COSEWIC
Assessment and Status Report

on the

Coast Manroot
Marah oreganus

in Canada

ENDANGERED
2009

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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COSEWIC
Assessment Summary

Assessment Summary – November 2009

Common name
Coast Manroot

Scientific name
Marah oreganus

Status
Endangered

Reason for designation
A long-lived perennial vine occurring at only three widely separated locations in southeastern Vancouver Island and adjacent Gulf Islands. Fewer than 20 mature plants remain with no evidence of seedling production. Losses of habitat, populations and mature individuals are projected in its Canadian range. Main threats are development of the few known sites, alien species and chance events affecting the handful of remaining individuals.

Occurrence
British Columbia

Status history
Designated Endangered in November 2009.

COSEWIC
Executive Summary

Coast Manroot
Marah oreganus

Species information

Coast Manroot (*Marah oreganus*) is a large climbing perennial of the cucumber family (Cucurbitaceae) that grows from an enlarged woody root and produces annual trailing stems with branched tendrils. The alternate stem leaves are about 20 cm long, stalked and irregularly palmately lobed. Plants produce separate whitish male and female flowers on the same plant. Male flowers are stalked, bell-shaped, with generally 5 floral parts and arranged along an elongate central inflorescence stalk arising from the angles between the leaf stalk and stem (leaf axil). Single, stalked female flowers, with a swollen base, are also formed at the leaf axils. Ovaries develop into a prickly fruit that contains several large, smooth, heavy seeds.

Distribution

Coast Manroot occurs from southern British Columbia to central California, mostly west of the Cascade Mountains. In Canada, it only occurs in a small area extending from southeast Vancouver Island to Pender Island in the Southern Gulf Islands. The species ranges over 77 km^2 but the few sites where it occurs cover <12 km^2.

Habitat

In British Columbia, habitat for Coast Manroot is correlated with the distribution of Garry Oak, which often occurs in the vicinity. The extant and historic populations occur on rocky, south-facing slopes, in roadside thickets or at the margins of wooded areas. They are found at low elevations near the coast of southeastern Vancouver Island and the southern Gulf Islands, often within 30 m of the water's edge**.**

Biology

This perennial herb develops one or more aerial stems yearly from an enlarged woody root. No asexual reproduction occurs. Seed germination involves a rapid downward elongation of the fused underground seed leaves (cotyledons) and the development of an underground perennial storage tube. This pattern of germination and seedling establishment is distinctive for species of the genus *Marah* and for a few other dicotyledonous plants. It is considered a complex adaptation that helps ensure fast and successful seedling establishment in seasonally arid areas, described as having a "Mediterranean" climate.

Population sizes and trends

In 2006, the Canadian population consisted of 18 mature individuals at three locations. The population at a fourth location is considered extirpated as no plants have been observed since 1964. No data on historic numbers are available from which to derive trends in population size.

Limiting factors and threats

The primary threats to Coast Manroot are habitat loss due to development, recreational activities and invasive species. One population has disappeared due to trampling; other populations are very small and are also affected by high levels of trampling.

Special significance of the species

British Columbia populations of Coast Manroot have a high conservation value because they represent the entire Canadian population of a very narrowly distributed species. Various parts of Coast Manroot have been used for medicinal purposes by Aboriginal Peoples.

Existing protection or other status designations

Coast Manroot is not protected by any species at risk legislation in Canada. Based on NatureServe rankings, it is globally secure (G5) but critically imperiled (S1) in B.C. The species does not occur in any protected areas.

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 (2009)

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.

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SPECIES INFORMATION

Name and classification

Scientific name:	*Marah oreganus* (Torr. ex S. Wats.) T.J. Howell
Synonyms:	(from Hitchcock *et al*. 1959) *Sicyos oregana* T. & G.; *Megarrhiza oregana* Torr. ex S. Wats.; *Echinocystis oregana* Cogn.; *Micrampelis oregana* Greene
Common names:	Coast Manroot, Old Man-in-the Ground, Western Wild Cucumber
Family:	Cucurbitaceae, Cucumber family
Major plant group:	Eudicot flowering plants

The generic name *Marah* comes from the Hebrew word for bitter, in reference to the fact that all parts of the plant, especially the root, have a bitter taste.

Marah oreganus is one of seven members of the genus *Marah* found in Pacific coastal areas from southern British Columbia southward into Baja California, Mexico. Five of the seven species occur at low and mid-elevations in the mountains of California; a sixth occurs on Guadalupe Island in Mexico and a seventh in Arizona and New Mexico. *Marah* is sometimes included in *Echinocystis* (Hitchcock *et al.* 1959; Schlising 1993).

Plants in this group are noted for their large perennial underground tubers, which can weigh in excess of 100 kg, and can send up annual shoots above ground after each winter rainy season. These vines display several features that are representative of the family: they bear tendrils, have palmately lobed leaves and are monoecious, with staminate flowers in axillary racemes and single pistillate flowers in the axils. Ovaries develop into prickly fruit that contain several large, heavy seeds.

Morphological description

Marah oreganus is a climbing perennial vine that grows from an enlarged tuberous root in late winter or early spring in response to increased rainfall. The stout annual stems have coiling tendrils that enable them to climb up other plants, or trail along level ground, and can grow to a length of 6 m. One to several stems may grow from the top of a root, but each root has many buds capable of producing shoots, if the root becomes fragmented.

Stem leaves are large, from 10 to 30 cm long (including the petiole) and 20 to 30 cm wide, alternate, stalked and irregularly palmately lobed, with five to seven lobes (Figure 1). Leaves are bristly above, sparsely hairy below and heart-shaped at the base. Stipules are absent. Individual plants show wide variation in leaf size and lobe length, even on the same plant (Douglas *et al*. 1998)

Figure 1. Illustration of *Marah oreganus* (Hitchcock *et al*. 1959. Published with permission of University of Washington Press).

Like other plants in the Cucurbitaceae, the flowers of *Marah oreganus* are monoecious, with separate male and female flowers produced on the same plant. The male (staminate) flowers are arranged in racemes that develop from the leaf axils. The perianths are whitish and bell-shaped, with 5 to 8 petals/sepals. Female (pistillate) flowers, distinguished by a swollen base, usually appear individually on short stalks arising from the same leaf axils as the male flowers (Douglas *et al*. 1998).

The fruits, which are a type of berry called a pepo, are spherical to football-shaped and up to 4 or 5 cm in diameter, tapering to a slight beak (Figure 2). They are covered in soft green spines, up to 1 cm long and without hooks. When unripe, fruits are bright green and are longitudinally striped with alternating light and dark bands, ripening to yellow as the dry summer season approaches. The fruit swells as it ripens, until it ruptures and releases three or more broad, tan-colored and slightly flattened seeds in early summer. The seeds, each weighing around 1 g, are smooth, turgid and slightly rounded at both ends (Hitchcock *et al.* 1959, Douglas *et al*. 1998). Seeds in *Marah oreganus* are more flattened than any other species of *Marah* (Abrams and Ferris 1960).

Figure 2. Ripening fruit of *Marah oreganus* from the single old specimen (Population #1) on the Saanich Peninsula (photograph by Matt Fairbarns).

The root of *Marah oreganus* is large, hard and tuberous and on old plants, can be several metres long and weigh more than 100 kg. The common names “Manroot” and “Old-man-in-the-ground” are derived from the swollen lobes and arm-like extensions of the unearthed tuber. Newly exposed tubers have a scaly, tan-coloured surface. Injured or decaying tubers take on a golden or orange colour.

Wild Cucumber (*Echinocystis lobata*), which has been introduced to western Canada from eastern North America, superficially resembles *Marah oreganus*. However, the fruits of Wild Cucumber are more globular and the seeds are rougher than those of *M. oregana*.

Population spatial structure and variability

The chromosome number for *Marah oreganus* is n = 16 (Hitchcock *et al.* 1959; Schlising 1966). No other information is available.

Designatable units

A single designatable unit is recognized in Canada because the species occurs within a very restricted geographical area within a single COSEWIC ecological area (Pacific).

DISTRIBUTION

Global range

Marah oreganus occurs from southern British Columbia to central California (Figure 3), mostly west of the Cascade Mountains, extending east, rarely, as far as the Snake River along the Oregon-Idaho boundary (Hitchcock *et al*. 1959). *Marah oreganus* is listed by NatureServe (2007) as occurring in Wyoming, Nebraska, and Montana, but these reports may be based on erroneous identifications of Wild Cucumber (*Echinocystis lobata*). Detailed county mapping in the US (USDA NRCS 2009) does not indicate presence in Wyoming, Nebraska, or Montana (see Figure 3).

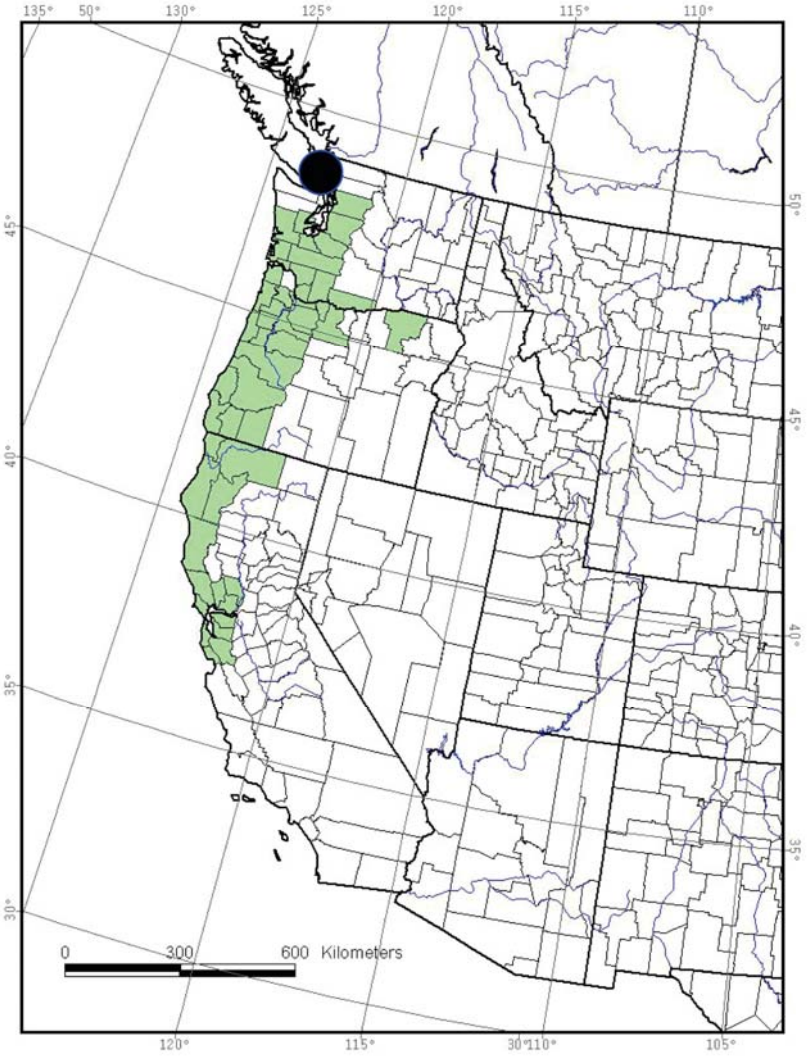

Figure 3. Global distribution of *Marah oreganus*. Solid filled circle (generalized occurrences in B.C.; shaded counties in the USA based on county records in USDA NRCS. 2009).

Canadian range

In Canada, *Marah oreganus* populations are restricted to a small area of southeastern Vancouver Island and the southern Gulf Islands (Figure 4). The contemporary Extent of Occurrence (EO) is estimated at less than 77 km^2, including intervening areas of ocean and 37 km^2 when ocean areas are excluded. The actual area of habitat occupied is 0.0031 km². The Index of Area of Occupancy is 3 km² based on a 1x1 km grid or 12 km² based on a 2x2 km grid.

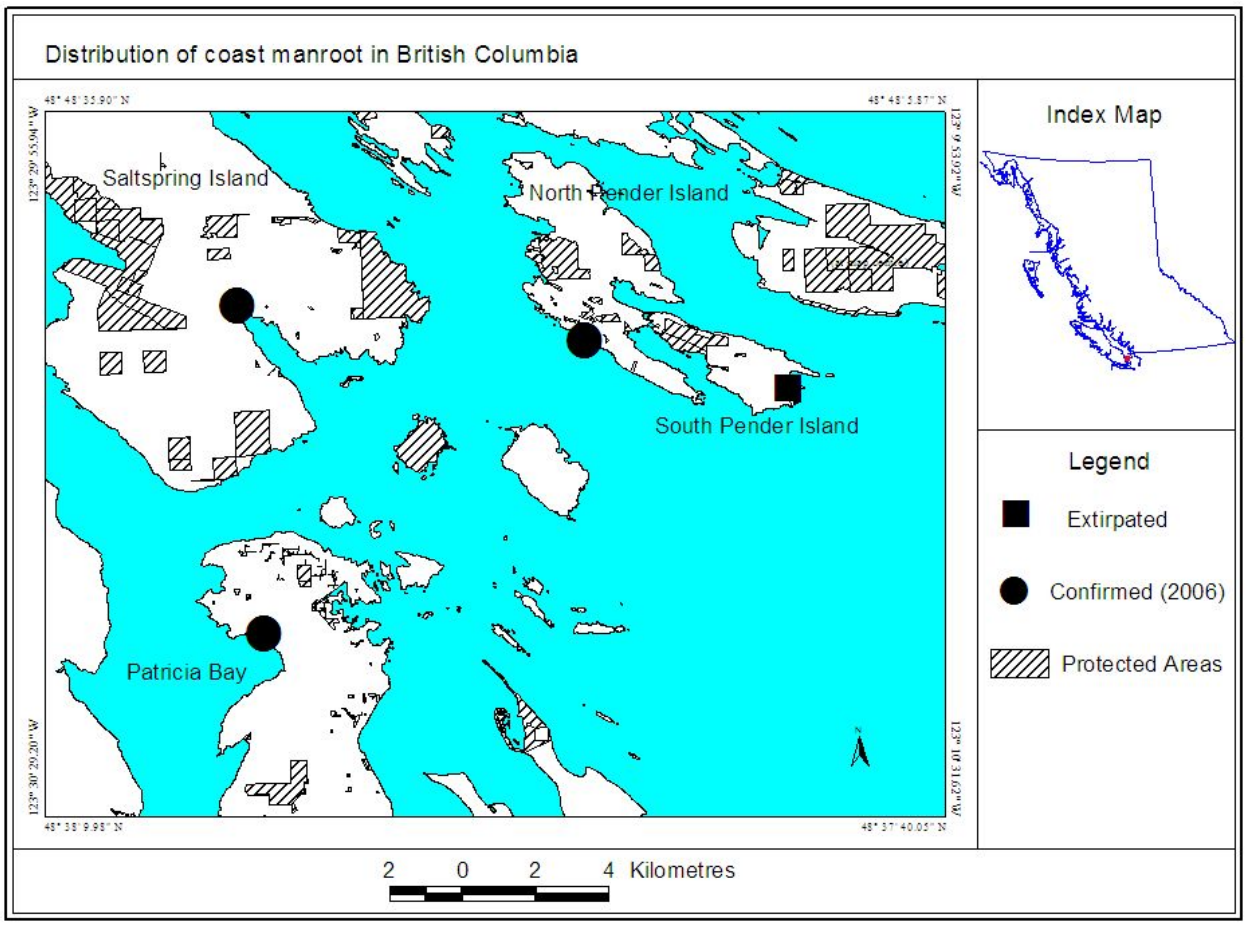

Figure 4. Canadian distribution of *Marah oreganus.*

Marah oreganus may have been planted by First Nations in British Columbia for medicinal uses (Turner and Bell 1971). However, given the close association between *Marah oreganus* and Garry Oak ecosystems and its occurrence, except for one of four sites, in areas not associated with First Nation lands, its presence in British Columbia should be viewed as a natural occurrence at the northern edge of the species' range. Since there is no concrete evidence to support the contention that the species was introduced by humans, it must be regarded as a native element of the provincial flora. The oldest record dates to 1898.

HABITAT

Habitat requirements

Habitat preferences of *Marah oreganus* are relatively consistent throughout its broad range. It generally prefers shrubby or open areas at forest edges, grassy fields, thickets, open woodlands and hillsides (Hitchcock *et al*. 1959, Schlising 1993, Atkinson and Sharpe 1993). At the southern edge of its range, in north and central-coastal California, it occurs up to 1,800 m (Schlising 1993). In northwestern Washington State, on San Juan Island, it is found as high as 500 m (Atkinson and Sharpe 1993). The plants can grow in full sun or heavily shaded conditions and will tolerate a variety of soil types and acidities, but require at least seasonally moist soil.

In British Columbia, habitat for *Marah oreganus* is correlated with the distribution of Garry Oak (*Quercus garryana*), which often occurs in the vicinity. The extant and historic populations occur on south-facing, rocky hillsides, in soil pockets amongst outcropping rock and in openings at the margins of mixed woodlands, at low elevations near the coast of southeastern Vancouver Island and the southern Gulf Islands, often within 30 metres of the water's edge. This area lies in the rain-shadow of the Olympic and Vancouver Island Mountains, which intercept moisture from the prevailing high pressure systems that move in from the Pacific Ocean, making for mild winters and dry, warm summers. Winter temperatures are moderated by proximity to the ocean, which is dominated by warm waters of the California Current all year long.

November is usually the wettest month of the year, receiving an average of 144 mm of precipitation, little falls as snow. January is the coldest month, with a daily mean temperature of 3.8^{o} C and a mean daily minimum of 0.7^{o} C[1]. Summers are warm and dry with a large semi-permanent high-pressure area extending over the north-eastern Pacific and dominating the general circulation in western Canada. July and August typically receive less than 25 mm of mean monthly precipitation and pronounced moisture deficits are frequent. The scarcity of snow and rarity of hard frosts on southern Vancouver Island allow for a longer growing season than the rest of British Columbia.

The population on the Saanich Peninsula (#1) consists of a single rambling plant which forms a tangled mass with Hedge Bindweed (*Convolvulus sepium*). This tangle sprawls over a small thicket of exotic shrubs including Himalayan Blackberry (*Rubus discolor* = *R. armeniacus*) and European Plum (*Prunus domestica*). *Marah oreganus* is rooted in deep soil on a low, southwest-facing bank, below the roadside.

[1] All figures are 1971-2000 climatic normals for Victoria International Airport. Source: Climatic Normals (Environment Canada); web site accessed July 2007: http://www.msc-smc.ec.gc.ca/climate/

The North Pender Island population (#2), consisting of two plants that are 15 m apart, occurs in a more natural setting. The site is a steep, south-facing rocky bluff 5-25 m above sea level, interspersed with pockets of coarse-textured soils that have a high component of coarse fragments. There are scattered Garry Oak and Douglas-fir (*Pseudotsuga menziesii*) trees, interspersed with openings and thickets composed of Nootka Rose (*Rosa nutkana*), Snowberry (*Symphoricarpos albus*) *and* Cream-bush Oceanspray (*Holodiscus discolor*). The openings are rocky, with California Blackberry (*Rubus ursinus*), Puget Sound Gumweed (*Grindelia integrifolia*), Wallace's Spikemoss (*Selaginella wallacei*), Pacific Stonecrop (*Sedum spathulifolium*), Great Camas (*Camassia leichtlinii*), Sierra Nevada Vetchling (*Lathyrus nevadensis*) and several introduced herbs including Hairy Cat's-ear (*Hypochaeris radicata*), Lesser Hawkbit (*Leontodon taraxacoides*), and the grasses Orchard Grass (*Dactylis glomerata*), Rip-gut Brome (*Bromus rigidus*), Barren Brome (*B. sterilis*), and Squirrel-tail Vulpia **(***Vulpia bromoides*) rooting in soil crevices**.**

Population (#3) on Saltspring Island, consisting of 15 plants covering an area of 2800 m^2, is located in a mixed second-growth woodland on a dry, steep, south-facing, colluvial slope of coarse talus of quartz diorite, rock outcrop and some medium-textured soil of various depths. Plants were of different sizes and ages and trailed along the ground and climbed into trees, up to about 4 m. The dominant vegetation included Douglas-fir, Garry Oak, Cream-bush Oceanspray and a variety of herbaceous plants and grasses, with many non-native herbaceous and graminoid species present. Dominant plants at the site included Scotch Broom (*Cytisus scoparius*), California Honeysuckle (*Lonicera hispidula*), Orchard Grass, Tapering Sweet Cicely (*Osmorhiza berteroi*), Kentucky Bluegrass (*Poa pratensis*), Sweet Vernal Grass (*Anthoxanthum odoratum*), Bristly Dog's-tail Grass (*Cynosurus echinatus*) and Blue Wild Rye (*Elymus glaucus*). Vegetation in the woodland was relatively dense in areas, but based on the species present, it is possible that the entire hillside may have been more open in the past, following logging, fires or grazing.

The extirpated population (#4) on South Pender Island occurred in a summer-dry, cleared pasture along the margin of a second-growth forest of Douglas-fir, Western Red Cedar (*Thuja plicata*) and Red Alder (*Alnus rubra*). The site is level, south-facing and partly shaded; soils are relatively deep and the parent materials are medium-textured. The cleared pasture that once provided suitable habitat for *Marah oreganus* is now dominated by dense, young forest. By decreasing the amount of exposed mineral soil or by competing for moisture during critical times of the growing season, the changes to species composition and community structure at this site could present conditions unfavourable to the germination and establishment of *Marah oreganus*.

The extent of suitable habitat within the Canadian range of *Marah oreganus* has not been measured but has probably never exceeded 1,000 ha.

Habitat trends

The amount of potential habitat has declined greatly over the past century as coastal areas in southeast Vancouver Island have been developed for residential and recreational uses.

In the Victoria area, Garry Oak ecosystems have declined to less than 5% of their original extent (Lea 2006) and this trend likely corresponds to the decline in suitable habitat for *Marah oreganus*. Most of the remaining habitat has been heavily altered by the abundant presence of invasive exotics including: shrubs such as Scotch Broom, Gorse (*Ulex europaeus*), California Blackberry, Spurge Laurel (*Daphne laureola*, English Holly (*Ilex aquifolium*); graminoids, including Barren Brome, Rip-gut Brome, Soft Brome (*Bromus hordeaceus*), Orchard Grass, Crested Dog's-tail Grass (*Cynosurus cristata*), Common Velvet Grass (*Holcus lanatus*); and forbs such as Hairy Cat's-ear, Hairy Hawkbit (*Leontodon taraxacoides*), Stork's-bill (*Erodium cicutarium*), Dove's-foot Crane's-bill (*Geranium molle*) and many others.

The historic population (#4) on South Pender Island is considered to have been destroyed by trampling of grazing animals. Regeneration of plants may have been inhibited by ongoing physical disturbance by grazing animals, but habitat modification may also have limited the ability of plants to re-establish. In addition to encroaching native woody plants, introduced species are abundant at this site and there is a particularly high cover of introduced grasses, especially bromes. *Marah oreganus* is capable of surviving in degraded ecosystems in British Columbia, but the impact of invasive exotic species that dominate many areas of suitable habitat on *Marah oreganus,* remains unclear. Like several other rare plants associated with Garry Oak ecosystems, invasive exotic species may effectively prevent successful germination and establishment of *Marah oreganus* seedlings and may also compete for nutrients and water during critical periods of the growing season (Parks Canada Agency 2006).

Habitat protection/ownership

Population #1, on the Saanich Peninsula, is located on an Indian Reserve. This population was easily observed from a public thoroughfare. Population #2 on North Pender Island and population #3 on Saltspring Island are on privately owned land. The extirpated population (#4) on South Pender Island also occurred on private land. None of the sites has any formal protection, although the population on North Pender Island is difficult to access and the site receives little foot traffic.

BIOLOGY

Life cycle

In the Berkeley Hills of California, *Marah oreganus* begins growth after the fall rains and cool temperatures in November and December and its survival may depend on this early start, while water is available. The shoots emerge from the ground in early March and the vines grow quickly, often overtopping shrubs and other adjacent plants, although other plants do not appear to be negatively affected by *Marah oreganus* clambering over them. Flowering begins shortly after the vines emerge and usually continues on any one plant for eight to ten weeks. The vines die back with the approach of the hot, dry summer season, and the below-ground portion of the plant remains dormant until the rains begin and the next year's shoots begin to grow from buds on the tuber (Schlising 1966). The species does not reproduce asexually but grows as a perennial herbaceous vine producing yearly shoots from the enlarged woody root.

Marah oreganus is monoecious. In California, variation has been observed in both the spatial and temporal flowering sequence of the separate staminate and pistillate flowers. In general, plants begin the season in a staminate phase (with only male flowers) or hermaphroditic phase (with both staminate and pistillate flowers present) and complete flowering in a phase that is mainly pistillate. The typical flower arrangement at each node during most of the flowering period consists of a leaf, a tendril, a branch bud, a raceme of several staminate flowers and a single pistillate flower, from the axil at the base of the staminate inflorescence. Occasionally, up to ten or twelve of the first flowering nodes on any one vine may each bear a single, stalked pistillate flower, either alone or in addition to the staminate inflorescence (Schlising 1966).

Early in the flowering season, staminate flowers open before the associated pistillate flowers, but as flowering progresses, the pistillate flowers open at the same time or before staminate flowers at the same node. Later in the season, most plants finish flowering with pistillate flowers predominating or with no associated staminate flowers. In addition, pistillate flowers may be found interspersed with staminate flowers in later staminate inflorescences or occasionally alone in the racemes (Schlising 1966).

Schlising (1966) suggested that environmental conditions such as temperature and photoperiod could affect the stages of the flowering sequence. For instance, *Marah* plants tend to become more pistillate as the days become longer and warmer.

Germination and seedling morphology

In the late 1870s Charles Darwin in England and Asa Gray in New England both observed that the mode of germination in *Marah* seeds obtained from California was quite unlike the germination known for most other dicotyledonous plants. The fused cotyledons (primary seed leaves) of *Marah* exhibit a rapid downward elongation within the soil (Gray 1877, Darwin 1897). In most other dicotyledonous plants, the two distinct cotyledons develop above ground.

Unlike Darwin and Gray who observed *Marah* seed germination in the hothouse, far from its natural habitat, seed germination and seedling establishment has been extensively studied for *Marah oreganus* in the Berkeley Hills in northern California, where it occurs naturally. Though the specific timing of events will be typically delayed, the sequence of events described from northern California is expected to be similar in British Columbia. For example, in B.C., most seedlings emerge in late April, whereas in the Berkeley Hills, the shoots reach the soil surface in early March (Schlising 1969).

After seeds of *Marah oreganus* have been exposed to a period of cool and moist conditions in late fall and early winter, an embryonic sprout emerges, enlarges and begins to grow directly downward into the soil carried by the elongating bases of the cotyledons. As the cotyledons elongate, they fuse to form a hollow tube, carrying the rest of the embryonic plantlet (i.e., the epicotyl, hypocotyl and radicle) out of the seed and down into the soil (Schlising 1969).

In laboratory germination experiments, both Stocking (1955) and Schlising (1966) found that few seeds of *Marah oreganus* and *M. fabaceus* germinated unless they had received at least 3 weeks of cool temperatures (40˚F/4.4˚C), suggesting that low temperatures may be necessary for germination of *Marah* seeds.

In northern California, the elongation of the petiole tube ceases by January when the underground seedling is from 5 to 25 cm long. This shoot then splits, with the epicotyl growing upward through the hollow petiole tube toward the surface to become the stem and the hypocotyl swelling underground forms the tuber. A remarkable amount of seedling growth occurs before the epicotyl produces a green shoot above ground. The hypocotyl begins tuber formation before the seedling is photosynthesizing, nourished by the fleshy, protein-rich cotyledon blades that remain in the seed coat below ground (Schlising 1969).

This unique pattern of germination and seedling establishment is distinctive for the genus *Marah* and a few other dicotyledonous plants, which all grow mainly in areas of hot and dry habitat. This elongation of the fused hypogeal cotyledons is considered a complex adaptation that helps ensure rapid seedling establishment in seasonally arid areas, described as having a Mediterranean climate (Schlising 1969).

Reproduction

Since *Marah oreganus* flowers are monoecious, pollen must be transferred to a flower from either the same plant or from a separate individual for fertilization to occur. Field observations in the Berkeley Hills, where the reproductive ecology of *Marah oreganus* has been extensively studied, suggested that plants of *M. oreganus* may be self-incompatible. In experiments where flowers were hand-pollinated, none of the flowers that were hand-pollinated with pollen from the same plants (self-pollinated) set fruit or seeds. However, forty-two percent (42%) of cross-pollinations, either from pollen applied from other individuals or through natural pollinations, did lead to fruit or seed formation. As well, nineteen percent (19%) of (interspecific) pollinations between *Marah oreganus* and *M. fabaceus* produced fruits and seeds (Schlising 1966).

Cross-pollination is aided by the fact that pistillate flowers at a given node are receptive before the staminate flowers at the same node are shedding pollen. Though isolated individual plants in the Berkeley Hills either did not produce fruit or seed or were much poorer seed and fruit producers than plants that occurred in groups, evidently some individual plants can set seed (Schlising 1966). The single specimen at population #1, produces ripe fruit and seed and a single plant cultivated from seed collected from San Juan Island in 2002 produced flowers, fruit and seeds in 2008 (C. Fryer pers. comm. 2008).

It is unknown if *Marah oreganus* is capable of parthenocarpic fruit production but a few varieties of cucumber are capable of producing fruit without pollination or other stimulation. Seedless cucumbers are an important product of the greenhouse trade and are grown by excluding pollinators or by treating pistillate flowers with growth regulators. Varying temperature and photoperiod can also affect stages in the flowering sequence or the balance of male to female flowers in cucumbers. Nitsch *et al.* (1952) and Rylski and Aloni (1990) reported how low night temperatures and short days stimulated parthenocarpy in cucumbers.

Both staminate and pistillate flowers of *Marah oreganus* contain nectar, which is a specific adaptation for insect pollination lacking in wind-pollinated plants. Additionally, staminate flowers also bear pollen, a supplementary insect food source.

In the Berkeley Hills, the most likely pollinators of plants include the introduced honeybee (*Apis mellifera*) and the smaller native Californian bees of genus *Ceratina.* Nectar-collecting visits by both types of bees take place during the period when most plants are in full flower and when the ovaries are beginning enlargement, indicating that pollination is occurring. In addition, although the actual transfer of pollen from the bee's body to the stigma of a flower has not been observed, both types of bees have been captured with pollen from *M. oreganus* on their bodies and pistillate flowers have pollen visible on the stigma after the bee visits (Schlising 1966).

It is usually about six to eight weeks from the time of pollination until fruits reach full size in the Berkeley Hills, with dehiscence taking place in early summer. Each fruit contains an average of three to four seeds and seed maturation continues for an additional three to five weeks within the full-sized fruits before they are shed (Schlising 1966).

Seedling establishment

Schlising (1969) contended the seeds that are buried and/or discarded by nocturnal rodents produce seedlings throughout the range of *Marah*. Planting experiments in the Berkeley Hills indicated that, in spite of the burying or "self-planting" mechanism of young seedlings, only 2% lying on the soil surface successfully established seedlings, compared with 69 to 100% seedling establishment from seeds planted at various depths in the soil (Schlising 1969). In the field, germination from seeds on the soil surface, protected from animals with screening, was also low (Schlising 1966).

Under natural conditions in the Berkeley Hills, seeds accompanying *Marah oreganus* seedlings were found from 5-10 cm below the soil surface. It is assumed that the seeds were carried to that depth by a rodent (Schlising 1966). If such a seed is not eaten by the animal, conditions are likely favourable for seed survival through the hot, dry summers and germination when the rainy season begins.

Herbivory

No foliar herbivory, fungal or insect damage was observed in any British Columbia populations, but in the Berkeley Hills of California, the leaves and young fruits were attacked by chrysomelid beetles, including *Diabrotica undecim-punctata* (= *D. duodecimo-punctata*) and *D. trivittata*. Damage to heavily infested plants by these chewing insects led to early drying of the vines (Schlising 1966). Other pests observed include insects in the family Miridae, such as the Hyaline Grass Bug, *Corizus* sp., the Black Plant Bug, *Irbisia* sp. and the Squash Bug, *Anasa tristis*. Like the beetles, these bugs can cause early drying of the vines by sucking juices from the leaf tissues. Earwigs (Order Dermaptera) and sow-bugs (Order Isopoda) are also commonly found in dehisced fruits, especially in fruits on the ground (Schlising 1966).

Although domestic animals do not appear to eat the plants, Schlising (1966) observed grazing of the tender growing vine tips of plants in the Berkeley Hills, presumably by Mule Deer (*Odocoileus hemionus*). In Washington State, there are unconfirmed reports that *Marah oreganus* appeared in greater numbers after cattle were removed (Burrill 1992). However, the reduction in trampling, rather than grazing itself may have been responsible.

Physiology

The nutritional and specific soil requirements of *Marah oreganus* have not been studied. In California and Oregon, *Marah oreganus* has been identified as a host plant of the wild cucumber mosaic virus (Code 77.0.1.0.018) which is transmitted by a beetle (*Acalymma trivittata*) (ICTVdB Management 2006). Habitats of *Marah oreganus* typically receive low amounts of precipitation during the growing season, but below-ground moisture, which is recharged each winter, is apparently sufficient for vegetative growth and flower and seed production before senescence during mid-summer.

Dispersal

In nature, seeds are dispersed either by gravity, which can transport seeds some distance downhill from the parent plant, or possibly by water during the rainy season. In the Berkeley Hills, seeds of *Marah oreganus* and *M. fabaceus* are dispersed and carried below ground, where they remain throughout the hot and dry summer months, by several species of nocturnal rodents, including the Pinyon Mouse (*Peromyscus truei*), Meadow Mouse (*Microtus californicus*) and the Pocket Gopher (*Thomomys bottae*). Seedlings were almost always found in areas of recent rodent diggings, often in ground with tunnels and commonly far from seed-producing plants (Vestal 1938, Linsdale and Tevis 1951, Schlising 1966).

Interspecific interactions

In the Berkeley Hills, small black ants (Hymenoptera: Formicidae), flies (Diptera: Bombyliidae and Syrphidae) and beetles (Coleoptera) are among the insects commonly observed visiting *Marah oreganus* (Schlising 1966), It is possible that these insects use the flowers or leaves as breeding platforms. *Marah oreganus* does not have any known mychorrhizal relationships. Other plants do not appear to be adversely affected by *Marah oreganus* clambering over or growing intertwined with them and this species does not appear to strangle other plants as it dies back.

Adaptability

The large size of Canadian plants, the scarcity of seedling regeneration at Canadian sites, and the massive roots which *Marah oreganus* may develop suggest that individual plants may live for decades, or perhaps even centuries. The longevity of individual plants, and the ability of the species to tolerate seasonally fluctuating moisture levels and to survive in semi-disturbed habitats once established, indicate that this species can adapt to variable environmental conditions.

Seeds collected from San Juan Island in 2002 were successfully germinated without any special treatment when planted in the Victoria area by two different individuals. All seven seeds planted germinated, but only one plant survived. No flowers were produced, but the root grew to 20-30 cm in diameter (J. Miskelly pers. comm. 2008). Of three seeds collected from the same source that were planted outdoors by another individual, one germinated. In 2003, during its first year of growth, this plant was small and disappeared quickly, but it has emerged each year since. In 2008, growth was particularly vigorous and after producing flowers, fruit and seeds, the plant persisted until October (C. Fryer pers. comm. 2008). It may be characteristic of the species to remain vegetative for a number of years before maturity. The species is hardy enough to be grown under typical garden conditions and may be a good candidate for reintroduction into the wild.

POPULATION SIZES AND TRENDS

Search effort

Suitable growing sites have been surveyed repeatedly since the early 1980s in a variety of projects designed to document the distribution of rare plants in open meadows and coastal bluffs in southeast Vancouver Island and the Gulf Islands. The principal surveyors include botanists familiar with the plant such as Hans Roemer, Matt Fairbarns, Frank Lomer and Harvey Janszen, who has completed boat surveys of the southern Gulf Islands. Many other botanists have searched these areas without having reported this striking plant.

Over 500 ha of suitable habitat in over 30 sites have been surveyed, often more than once over the past five years. During the past decade, over 100 person-days have been spent searching suitable habitats.

There have been four annual searches specifically targeted to find *Marah oreganus* (approximately 1 person-day in 2003, 4 in 2004, 2 in 2005 and 2 in 2006). Despite this effort, no new populations were discovered.

Abundance

There are fourteen collections of *Marah oreganus* from 1898 to 1980. Eleven of these specimens appear to have been collected from the Patricia Bay Indian Reserve at Union Bay on the Saanich Peninsula (Population #1), where the plant is quite conspicuous. The relative abundance of collections from this site may be a reflection of the fact that the Saanich Peninsula was settled quite early in comparison to locations on the Gulf Islands. In total, there are 18 plants at three extant sites (Table 1).

Table 1. Population data for *Marah oreganus*.			
Population and First Observation/Collection	**Observer/Last Observation**	**Total area occupied**	**Number of individuals**
#1: Saanich Peninsula Anderson in 1898	Fairbarns, Donovan, Ford and Penny 2004	150 m^2	1
#2: North Pender Island Penny in 1996	Fairbarns, Donovan, Bennett and Kirkby 2004	100 m^2	2
#3: Saltspring Island Ashlee in 1958	Roemer 2006	2800 m^2	15
#4: South Pender Island Ashlee in 1958	Ashlee 1964	extirpated	extirpated

Fluctuations and trends

Plants have been observed at the site on the Saanich Peninsula (Population #1) since 1898, and a number of collections made over the years, but information on the number and the size of plants is lacking. Currently it would appear that the tangle of aerial shoots at this population represents a single plant. A site visit was made in 2006 to the Union Bay Reserve community by a Canadian Wildlife Service staff member. This resulted in information that the plant (Population #1) had been known to be present over the period of the chief's lifetime, at least 61 years (Donovan pers. comm. 2008). Since historical population sizes are unknown and the populations have not been monitored regularly in recent years, trends cannot be determined for any of the 3 extant populations.

Rescue effect

The nearest known population of *Marah oreganus* outside Canada occurs at English Camp, on San Juan Island in Washington State (T. Dominico pers. comm.). This population is separated from the nearest population in British Columbia by >20 km of open water. Since the heavy seeds float and may be dispersed long-distances by water, there is the possibility for unassisted immigration of seeds from the United States. The viability of seeds potentially transported by salt water currents is unknown. However, the species reproduces infrequently in British Columbia and there appears to be some other factor that limits the successful establishment of *Marah oreganus*. Therefore, the species is unlikely to become re-established through natural recolonization. On the other hand, given the successful establishment of at least one plant from seed collected from Washington State, southern populations may serve as an important source of seed for manual reintroduction to Vancouver Island.

LIMITING FACTORS AND THREATS

Habitat loss and fragmentation

Marah oreganus was likely never common in British Columbia given that the species is at the northern edge of its range and because of its low colonization rate. Its historical range is difficult to determine because of limited information in the literature and collections are few. However, it is likely that alteration of habitat within its distribution has resulted in the loss of some pre-settlement populations.

Each population of *Marah oreganus* in Canada exists in landscapes highly fragmented by residential and recreational development. The largely discontinuous areas of suitable shoreline habitat increase the dependence of this species on relatively rare long-distance dispersal events across hostile habitats such as roads and farmland. Plants would have to become established in open areas now colonized by aggressive weedy exotics. Forest succession on similar sites in the surrounding landscape may also limit establishment.

The three extant populations could perhaps be considered to be severely fragmented under IUCN definition based on the questionable viability of 2 of the three "populations". The total population is comprised of only 18 individuals, with populations separated by considerable distances (> 5 km) within a landscape of fragmented habitats. The populations are also separated by stretches of ocean. Although individual plants can have a long lifespan, it is questionable whether sites with 1, 2 or even 15 long-lived plants can be considered to represent viable populations in the long run. Two of the 3 populations (#1 and #2) cover a combined area totaling only 250 m^2 out of a total of about 3000 m^2. Although the species is considered to be weedy in parts of its core range in the US where it is abundant (Burrill 1992), the three British Columbia populations consist of few plants that are not spreading from their original points of establishment, likely many decades or even centuries ago.

Threats associated with invasive alien plants

A variety of non-native plant species have invaded existing and potential habitat of *Marah oreganus*, but once it is established, this species appears to tolerate some degree of disturbance. For example, population (#1) on the Saanich Peninsula grows in non-native vegetation at the top of a bank above the beach, along a weedy roadside that is mowed irregularly. Portions of the vine at this site have been cut back by mechanical brush control, apparently aimed at controlling blackberry, yet the plant continues to flower and produce fruit. Once established, an older plant with a large root containing ample food reserves and many buds is capable of producing new shoots after mechanical disturbance such as mowing or grazing.

Current populations seem to persist for years without establishing new plants from seeds but the low abundance and low colonization rate suggest that there are other factors (e.g., microclimatic, self-incompatibility) that limit the successful establishment and persistence of *Marah oreganus* in British Columbia. Interspecific competition for rooting space, soil moisture and nutrients from invading trees and shrubs such as Scotch Broom, Blackberry or Hedge Bindweed may be limiting and present conditions unfavourable to germination and survival. For Populations 1 and 2, chemical pesticides or herbicides in the surrounding residential landscape may also possibly harm or kill the plant or its pollinators. In parts of its range in the US where the species is considered a weed, herbicides have been demonstrated to kill the foliage of *Marah oreganus* but the long-term impact on the root and its ability to resprout is unknown (Burrill 1992).

Grazing

After it was last observed in 1964, the single plant on South Pender Island (Population #4) was likely destroyed by trampling after the fence that had protected it from grazing broke down. It is possible that the mortality of *Marah oreganus* at this location may not have been a consequence of direct browsing or trampling of the plant itself, but rather of the increased compaction and subsequent water logging of soils.

Altered hydrological regimes

Rodenhuis *et al.* (2007) summarized data from climate models that project continued warmer temperatures throughout British Columbia and drier summer conditions in the southern and coast regions, as part of a broader pattern of global climate change. There is no firm consensus on the consequences of climate change for regional vegetation, but the data suggest that there will be impacts to phenology, growth rates, development, reproduction and interactions between species. Impacts to ecosystem functions such as nutrient and water cycling are also expected (B.C. Ministry of Environment. 2007).

Modified precipitation or localized water flow patterns, as a result of climate change or land use changes, may have negative effects on the persistence of *Marah oreganus* by increasing or reducing water flows at critical times during the growing season. Less moisture during the germination period could result in increased competitors that are no longer constrained by wet conditions. Similarly, excessive moisture during periods of dormancy can lead to fungal infection and cause root rot.

The plant on the Saanich Peninsula (#1) grows along the roadside, across the highway from a residential area, and may be vulnerable to urban storm drainage and nutrient-rich run-off resulting from fertilizers or pesticide use. Increased sedimentation and ground disturbance from road building or maintenance also presents a potential threat to the persistence of *M. oreganus* at this site.

Development

The Gulf Islands and the Victoria area are considered one of the most desirable regions in the province for human settlement because of the warm climate, attractive landscapes and gentle topography suited to development and agriculture. Growth has been rapid in this region, particularly on privately owned land, and development pressures are intense, resulting in the continuing loss of natural areas through clearing, draining and conversion to commercial and residential development and agriculture (Ward *et al*. 1998). Specific development plans for the three sites occupied by the remaining populations are unknown at this time, but they all occur on privately owned land and are afforded no protection from future land use changes.

SPECIAL SIGNIFICANCE OF THE SPECIES

Various parts of *Marah oreganus* have been used by Aboriginal Peoples for medicinal purposes (Turner and Bell 1971, Gunther 1973, Baker 1981, Pojar and MacKinnon 1994).

Marah oreganus is a source of ribosome inactivating proteins (RIPs). These proteins have a variety of potentially useful pharmaceutical properties such as antiviral, antitumor, antidiabetic, abortifacient and immunomodulatory. A trichosanthin protein isolated from the root tuber of another member of the cucumber family, *Trichosanthes kirilowii*, selectively inhibits viral replication in human blood cells infected with HIV-1 and has completed clinical trials as an AIDS drug (Shih *et al*. 1998).

The British Columbia populations of *Marah oreganus* are at the northern extent of the geographic range of the species. Isolated peripheral populations are often genetically and morphologically divergent from central populations. The ability of a species to adapt to changing ecological conditions and, therefore, its long-term survival, may rest on the conservation of these genetically distinct peripheral populations (Lesica and Allendorf 1995).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Marah oreganus is not covered under the Convention on International Trade in Endangered Species (CITES), the *Endangered Species Act* (USA) or the IUCN Red Data Book.

Marah oreganus has a global ranking of G5 (globally secure) and a provincial ranking of S1 (critically imperiled) in British Columbia (NatureServe 2007, B.C. Conservation Data Centre 2007). The species does not occur in any protected areas such as parks or conservation lands.

Marah oreganus is ranked SNR - Conservation status not yet assessed in California, Oregon and Washington (NatureServe 2007).

The Province of British Columbia does not provide any legal protection for *Marah oreganus*.

TECHNICAL SUMMARY

Marah oreganus
Coast Manroot Marah d'Orégon
Range of occurrence in Canada (province/territory/ocean) : British Columbia

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines(2008) is being used)	Unknown but likely decades or more
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Loss of population #4 in less than 3 generations and the persistence of two of three very small extant populations is questionable; no seedlings produced.	Inferred continuing decline
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	Unknown
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	77 km²
Index of area of occupancy (IAO) 3 km² if based on 1x1 km grid, 12 km² if based on a 2x2 km grid	12 km²
Is the total population severely fragmented? Yes if 2 of the three very small populations are not considered to be viable based on the lack of seedling production.	Yes
Number of "locations" (as per definition, in relation to threat)	3
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence? Population #4 has been lost and the viability of two additional populations is questionable.	Yes
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? Population #4 has been lost and the viability of two populations is questionable.	Yes
Is there an [observed, inferred, or projected] continuing decline in number of populations? Population #4 has been lost and the viability of two populations is questionable.	Yes
Is there an [observed, inferred, or projected] continuing decline in number of locations? Population #4 has been lost and the viability of two of the three extant populations is questionable.	Yes

Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? Lack of seedling regeneration may indicate that the habitat quality has declined.	Decline in quality may have occurred with the spread of exotic plants.
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations (as per definition, in terms of threat)?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
Saanich Peninsula	1
North Pender Island	2
Saltspring Island	15
Total	18

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	None available

Threats (actual or imminent, to populations or habitats)

Existing threats but degree of impact is uncertain: habitat loss, grazing, invasive alien species, altered hydrological regimes

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: : unknown and awaiting formal assessment	
Is immigration known or possible? No and unlikely due to the species scarcity in nearby regions and the large expanse of open ocean between Canadian and US populations	Not known
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Likely
Is rescue from outside populations likely?	**No**

Current Status

COSEWIC: Endangered (November 2009)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i); D1

Reasons for designation:
A long-lived perennial vine occurring at only three widely separated locations in southeastern Vancouver Island and adjacent Gulf Islands. Fewer than 20 mature plants remain with no evidence of seedling production. Losses of habitat, populations and mature individuals are projected in its Canadian range. Main threats are development of the few known sites, alien species and chance events affecting the handful of remaining individuals.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. % decline is unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v) based on EO and IAO below critical values, occurrence at only 3 extant and severely fragmented locations with extremely low population sizes and lack of seedling recruitment pointing to continued declines; loss of the Pender Island population indicates past declines in subcriteria i-v, likely in the last three generations.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered C2a(i) based on the presence of <250 mature individuals with a continued decline inferred based on the previous loss of one population and the likely loss of additional populations such as the single plant on the Saanich Peninsula due to the lack of seedling recruitment at all sites.
Criterion D (Very Small Population or Restricted Distribution): Meets Endangered D1 based on <250 mature individuals.
Criterion E (Quantitative Analysis): None available.

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Goulet, Gloria. Coordinator. Aboriginal Traditional Knowledge. COSEWIC Secretariat. Canadian Wildlife Service. Environment Canada. Ottawa, ON, K1A 0H3.

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COLLECTIONS EXAMINED

The following collections were consulted:

- Royal BC Museum herbarium (V)
- University of Victoria herbarium (UVIC)
- University of British Columbia herbarium (UBC)