819) 997-4991

STATUS REPORT ON THE DELTOID BALSAMROOT *BALSAMORHIZA DELTOIDEA*

IN CANADA

BY

MICHAEL RYAN

AND

GEORGE W. DOUGLAS

STATUS ASSIGNED IN 1996
ENDANGERED

REASON: FEW HIGHLY REDUCED POPULATIONS MAINLY IN THREATENED GARRY OAK HABITATS. AT RISK FROM DEVELOPMENT AND COMPETITION FROM EXOTICS.

OCCURRENCE: BRITISH COLUMBIA

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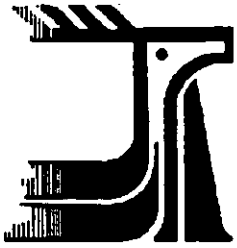
STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA

Deltoid Balsamroot

COMMITTEE ON THE STATUS
OF ENDANGERED WILDLIFE
IN CANADA

COSEWIC



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JUNE 1994

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DEFINITIONS

SPECIES:	"Species" means an indigenous species, subspecies, variety or geographically defined population of wild fauna and flora.
VULNERABLE: (V)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
THREATENED: (T)	A species likely to become endangered if limiting factors are not reversed.
ENDANGERED: (E)	A species facing imminent extirpation or extinction.
EXTIRPATED: (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
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STATUS REPORT ON THE DELTOID BALSAMROOT *BALSAMORHIZA DELTOIDEA*

IN CANADA

BY

MICHAEL RYAN

AND

GEORGE W. DOUGLAS
CONSERVATION DATA CENTRE
BRITISH COLUMBIA MINISTRY OF ENVIRONMENT, LANDS AND PARKS
VICTORIA, BRITISH COLUMBIA
V8V 1X4

STATUS ASSIGNED IN 1996
ENDANGERED

Executive Summary

Description

Balsamorhiza deltoidea (deltoid balsamroot) is a large (20-100 cm tall) perennial herb with large triangular leaves and a large, showy, often solitary, bright yellow head containing both disk and ray flowers. It is distinguished from *B. sagittata* by its lack of both the dense, soft hairs and silvery appearance on the undersides of the leaves.

Distribution

In Canada, *Balsamorhiza deltoidea* is restricted to the dry southeastern side of Vancouver Island. It extends southwards, west of the Cascade Mountains in Washington and Oregon, to California where it occurs along the coast and on the western slopes of the Sierra Nevada.

Population Size and Dynamics

Of the 14 Canadian sites from which *Balsamorhiza deltoidea* has been collected, only five sites have been confirmed recently. The status at an additional four sites remains uncertain and it is believed to be extirpated at five sites. Little is known regarding the specific sizes of past populations although it is likely some of these were larger at one time. The largest population (1700 plants) is located on an native reservation near Campbell River. All other populations number less than 100 plants.

Habitat

Balsamorhiza deltoidea is restricted mainly to xeric exposed sites along the eastern edge of Vancouver Island from Campbell River south to Victoria. Most populations occur in rocky exposed areas where *Quercus garryana* is common. Other associated species include *Cytisus scoparius*, *Symphoricarpos albus*, *Sedum spathifolium*, *Allium cernuum*, *Delphinium menziesii*, *Anthoxanthum odoratum*, and several species of *Bromus*. The largest population at Campbell River is located in an open meadow adjacent to the ocean.

General Biology

Very little information is available regarding the biology of *Balsamorhiza deltoidea*. It emerges in the spring from the perennial taproot followed by flowering. By mid-summer, when drought conditions are prevalent, seed set has occurred and the leaves wither and turn brown. Although seeds are to be relatively easy to germinate, the cultivation of young plants in the Victoria area appears to be difficult because they seem to be very sensitive to soil moisture conditions during the growing season. Compared to the large number of flowers comprising the floral head, seed production is low. No information is available regarding the population dynamics of this species including the extent to which seed remains viable in the soil, the frequency with which recruitment occurs from established seedlings, and the average life-span of mature plants.

Limiting Factors

Development threatens the largest population, located at Campbell River. Populations at other sites, while less directly threatened with development, are endangered by competition

of aggressive introduced species, including *Cytisus scoparius*. This plant directly competes with *Balsamorhiza deltoidea* for resources or prevents the germination and establishment of seedlings. Furthermore, fire suppression appears to have favoured the expansion of some native species including *Symphoricarpos albus* which may also competitively exclude *Balsamorhiza* from existing sites or prevent its establishment at new sites. Specific populations have not been monitored over time, although, given the extent to which *Quercus garryana* vegetation has been altered or destroyed on southern Vancouver Island, it is likely current populations are smaller in size and fewer in number compared to those in the past.

Protection

There is no specific legislation in British Columbia for the protection of rare and endangered species although some populations are located in parks or ecological reserves which provides them some protection from human activities. However, many populations may be endangered by more aggressive plant species which have either been introduced to western North America or have increased in abundance as a result of fire suppression. The largest Canadian population is located on the Campbell River Indian Reserve and receives no protection. Other than the few attempts to cultivate this species in the Victoria area and broadcast seed in suitable habitats, no attempts have been made to introduce this species at new sites. Individuals have attempted to control competing shrubs at some sites but most of these populations only number a few plants and no recruitment, necessary to maintain or increase these populations, appears to be occurring.

Conclusions

Only a few populations of *Balsamorhiza deltoidea* have been found in Canada and all of them are restricted to southeastern Vancouver Island. Some populations only comprise a few individuals and are in danger of extirpation as is the largest population located at Campbell River. It is recommended that *B. deltoidea* be considered an endangered species. The prognosis for this species is not good considering the threats posed by aggressive competitive species including *Cytisus scoparius* which dominate many suitable habitats and directly threaten some populations. Hence, even if all populations were protected from human interference, many populations may eventually disappear as a result of aggressive competitive species. Likewise, much of the *Quercus garryana* vegetation in which *Balsamorhiza deltoidea* is usually found has been extensively altered or destroyed, thus limiting the potential of this species to become established at new sites. It is essential that research on the biology of *Balsamorhiza deltoidea* be initiated so that effective management practices can be implemented to ensure the survival of this species in Canada.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. SPECIES INFORMATION

1. Classification and Nomenclature

Scientific name:

Balsamorhiza deltoidea Nutt.

Bibliographic citation:

Trans. Am. Phil. Soc. II. 8: 351. 1840.

Pertinent synonyms:

none

Common Names:

Deltoid balsamroot
Puget balsamroot

Family Name:

Asteraceae

Major Plant Group:

Angiosperm

History of taxon:

Balsamorhiza deltoidea is one of about a dozen species of balsamroot found in western North America. It was first described by Nuttall from a specimen collected "near the outlet of the Wahlmet" (the Willamette River enters the Columbia River at Portland, Oregon). All species are perennial tap-rooted herbs.

Balsamorhiza, is part of the large family Asteraceae that encompasses about 950 genera and 20,000 species found throughout the world (Bailey and Bailey 1976). The family is divided into 12 or 13 tribes and numerous subtribes. *Balsamorhiza* belongs to the tribe, Heliantheae, which comprises more than 150 genera mostly found in the western hemisphere and are often characterized by yellow ray and disk flowers on scaly receptacles (Bailey and Bailey 1976). There is some confusion regarding the subtribe to which *Balsamorhiza* belongs; Stuessy

(1977) placed it in the subtribe Helianthinae whereas Robinson (1981) placed it in the subtribe Ecliptnae. Recent chemical analysis of *Balsamorhiza sagittata* suggests that *Balsamorhiza* belongs to the latter subtribe (Bohlmann *et al.* 1985).

The species of *Balsamorhiza* have been divided into two sections, *Artorhiza* and *Eubalsamorhiza*. *Balsamorhiza deltoidea* belongs to the former section of which the members are characterized by having large entire leaves while species belonging to *Eubalsamorhiza* generally have pinnatifid leaves (Ownbey and Weber 1943). Genetic barriers between species appear to be few or absent so that hybrids are usually present wherever two species come into contact with one another. This has caused some confusion in the delineation of species (Cronquist 1955). *Balsamorhiza deltoidea* freely interbreeds with *B. careyana* where their ranges overlap in Washington and Oregon. Ownbey and Weber (1943) reported that specimens collected in the Columbia Gorge and the eastern Cascades of Washington and Oregon exhibited characteristics of both species and could not be accurately delineated. However, Cronquist (1955) believed the persistence of ray flowers after flowering was a reliable character that separated most specimens of *B. careyana* from those of *B. deltoidea*. Regardless of these problems, specimens collected in British Columbia and along the west coast of the United States are easily identified as *B. deltoidea*.

2. Description

Taxonomic Description

Balsamorhiza deltoidea

[Description from Cronquist (1955)]

General: Perennial with a deep-seated, woody taproot; stems 20-100 cm tall, usually with several strongly reduced, narrow leaves.

Leaves: Mostly basal, long-petiolate, the blade mostly triangular, up to 30 cm long and 20 cm wide, green inconspicuously stiff-hairy and often glandular, often crenate.

Flowers: Heads solitary or with a few reduced ones below, rays bright yellow, 2-5 cm long, commonly 13 or 21, soon deciduous; involucres only slightly or scarcely woolly, the outer bracts tending to be enlarged and leafy.

Fruits: Achenes glabrous; pappus absent.

Illustrations

1) see p. 105 in Cronquist (1955).
2) see Plate 190 in Rickett (1971).
3) see Fig. 5143 in Abrams and Ferris (1960).

Diagnostic Features

Only two species of *Balsamorhiza* occur in Canada; *B. deltoidea* and *B. sagittata*. *Balsamorhiza deltoidea* is distinguished by its inconspicuously stiff-hairy leaves that do not appear as a silvery tint on the underside of leaves like the dense soft-hairy leaves of *B. sagittata*. In addition, the woolly hairs on the involucre of *B. deltoidea* are less dense.

In the United States, the only other species likely to be confused with *B. deltoidea* is *B. careyana,* which has ray flowers that become papery and remain attached after anthesis unlike *B. deltoidea* where the ray flowers are deciduous. *B. deltoidea* tend to be thinner with fewer distinct veins than those of *B. careyana*. According to Ownbey and Weber (1943), these two species overlap in their distributions along the Columbia Gorge and the eastern Cascades of Washington and Oregon whereas Cronquist (1955) contended that they overlap only in the Columbia Gorge.

3. Distribution

Balsamorhiza deltoidea occurs on the west coast of North America from southwestern British Columbia along the western slopes of the Cascade Mountains in Washington and Oregon to the western slopes of the Sierra Nevada in California (Figure 1). In Canada, it is restricted to southeastern Vancouver Island.

4. Climate

The climate on the southeastern side of the island is characterized by mild wet winters and warm dry summers in which the bulk of the rainfall (95%) occurs during the winter months. Annual rainfall is particularly low in the southeastern corner of Victoria which receives about one-third of the rainfall to that west of Victoria (Figure 2).

5. Habitat

Balsamorhiza deltoidea tends to occupy very dry microsites where soils are shallow and sites are exposed or partially shaded by individual trees. Shrub species, particularly *Cytisus scoparius*, are often present as scattered individuals but do not usually form dense thickets, as they do in other areas, possibly because soils are too shallow. The ground tends to be dominated by a mixture of introduced grasses including *Dactylis glomerata*, *Poa* sp., *Cynosurus echinatus*, and *Anthoxanthum odoratum*. Soils vary from shallow dark brown brunisols to brownish-red brunisols.

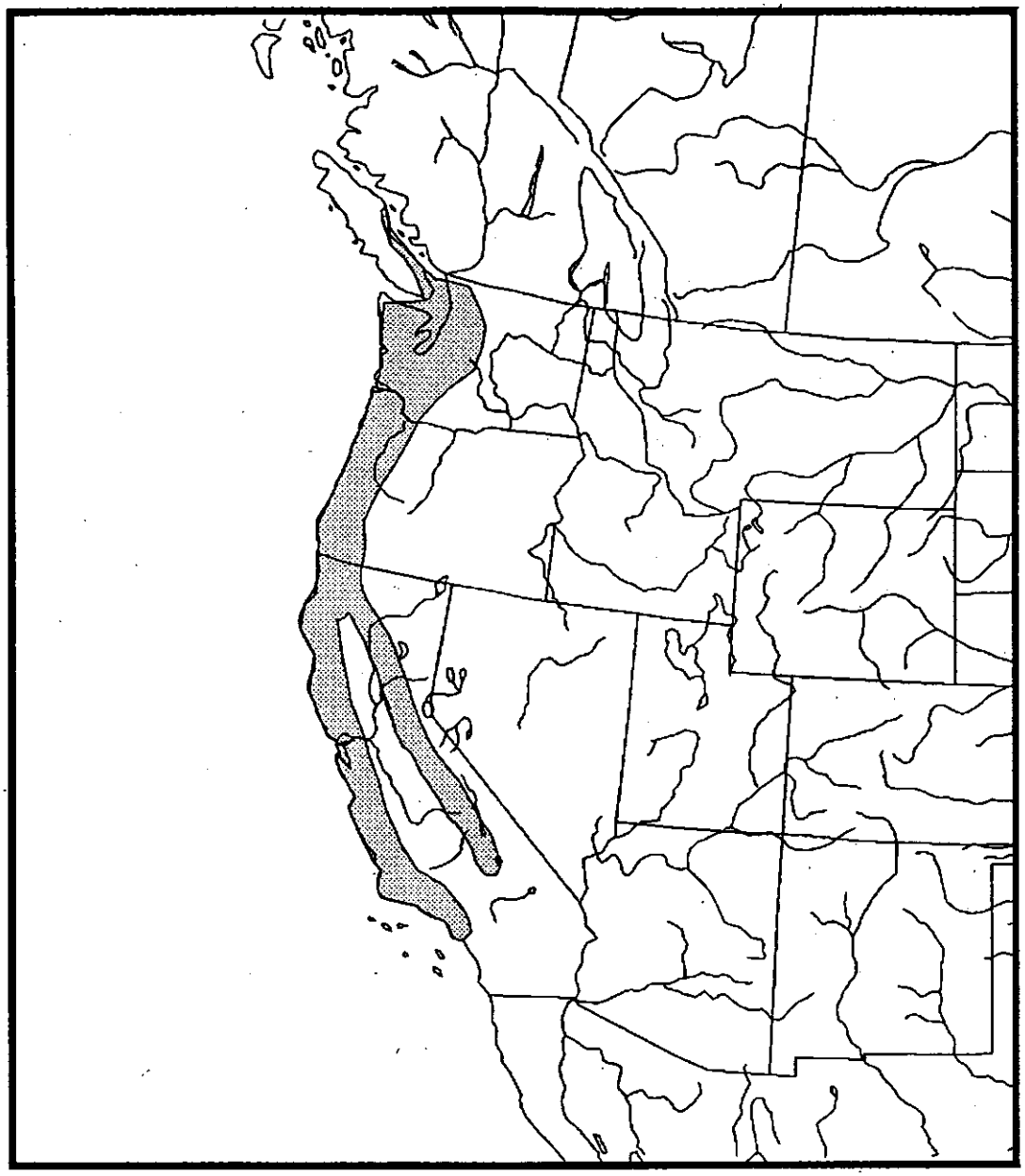

Figure 1. Range of *Balsamorhiza deltoidea*.

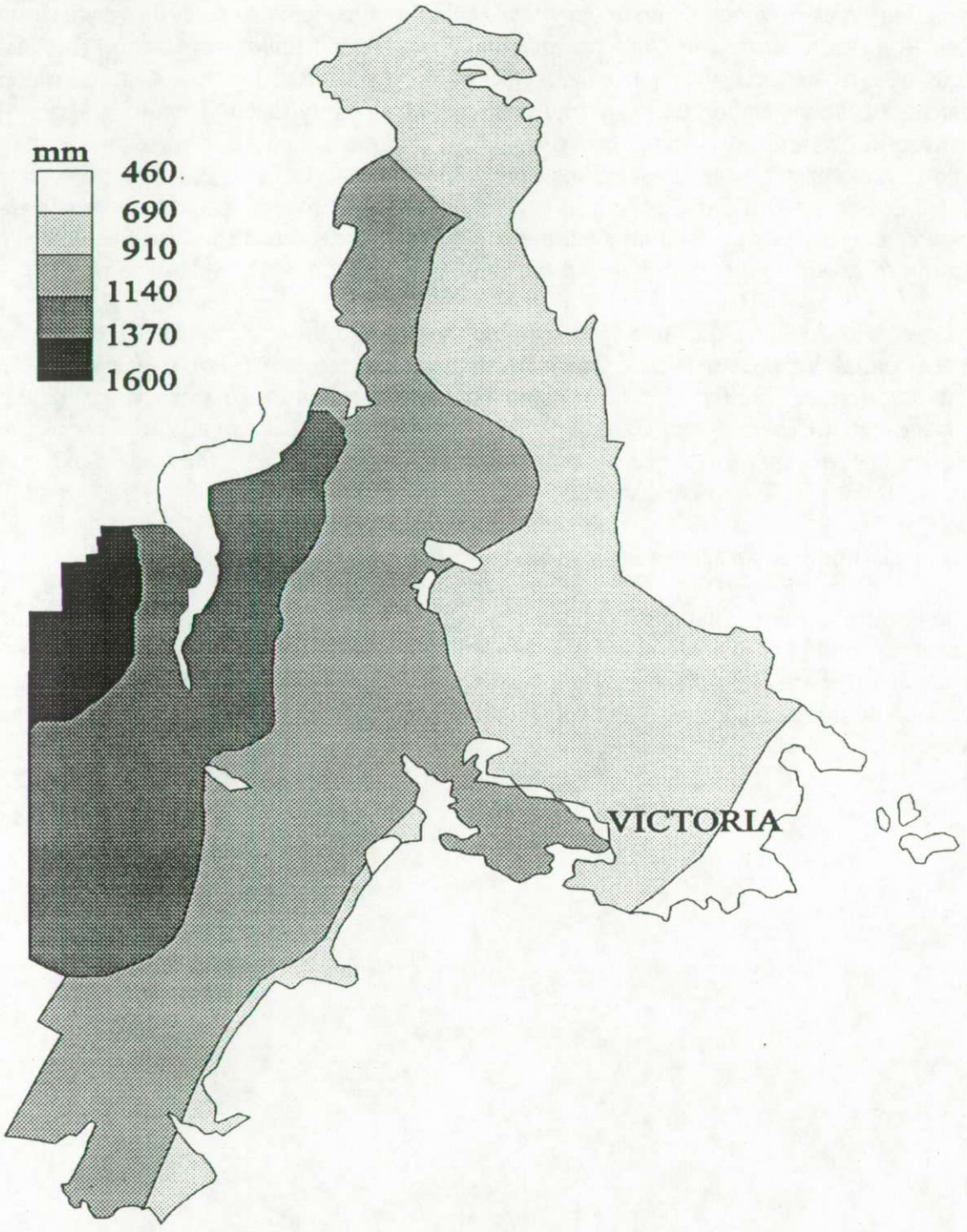

Figure 2. Average annual rainfall in the Victoria region. Redrawn from McMinn et al. (1976).

Although it is possible that *Balsamorhiza deltoidea* has been collected throughout most of the vegetation types in which *Quercus garryana* is a common element, recently verified populations are restricted to *Quercus garryana-Holodiscus discolor* vegetation. This includes stands west of Victoria where *Arbutus menziesii* and *Pseudotsuga menziesii* are also common elements of the vegetation on dry rocky outcrops. It is likely that *Balsamorhiza* once occurred in *Quercus garryana-Bromus* vegetation and grass-dominated meadows in the Victoria area but no extant populations have recently been verified. A single population, located at Beacon Hill Park, occurs in vegetation that corresponds to *Quercus garryana-Bromus* vegetation or grass-dominated meadows but disturbance at this site (including the planting of exotic *Pinus*) has obscured the type of vegetation which was once present.

Balsamorhiza deltoidea has also been collected at two sites near Campbell River, on the east side of central Vancouver Island, which lies outside the range of *Quercus garryana*. Here, the average annual rainfall (1557 mm) is similar to that found in the western part of the Victoria region (Environment Canada 1981). At one site visited recently, the populations were located in a meadow adjacent to the ocean. Drainage at these sites was rapid, hence, it is likely these plants were able to persist despite the damp climate.

6. Population Size and Trends

Balsamorhiza deltoidea has been collected at 14 sites in Canada with all of these populations located on southeastern Vancouver Island (Table 1). During this study only five sites could be verified (Figure 3). Of the remaining nine sites, five are likely extirpated while four others could not be relocated. It is possible that populations may still occur at these latter sites.

Table 1. *Balsamorhiza deltoidea* sites in Canada.

Collection Site	Last Observation	Collector	Population (no./area)
Tolmie Farm (Victoria)	1891	Newcombe	Extirpated
Lost Lake (Victoria)	1916	Newcombe	Extirpated
Lake Hill (Victoria)	1926	Walker	Extirpated
Royal Oak (Victoria)	1935	Goddard	Extirpated
south of Campbell River	1959	Beamish	
Mill Hill (Victoria)	1963	Hett	
Witty's Lagoon (Victoria)	1965	Carl	
Fort Rodd Hill (Victoria)	1966	Ashlee	
Portage Inlet (Victoria)	1976	Brayshaw	Extirpated
Tyee Spit (Campbell River)	1992	Douglas	1700+/1260 m^2
Thetis Lake (Victoria)	1993	Ryan	72/60 m^2
south of Francis-King Park (Victoria)	1993	Roemer	70/20 m^2
Mount Tzuhalem (Duncan)	1994	Douglas	60/40 m^2
Beacon Hill (Victoria)	1994	Douglas	5/1 m^2

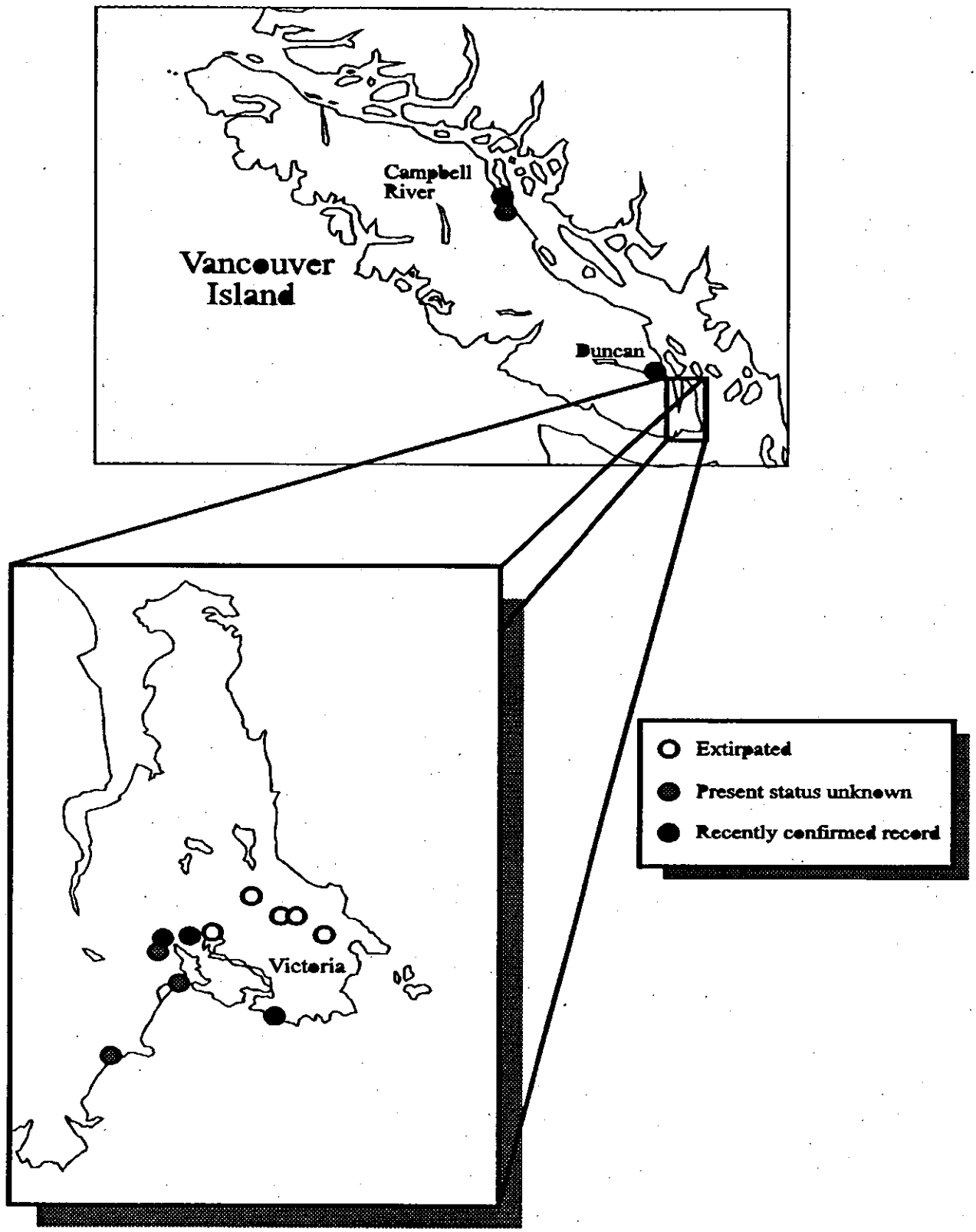

Figure 3. The location and status of *Balsamorhiza deltoidea* at sites in British Columbia.

Recently verified populations

Beacon Hill (Victoria)

A single population of five mature plants was located in a 1 m^2 area on a gentle slope with a northeast aspect. The site lacked a forest canopy although it was partially shaded to the south by a row of mature exotic *Pinus*. The immediate vegetation was dominated by introduced grasses including *Dactylis glomerata*, *Anthoxanthum odoratum*, *Elytrigia repens*, *Bromus hordeaceus*, and *Poa* sp.. Other plants included the introduced species *Taraxacum officinale* and *Plantago lanceolata*, and the native species, *Lomatium utriculatum*. A dense thicket of *Symphoricarpos albus* partially surrounded the area in which *Balsamorhiza deltoidea* was located. Upper soil horizons were dark brown with abundant grass roots in the upper 20 cm of the profile. Humus appeared to be rapidly incorporated into the mineral soil.

South of Francis-King Park (Victoria)

Balsamorhiza deltoidea was recently discovered (1993) at three sites on private property located south of Francis-King Park. The vegetation of the area was predominantly *Quercus garryana -Holodiscus discolor* vegetation on shallow soil with exposed bedrock on steep slopes. *Pseudotsuga menziesii* and *Arbutus menziesii* were common elements on deeper soils. *Pseudotsuga menziesii* appears to have been more abundant at one time but the larger trees have been logged.

At one site, a population of about 50 plants (both juvenile and mature plants) was located in a 10 m^2 area on a moderate slope with a southwest exposure. The site was open and exposed and consisted of scattered *Quercus garryana* (2-6 m tall) with abundant *Cytisus scoparius*. In open areas, the herb layer was dominated by grasses, primarily *Aira praecox* and *Aira caryophyllea*, two introduced species characteristic of very dry sites on shallow soils. Other species at this site included *Fritillaria lanceolata*, *Clarkia amoena*, and *Camassia leichtlinii*.

A second group of *Balsamorhiza deltoidea*, with approximately 20 juvenile and mature plants, was located in a 10 m^2 area on a rocky exposed slope with a southeast aspect. Scattered *Quercus garryana* (4-6 m tall) and abundant *Symphoricarpos albus* dominated the vegetation. In open areas, herbs were present including *Camassia leichtlinii*, *Eriophyllum lanatum*, *Lomatium dissectum*, *Clarkia amoena*, and *Stipa lemmonii*. A third mature flowering *Balsamorhiza deltoidea* was observed during the spring of 1993 on a rocky ledge on a steep rocky west-facing slope (H. Roemer,pers. comm.). It could not be relocated later in the season but likely grew in a habitat similar to that of the second group.

Thetis Lake (Victoria)

Four populations of *Balsamorhiza deltoidea* were observed near Thetis Lake. The first group was located in an open rocky area with scattered *Quercus garryana*, *Arbutus menziesii*, and

Pseudotsuga menziesii. Four mature plants were present in a 15 m^2 area shaded by a lone *Arbutus menziesii*. Associated species included *Quercus garryana* shrubs, *Cytisus scoparius*, *Symphoricarpos albus*, *Lonicera hispidula*, *Cynosurus echinatus*, *Elymus glaucus*, and *Camassia* sp.. Soils were brownish-red brunisols.

The second group of plants consisted of three mature plants in a 1 m^2 area alongside a path between adjacent stands of *Quercus garryana* and *Pseudotsuga menziesii* and an open and exposed rocky ridge. The plants were partially shaded by *P. menziesii*. Associated species included *Lonicera hispidula*, *Dactylis glomerata*, *Elymus glaucus*, and *Poa pratense*.

About 50 mature and juvenile plants formed a third group located in an open rocky area with scattered *Quercus garryana*, *Arbutus menziesii*, and *Pseudotsuga menziesii*. The vegetation was dominated by scattered *Cytisus scoparius* but also included *Lonicera hispidula*, *Mahonia aquifolium*, *Bromus* sp., *Anthoxanthum odoratum*, *Aira praecox*, *A. caryophyllea*, and *Cynosurus echinatus*. Soils appeared to be very shallow where *Balsamorhiza deltoidea* was present.

The fourth group of 20 juvenile and mature plants was located on a very dry open and exposed steep rocky slope with short shrub-like *Quercus garryana* (3 m tall), *Cytisus scoparius*, and *Holodiscus discolor*. Associated species included *Symphoricarpos albus*, *Mahonia aquifolium*, *Aira praecox*, *Sedum spathifolium*, and *Lomatium dissectum*. The mosses *Rhytidiadelphus triquetrus* and *Eurhynchium oreganum* covered exposed bedrock. Soils were very shallow and contained a substantial amount of colluvium.

Mount Tzuhalem (Duncan)

Two populations of *Balsamorhiza deltoidea* were located on Mount Tzuhalem. The first consisted of 30 plants over a 20 m^2 area. These plants grew on a well-drained rocky site under an open, stunted *Quercus garryana* stand. Associated vegetation on this south-facing site included: *Festuca idahoensis*, *Eriophyllum lanatum*, and *Achillea millefolium*. *Cytisus scoparius* was an invading species on the periphery of this stand.

The second population occurred in a gully about 200 m to the north. The population consisted of 30 plants over a 20 m^2 area. The site was dominated by a closed *Quercus garryana-Holodiscus discolor* stand. This site was relatively moist in spring with a 10-20 cm deep, dark upper soil horizon. It was the only location where *Balsamorhiza deltoidea* grew with *Viola praemorsa* ssp. *praemorsa*.

Tyee Spit (Campbell River)

The largest population of *Balsamorhiza deltoidea* in Canada was found at this site. More than 1700 plants occurred in a 1260 m^2 area. In addition, four smaller populations (15, 15, 10, and 3 plants, respectively, on areas totalling less than 150 m^2) were located nearby on sandy roadsides and waste areas. The main population was extremely healthy with 80% of

the plants mature. The associated vegetation represented a rich meadow including such species as *Achillea millefolium*, *Cytisus scoparius*, *Eriophyllum lanatum*, *Lupinus littoralis*, *Fritillaria lanceolata*, *Solidago spathulata*, and *Zygadenus venenosus*. The soil at this site was sandy, poorly developed and well drained.

Status Unknown

Fort Rodd Hill (Victoria)

Balsamorhiza deltoidea was collected in 1966 on rocky cliffs along the shoreline. Today, the vegetation along the shoreline at Fort Rodd Hill is predominantly *Quercus garryana* forest on shallow soils with rock outcrops. Much of the understorey vegetation is composed of *Symphoricarpos albus* and the introduced species *Daphne laureola*. It appears that shrubs now dominate what was once a more open understorey dominated by forbs and grasses. Open areas consist primarily of introduced grasses and forbs; there appears to be few native species. It is possible that *Balsamorhiza deltoidea* is still present at this site but it is unlikely given the relatively dense shrub layer in the *Quercus garryana* forests and the domination of open areas by introduced species.

Mill Hill (Victoria)

On the upper slopes of Mill Hill, located west of Victoria, scattered clumps of *Quercus garryana* and rock outcrops with grasses and forbs are dominant features. *Arbutus menziesii* is also a significant component of the vegetation. The lower slopes are dominated by *Pseudotsuga menziesii* forests. *Balsamorhiza deltoidea* was last collected in 1963 between two *Arbutus* groves. Observations made at this site suggest that this population of *Balsamorhiza deltoidea* was healthy in that it was composed of both mature and immature plants (Roemer, pers. comm.). Although this area was carefully searched in 1993, no specimens were found. This site will have to be revisited in the future to confirm the status of *Balsamorhiza*.

Witty's Lagoon (Victoria)

Witty's Lagoon is a regional park located west of Victoria. The site is dominated by coniferous forest and most areas do not provide suitable habitats for *Balsamorhiza deltoidea* except a portion of the shoreline where *Quercus garryana* is present. Unfortunately, no information is available as to the specific location of this species and it has not been observed in recent years (Roemer, pers. comm.).

Campbell River (south of)

No information is available on the specific location in which *Balsamorhiza deltoidea* was collected in 1959. An extensive search of the beaches during 1991 and 1992 failed to relocate this species, hence, its present status remains unknown.

Extinct Populations

Lake Hill (Victoria)

Balsamorhiza deltoidea was collected in 1926 from the Lake Hill area. Today, Lake Hill is dominated by family residences and very little of the existing vegetation remains except beneath some powerlines which intersect this area. It is very unlikely this species is extant.

Lost Lake (Victoria)

Lost Lake, where *B. deltoidea* was collected in 1916, is located north of Victoria. Today, none of the original *Quercus garryana* vegetation remains in this area except for a few remnant trees on rocky knolls. All of the terrain surrounding Lost Lake has been converted to agricultural land or is dominated by introduced species, particularly *Rubus discolor*.

Portage Inlet (Victoria)

Although *Balsamorhiza deltoidea* was collected in 1976 at the north end of Portage Inlet, many changes have occurred at this site. The adjacent highway has been widened and has obliterated the collection site (Brayshaw, pers. comm.). The area next to Portage Inlet has also been landscaped and planted with horticultural species. It is extremely unlikely that *Balsamorhiza* is extant at this site.

Royal Oak (Victoria)

The specific site at which *B. deltoidea* was collected in 1935 is not known. However, almost none of the original vegetation remains in this area except for a few remnant *Quercus garryana* and *Pseudotsuga menziesii* stands. Suitable habitats for *Balsamorhiza deltoidea* are no longer present because much of the land is now occupied by family residences and businesses.

Tolmie Farm (Victoria)

Except for some *Quercus garryana* vegetation near the summit of Mount Tolmie and on the University of Victoria campus, none of the herbaceous understorey vegetation remains intact in this area. Most of the land is now occupied by family residences. It is unlikely *Balsamorhiza deltoidea* is extant considering it has not been collected here since 1891.

7. General Biology

Almost all of the studies involving the genus *Balsamorhiza* have focused on the delineation of taxa, its relationship to other genera of the Asteraceae, and its position in the Heliantheae tribe. Any ecological information is largely anecdotal.

Balsamorhiza deltoidea, like other spring-flowering herbs found in *Quercus garryana* vegetation, take advantage of the warm temperatures, ample moisture, and high light levels found in early spring. One or more basal rosettes of large triangular or cordate leaves emerge in the spring from the perennial woody taproot followed by a (usually) single large head on a tall peduncle. By mid-summer, when drought conditions prevail in *Q. garryana* vegetation, the seeds have matured and the leaves begin to wilt and turn brown so that by the end of August, the plants have died back to the perennial taproots.

Juvenile plants have smaller, elliptic leaves that are fewer in number than mature plants. Bailey and Bailey (1976) stated that it took several years following seed germination before *Balsamorhiza* reached maturity.

Young and Evans (1979) investigated the germination of *Balsamorhiza sagittata*. Germination appeared to be enhanced by cool-moist stratification at low temperatures between 2°C and 5°C. Some seeds germinated during stratification, suggesting that the optimal germination temperature was the same as that for optimal stratification. Without stratification, germination was low and erratic. It is possible that *B. deltoidea* seeds may also germinate at low temperatures but this requires further investigation since the above results may reflect the colder climatic conditions where *B. sagittata* is found.

Two attempts were made to cultivate *B. deltoidea* in Victoria at the Royal British Columbia Museum (J. Pinder-Moss, pers. comm.). Of five seeds collected from Mount Tzuhalem and planted in December 1986, four seedlings emerged the following April. Of 25 seeds collected from Campbell River and planted in December 1992, 12 seeds germinated the following March and April. In both instances, the seeds were planted in pots and placed outside during the winter months, under glass, where they occasionally experienced freezing temperatures. From a number of seeds germinated in 1986, three individuals were later transplanted to a garden and have survived to date. Even though the plants are now quite large, they have not yet flowered. Dr. Hans Roemer also attempted to grow this species from collected seed and found that although the seeds were easy to germinate, young plants were often difficult to maintain because the roots appeared to be very prone to rot during the summer months if soil moisture was high.

In a study of development constraints in ovule and fruit development of *B. sagittata* and *B. hookeri*, Maze *et al.* (1990) reported that both species exhibited a high rate of ovule abortion. Similar field observations of the heads of *B. deltoidea* also seemed to suggest that few mature seeds were produced in comparison to the large number of flowers contained in a head. It was often difficult to find more than a dozen viable seeds from a single head (J. Pinder-Moss, pers. comm.).

No demographic information is available on *B. deltoidea* including the extent to which seeds remain dormant in the soil, survival rates of seedlings and adult plants, the average life span of individual plants, and its relationship with other species and the role it plays in the ecosystem. The identity of pollinators and their importance are not known.

8. Limiting Factors

Specific Threats

The most direct and immediate threat to *Balsamorhiza deltoidea* is habitat destruction. This is of particular concern in the grass-dominated meadows often associated with *Quercus garryana-Bromus* stands that are limited to the southeastern side of Vancouver Island and some of the Gulf Islands. Both types of vegetation are believed to have been much more common before colonization by European settlers. Although few records indicate the extent of these communities prior to, and during, colonization by European settlers, it is likely they once encompassed much of the area now occupied by the city of Victoria (see map pp. 9-10 in McMinn *et al.* 1976). In fact, Roemer (1972) believed that the attractiveness of *Quercus garryana* vegetation was one of the reasons for the establishment of Fort Victoria. Their destruction has continued to the present resulting in the elimination of almost all sites occurring outside parks or ecological reserves. These sites are the most vulnerable to destruction because of their location on gentle slopes near the most populated and climatically-favourable areas on Vancouver Island making them particularly susceptible to agricultural and residential development. The Conservation Data Centre (BC Ministry of Environment, Lands, and Parks) has assigned a rank of S1 to *Quercus garryana-Bromus* vegetation which indicates this vegetation is, "critically imperiled because of extreme rarity (5 or fewer extant occurrences or very few remaining individuals) or because some factor(s) making it especially vulnerable to extirpation or extinction" (C. Cadrin, pers. comm.). Although grass-dominated meadows have not been designated a ranking, it is likely they are even more limited in area and are just as much at risk as *Quercus garryana-Bromus* vegetation.

At this time, pressures to develop unprotected grass-dominated meadows and *Quercus garryana* stands for the expansion of the urban infrastructure of Victoria, and other population centres on Vancouver Island, are intense. Currently a number of stands are threatened or are in the process of being destroyed as a result of residential development and the expansion of services associated with it. Loss of these habitats severely limits the availability of sites for the establishment of *Balsamorhiza deltoidea* and imposes severe limitations on the longterm survival of this species in British Columbia.

Fortunately, the steep rocky xeric sites located to the west and north of Victoria are less at risk. These sites have no agricultural potential and are unsuitable for most forms of development. However, their value for residential development may increase given the rapid expansion of Victoria and many eastern Vancouver Island communities. Despite the steep rocky terrain, these sites may become very valuable real estate because of the broad panoramas they provide of the surrounding landscape.

Historically, *Quercus garryana* communities and grass-dominated meadows have always been heavily influenced by human activity. Aboriginal peoples set fire to these stands to maintain them as an important habitat for wildlife and for harvesting *Camassia*, a member of the

Liliaceae whose bulbs were an important source of starch in the diet of aboriginal people (Roemer 1972, Turner and Bell 1971). Roemer (1972) believed that without human interference some of these stands would have eventually been replaced by *Pseudotsuga menziesii* forests.

The suppression of fire within the past century may have contributed to the demise of *Balsamorhiza deltoidea* populations. All of the sites in which *B. deltoidea* has been collected were likely maintained in the past as a result of periodic fires. This would have destroyed much of the competing vegetation resulting in newly-created habitats where *B. deltoidea* might become established. However, since that time, these sites have experienced little disturbance, resulting in the invasion and expansion of other species at these sites including the shrubs *Symphoricarpos albus* and *Cytisus scoparius*.

The introduction of European species has resulted in substantial changes not only to the grass-dominated meadows associated with *Quercus garryana* but also the rocky xeric sites north and west of Victoria where *Balsamorhiza deltoidea* has been collected in the past. One of the most troublesome species is *Cytisus scoparius* which has become a dominant species on xeric, exposed sites throughout much of eastern Vancouver Island and the Gulf Islands. Similarly, the herbaceous vegetation observed today in grass-dominated meadows and rocky xeric sites is substantially different from that which occurred before Europeans colonized coastal British Columbia. Much of the vegetation is composed of introduced grasses which likely make up greater than 90% of the biomass of the herb layer. These species include *Anthoxanthum odoratum, Dactylis glomerata, Cynosurus echinatus, Aira praecox,* and several species of *Bromus*. As noted by Roemer (1972) with respect to *Quercus garryana* vegetation, it is not possible to know which native species and to what extent they have been displaced because all sites are now composed primarily of introduced species and there are no longer any examples of "pre-European" vegetation. This would also apply to the rocky xeric sites west and north of Victoria where *Balsamorhiza deltoidea* has been collected in the past.

Changes in Populations

In British Columbia, *Balsamorhiza deltoidea* populations have not been monitored over time thus it is not possible to identify their decline or increase. It is possible that existing populations of *Balsamorhiza deltoidea* are remnants of a more contiguous distribution along the southeastern portion of Vancouver Island.

Given the extent to which *Quercus garryana* stands have been altered or destroyed in British Columbia, it is almost certain that the size and number of *Balsamorhiza deltoidea* populations has declined over time, particularly in the previous 100 years with the rapid expansion of European settlements and the introduction of resilient competitive species. Furthermore, the lack of juvenile plants in some populations suggests that little or no recruitment is occurring. Without some attempt at rehabilitation, these populations may disappear.

9. Protection

Regulatory Measures

There is no specific legislation for the protection of rare and endangered vascular plants in British Columbia. However, some populations of *Balsamorhiza deltoidea* are protected to a certain extent by their location on public property.

Beacon Hill (Victoria)

Beacon Hill Park is a municipal park managed by the City of Victoria. Because of its location near downtown Victoria, it is heavily utilized by the public and has been extensively altered with the construction of roads and recreational facilities and the conversion of many natural areas to landscaped, managed gardens and ponds. The site in which *Balsamorhiza* is found has been less strongly impacted than other areas of the park. Park staff leave this area relatively untouched and do not actively manage it unlike other areas where the grass-dominated vegetation is often mowed. Although its location in the park may provide *Balsamorhiza* with some protection from direct habitat destruction, the focus of park management is more on recreational activities than on the preservation of natural vegetation. Unfortunately this lack of concern has resulted in the elimination of several rare species by direct habitat destruction (A. Ceska, pers. comm.). Three naturalist groups, "The Friends of Beacon Hill Park", "The Garry Oak Meadow Preservation Society", and "The Victoria Natural History Society" have taken an active role in publicizing and promoting the preservation of the natural vegetation and rare species located within the park.

An encroaching thicket of *Symphoricarpos albus* threatens the survival of the few *Balsamorhiza* plants located at this site. Although *Symphoricarpos* shoots in the immediate vicinity of *Balsamorhiza* were being manually removed, there appeared to be no recruitment of the latter species from germinating seedlings so that even the control of *Symphoricarpos albus* may not prevent the eventual disappearance of this population.

Fort Rodd Hill Park (Victoria)

If *Balsamorhiza deltoidea* is still present, it is protected to a certain extent by its location in a National Historic Park. Although the park is managed primarily for its historical significance, staff were attempting to provide some protection of the native vegetation from disturbance by erecting signs that prohibited public access to most areas where native vegetation was present.

Francis-King Park (south of)

The three sites where *B. deltoidea* was found were located on private property, hence, they have no legal protection. One population was being threatened by encroaching *Cytisus*

scoparius. The two other populations had a number of juvenile plants thus site conditions appeared to be suitable for the germination and establishment of seedlings.

Mill Hill (Victoria)

If *Balsamorhiza deltoidea* is still present at this site it is likely to be protected since the most suitable habitats for this species are located in the regional park at Mill Hill.

Thetis Lake (Victoria)

The *Balsamorhiza deltoidea* populations are located in Thetis Park Nature Sanctuary west of Victoria, thus they are provided some protection. Of the four populations, two were in danger of being eliminated by competing *Cytisus scoparius*. In addition, both of the latter groups numbered less than five plants each and were located adjacent to heavily-used paths.

The remaining two populations of *Balsamorhiza deltoidea* were larger in size and contained a number of juvenile plants. *C. scoparius* was a potential threat to both groups but soils appeared to be very shallow and it is unlikely that conditions were suitable for the expansion of *C. scoparius* at these sites.

Witty's Lagoon (Victoria)

Witty's Lagoon is a regional park located west of Victoria, thus, if *Balsamorhiza* still exists, it is afforded some protection.

Mount Tzuhalem (Duncan)

Of the *Balsamorhiza* populations known in British Columbia, those located on Mount Tzuhalem receive the greatest degree of protection because of their location within an ecological reserve. This area encompasses 18 ha of *Quercus garryana* woodland, spring-flowering meadows, and rock outcrops which have been preserved to represent an example of *Q. garryana* woodlands and associated spring-flowering herbs. Unfortunately, the reserve is adjacent to a residential area and some human disturbance has occurred within the reserve in the form of trampling caused by hikers and mountain bikes. Furthermore, *Cytisus scoparius* has become a dominant species at this site and threatens many herbaceous species including *Balsamorhiza deltoidea*. The junior author removed all *Cytisus scoparius* plants threatening both populations in 1992 and 1994.

Campbell River (south of)

The specific location in which *Balsamorhiza deltoidea* was collected in 1959 is not known, hence, it is not possible to determine if this population, if it still exists, is protected.

Tyee Spit (Campbell River)

Although this site contained the only large population of *Balsamorhiza deltoidea*, it was probably the most threatened. It occurred on a small plot (28 x 45 m) on the Campbell River Indian Reserve. The plot was surrounded by roads or parking areas and is scheduled for development as part of a marine project. The band managers, to date, have not shown much interest in preservation of the site. Periodically vehicles drive over, or park on, the site but *B. deltoidea* continues to persist as a healthy population.

Rehabilitation Efforts

The only attempt to introduce *Balsamorhiza deltoidea* to suitable habitats or to increase the numbers of individuals at current locations is the recent dispersal of collected seed in several habitats south of Francis-King Park (H. Roemer, pers. comm.). The results of this experiment are not yet known.

The extent to which *B. deltoidea* may be cultivated is also unknown at this time. Kruckeberg (1982) stated that *Balsamorhiza* species did not transplant well and that seed propagation should be used. He reported attempts to grow *Balsamorhiza* on the coast had usually resulted in failure because of damp climatic conditions whereas they were easy to establish east of the Cascades in drier desert-like climates. Kruckeberg suggested that it may, however, be possible to establish plants in dry areas along the coast where soil conditions were suitable (primarily dry gravelly soils with rapid drainage).

Volunteers were attempting to control competing species at some *Balsamorhiza deltoidea* sites. This may not be enough, however, to prevent the decline of these populations since they were few in number and lacked immature plants. Unfortunately, there is no information available on the management of *B. deltoidea* populations.

Attempts to control or remove *Cytisus scoparius* in *Quercus garryana* stands have been difficult and have met with failure to this date. Unfortunately, *Cytisus scoparius* will readily resprout from roots if the aerial portion of the plants are removed. Alternatively, removing whole plants, including the roots, disturbs the soil resulting in the germination of *Cytisus* seeds which quickly become established and eventually dominate the site (W. MacGillavary, pers. comm.). In a recent examination of seed germination of *C. scoparius*, Bossard (1993) reported that both fresh and stored seed were found to be 98% viable. The hard, impervious seed coat limited the germination of greater than 65% of the seeds for several months or years, hence, a large amount of dormant viable seed would be present in the soil throughout the year.

Some introduced grass species which now dominate the understorey vegetation in many *Quercus garryana* stands may also pose a threat to *Balsamorhiza deltoidea* by smothering or shading small immature plants or preventing the germination and establishment of seedlings. Unfortunately, the control of most species is likely to be difficult, if not impossible, given

their ability to resprout from the dense network of roots located in the soil. Furthermore, many species are likely to reappear after any form of soil disturbance from buried viable seeds.

Fire, as it was historically used by the aboriginal peoples of BC, may have favoured the habitats in which *B. deltoidea* occurred by eliminating dense thickets of shrubs and maintaining a forb-rich understorey in *Quercus garryana* stands. Unfortunately, today, fire does not appear to be a viable management option for a number of reasons:

1) Most *Quercus garryana* stands are in parks or near residential areas where burning is not likely to be permitted.

2) The impact of burning sites inhabited by *Balsamorhiza deltoidea* is not known. Since this species is known from so few locations, it would be unwise to attempt such a drastic form of management without a better understanding of its ecology.

3) Most *Quercus garryana* stands have not been burned in many years which has resulted in the excessive buildup of woody fuels in the understorey. To burn these stands now would likely create fires of such intensity that many species would be killed as a result.

4) Burning is likely to encourage the germination and spread of many species which have been introduced over the past 100 years, particularly species such as *Cytisus scoparius* whose seeds remain viable in the soil for long periods of time.

II. ASSESSMENT OF STATUS

10. Comments on Status

Globally, *Balsamorhiza deltoidea* is ranked as a G5 species by the B.C. Conservation Data Centre. This ranking indicates that, on a global scale, it is considered to be "common to very common; demonstrably secure and essentially ineradicable under present conditions".

In British Columbia, *B. deltoidea* is ranked as an S1 species, "critically imperiled because of extreme rarity (typically five or fewer occurrences or very few remaining individuals) or because of some factor(s) making it especially vulnerable to extirpation or extinction.". This is the most critical status which can be applied to a species at the provincial level.

11. Status Recommendations

Balsamorhiza deltoidea should be ranked as an endangered species for the following reasons:

1) Populations of *B. deltoidea* in Canada are few in number and, in some instances, only consist of a few individuals.

2) Some populations are directly threatened by introduced species which have dominated many of the habitats in which *B. deltoidea* occurs.

3) *Balsamorhiza deltoidea* in British Columbia represents the northern limits of this taxon and may represent populations that are genetically distinct to those found elsewhere.

4) The largest Canadian population, located at Campbell River (1700 plants), is also the most seriously threatened group. The loss of *Balsamorhiza deltoidea* at this site seriously jeopardizes the future of this species in Canada considering that the number of individuals comprising the remaining populations number less than 250 plants.

12. Prognosis

Even if the threat to the largest population located at Campbell River is removed, the prognosis for this species is not good. Although almost all of the recently verified populations are partially protected on public land, it is possible that some of these populations (particularly those that are few in number and comprise only mature plants) will disappear without some form of management. Some assurance would be provided if the stands in which *Balsamorhiza deltoidea* occur could be considered stable natural ecosystems. However, with the introduction and domination of these stands by many non-native species, and with the suppression of fire, it is apparent that the composition and structure of the vegetation is changing. It is difficult to predict what impact these changes will have on the success or failure of *B. deltoidea* populations. In some stands, *Symphoricarpos albus* and *Cytisus scoparius* appear to be increasing in area at the expense of native herbaceous species. Unfortunately, there appears to be few management options available to successfully control these species. Likewise there are no existing *Quercus garryana* stands in which introduced species are not a significant component of the vegetation; hence, there is no basis by which to compare existing stands with those that were present before Europeans settled on the west coast of British Columbia. Even with the apparent control of shrub species at some sites, it appears that some populations will eventually disappear given the absence of juvenile plants which suggests no recruitment is occurring. It is likely that the dense turf formed by grasses may prevent the germination of seeds or establishment of juvenile plants in suitable microsites.

Management of *Balsamorhiza deltoidea* is hampered because very little is known regarding the ecology of this plant and its relationship to the environment and other species.

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