

COSEWIC
Assessment and Status Report

on the

Seaside Birds-foot Lotus
Lotus formosissimus

in Canada



ENDANGERED
2010

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada



COSEPAC
Comité sur la situation
des espèces en péril
au Canada

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

COSEWIC. 2010. COSEWIC assessment and status report on the Seaside Birds-foot Lotus *Lotus formosissimus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 19 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Previous report(s):

COSEWIC. 2000. COSEWIC assessment and status report on the Seaside birds-foot lotus *Lotus formosissimus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 18 pp.

Ryan, M. and G.W. Douglas. 1996. COSEWIC status report on seaside birds-foot lotus *Lotus formosissimus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-18 pp.

Production note:

COSEWIC would like to acknowledge James Miskelly for writing the status report on the Seaside Birds-foot Lotus, *Lotus formosissimus* in Canada, prepared under contract with Environment Canada, overseen and edited by Erich Haber, Co-chair, COSEWIC Vascular Plants Species Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le lotier splendide (*Lotus formosissimus*) au Canada.

Cover illustration/photo:

Seaside Birds-foot Lotus — © Barbara J. Collins.

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Catalogue No. CW69-14/42-2011E-PDF

ISBN 978-1-100-18576-7



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COSEWIC Assessment Summary

Assessment Summary – November 2010

Common name

Seaside Birds-foot Lotus

Scientific name

Lotus formosissimus

Status

Endangered

Reason for designation

This showy perennial has a highly restricted range limited to a few sites of vernal pools and areas of seepage in Garry Oak ecosystems of southeastern Vancouver Island. Its small populations appear stable but are under continued threat from loss of habitat resulting from succession by woody species, spread of invasive plant species, and grazing by introduced rabbits.

Occurrence

British Columbia

Status history

Designated Endangered in April 1996. Status re-examined and confirmed in May 2000 and November 2010.



COSEWIC
Executive Summary

Seaside Birds-foot Lotus
Lotus formosissimus

Wildlife species description and significance

Seaside Birds-foot Lotus (*Lotus formosissimus*) is a perennial herb of the pea family (Fabaceae) that produces multiple sprawling, leafy stems up to 50 cm long. Clusters of flowers are produced on short branches in late spring. Flowers are yellow and purple and give way to slender seedpods in summer.

Distribution

Seaside Birds-foot Lotus is found sporadically on Vancouver Island and in western Washington and relatively continuously through western Oregon and coastal California. In Canada, it occurs in four populations in the Victoria area, including adjacent islands.

Habitat

In Canada, Seaside Birds-foot Lotus is confined to coastal seeps, vernal pools, and maritime meadows in the Coastal Douglas-fir Biogeoclimatic Zone. These habitats are considered Garry Oak and associated ecosystems and are characterized by warm, dry summers, mild, wet winters, and a distinctive flora. Less than 5% of the original extent of these ecosystems remains in a near-natural state. Outside Canada, Seaside Birds-foot Lotus is found mostly in wetland situations and occasionally in non-wetland habitat.

Biology

The species reproduces only by seed and is thought to be long-lived. Seed is produced abundantly at Canadian populations, but establishment of new seedlings is rare.

Population sizes and trends

The four Canadian populations include an estimated total of 650 – 960 mature individuals. One population contains only three mature individuals, while the other three each number in the hundreds. One historic population is considered extirpated. The extant populations do not appear to be declining.

Threats and limiting factors

Seaside Birds-foot Lotus may be limited in Canada due to encroachment from woody vegetation and by competition from non-native grasses. Grazing by non-native animals may also be a threat to some subpopulations.

Protection, status, and ranks

Seaside Birds-foot Lotus is listed as Endangered on Schedule 1 of the federal *Species at Risk Act*, making it unlawful to harm individuals on federal land. All Canadian populations are found at least partially on federal land. One is found partly in an ecological reserve, where it is also legally protected. Recovery actions are being implemented for all Canadian populations.

Lotus formosissimus is listed by NatureServe as critically imperilled in British Columbia. In Canada, it is ranked nationally as critically imperilled but is globally apparently secure in view of its national rank in the U.S. of vulnerable to apparently secure.

TECHNICAL SUMMARY

Lotus formosissimus

Seaside Birds-foot Lotus

Lotier splendide

Range of occurrence in Canada (province/territory/ocean): BC

Demographic Information

Generation time	Unknown but likely considerably >2 years
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within 5 years	None
Percent reduction or increase in total number of mature individuals over the last 10 years.	Unknown, apparently stable
Projected or suspected percent [reduction or increase] in total number of mature individuals over the next 10 years.	Unknown, probably stable
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.	Probably stable
Are the causes of the decline clearly reversible and understood and ceased?	NA
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence Actual EO of 4 km ² has been changed to the value of the IAO as per COSEWIC convention when EO is < IAO.	24 km ²
Index of area of occupancy (IAO)	24 km ²
Is the total population severely fragmented?	No
Number of "locations*"	Maximum of 5
Is there a continuing decline in extent of occurrence?	No
Is there a continuing decline in index of area of occupancy?	No
Is there a continuing decline in number of populations?	No
Is there a continuing decline in number of locations?	No
Is there a continuing decline in area, extent and/or quality of habitat?	Yes in area and quality
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Trial Island	400 – 600
William Head	3
Rocky Point (Church Hill)	140 – 220
Rocky Point (East)	115 – 145
Total	658 – 968

* See definition of location.

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not done
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Threats (actual or imminent, to populations or habitats)

Woody encroachment, invasive shrubs, invasive grasses, herbivory, climate change.

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Secure	
Is immigration known or possible?	Unknown and unlikely
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered (November 2010)
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Status and Reasons for Designation

Status: Endangered	Alpha-numeric code: B1ab(iii)+2ab(iii)
This showy perennial has a highly restricted range limited to a few sites of vernal pools and areas of seepage in Garry Oak ecosystems of southeastern Vancouver Island. Its small populations appear stable but are under continued threat from loss of habitat resulting from succession by woody species, spread of invasive plant species, and grazing by introduced rabbits.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. No decline evident.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(iii)+2ab(iii) with EO and IAO within criterion limits, and a maximum of five locations where area and quality of habitat have declined.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. No decline evident.
Criterion D (Very Small or Restricted Total Population): Meets Threatened D1 with <1000 mature individuals.
Criterion E (Quantitative Analysis): None available.

PREFACE

Since the preparation of the original status report (Ryan and Douglas 1996), one population of *Lotus formosissimus* that was believed extirpated has been relocated. Increased survey effort at the known locations has resulted in population estimates at least three times higher than in 1996. The *Species at Risk Act* has been enacted, providing protection for this species on federal lands. In accordance with the Act, a recovery strategy has been posted to the SARA Public Registry (Parks Canada Agency 2006) that represents a multi-species at risk approach and includes actions proposed to assist nine species of maritime meadows in Garry Oak ecosystems, including Seaside Birds-foot Lotus. Specific actions have been taken at various sites to control the spread of invasive species and to remove encroaching shrubs and conifers.



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 (2010)

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

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

Scientific name: *Lotus formosissimus* Greene

Synonyms: *Hosackia gracilis* Benth.

English common names: Seaside Birds-foot Lotus, Seaside Bird's-foot Trefoil, Coast Lotus, Witch's Teeth, Coast Hosackia

French common name: Lotier splendide

Family: Fabaceae (pea family)

Major plant group: Eudicot flowering plant

Lotus formosissimus was described as *Hosackia gracilis* based on specimens collected in California (Bentham 1837). Greene (1890) later showed that *Hosackia* was a synonym of *Lotus*. Because the name *Lotus gracilis* already applied to a European species, a new specific epithet was assigned (Greene 1890).

Morphological description

The morphology of *Lotus formosissimus* is described in Douglas *et al.* (1998) and illustrated in Figure 1. *L. formosissimus* is a perennial herb that grows from a branching root crown. Stems are sprawling to ascending and 20 to 50 cm long. Pinnately compound leaves are born alternately along the stems. Leaves consist of five to nine oppositely arranged, elliptic to oblong leaflets. Long-stalked umbels of three to nine flowers each are produced along the stem from the leaf bases. Umbels are subtended by a three-parted bract. Corollas are strongly bicoloured, with yellow banners, pink-purple wings, and purple-tipped keels. Calyces are five to six mm long with teeth slightly shorter than the tube. Fruits are slender pods 2 – 3 cm long, containing few seeds.

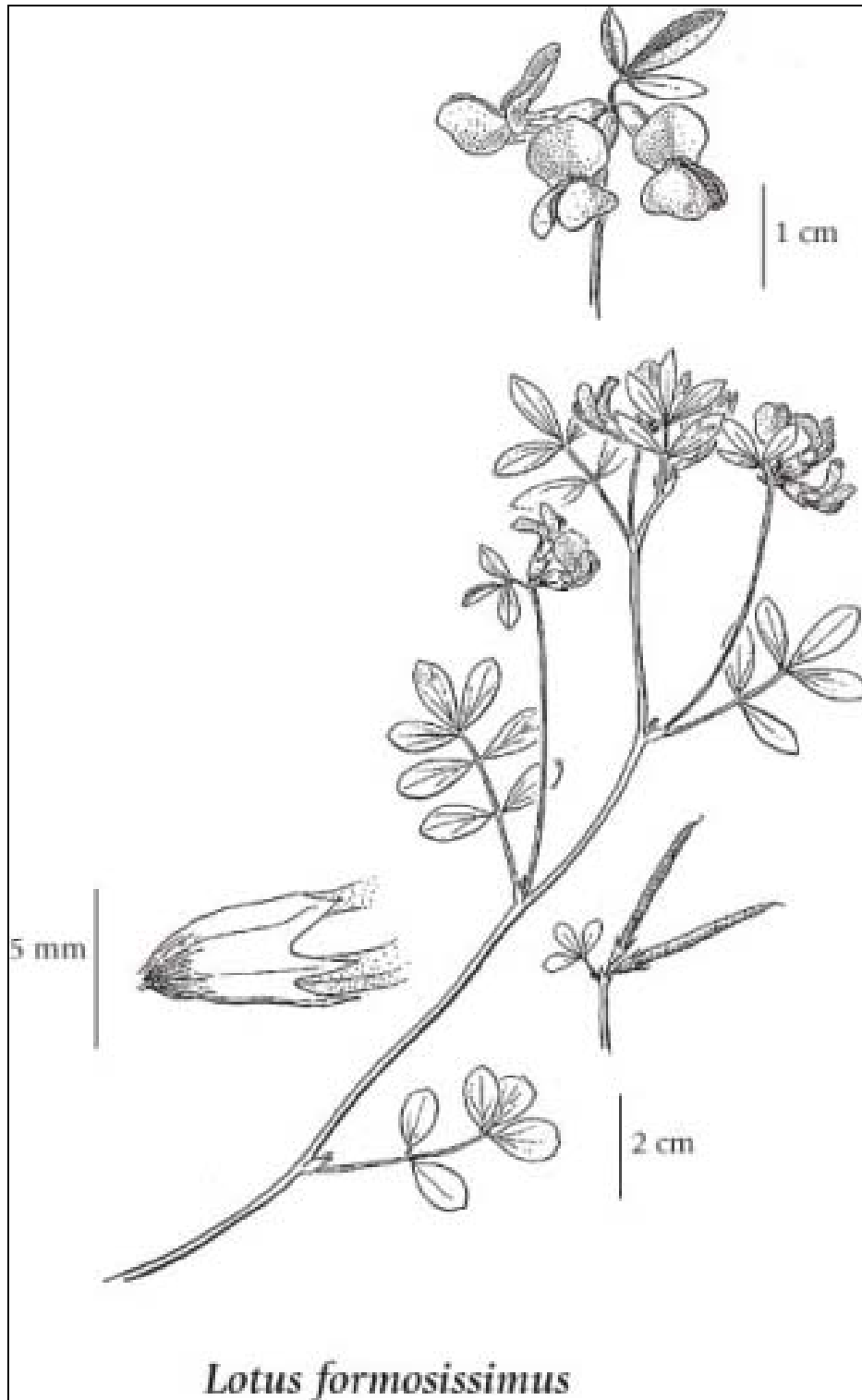


Figure 1. Illustration of Seaside Birds-foot Lotus, *Lotus formosissimus*. Reprinted with permission from Hitchcock and Cronquist (1973).

Lotus formosissimus may be distinguished from other *Lotus* species in British Columbia by the bicoloured yellow and purple flowers or by the combination of perennial habit, stalked leaves, leaf-like stipules and umbels subtended by a three-parted bract.

Population spatial structure and variability

Canadian populations of *Lotus formosissimus* are disjunct from other populations and, therefore, reproductively isolated. No information is available on the genetic effects of this isolation. Most populations are composed of several spatially separate subpopulations.

Designatable units

Designatable units are not recognized. The species has a restricted Canadian range and no infraspecific taxa are recognized. Also, it occurs in only one COSEWIC national ecological area (Pacific).

Special significance

Lotus formosissimus is found in a restricted area of Canada, and within restricted habitats within that geographic area. The coastal seeps and vernal pools where it occurs have been greatly reduced through residential development. At least 15 other threatened or endangered plant species, and many provincially red- or blue-listed species, occur in the same habitats. These habitats are floristically and climatically unique in Canada. The species is disjunct in Canada from its core range to the south. Canadian populations likely represent relicts from a larger past distribution. This species is a living link to British Columbia's biogeographical and paleoecological heritage.

Lotus formosissimus is renowned for its beauty, described as the most beautiful species in the genus (Greene 1890). It is a popular garden plant in California and may have horticultural potential in Canada.

No Aboriginal Traditional Knowledge is available for this species.

DISTRIBUTION

Global range

Lotus formosissimus is found on the west coast of North America, including southern Vancouver Island, western Washington and Oregon, and coastal California (Figure 2).



Figure 2. Global range of Seaside Birds-foot Lotus, *Lotus formosissimus*.

Canadian range

In Canada, *Lotus formosissimus* is restricted to four populations in the Victoria area, including southern Vancouver Island and adjacent islands. The index of area of occupancy (IAO), based on the number of two-kilometre grid squares containing populations, is 24 km², and based on one-kilometre grid squares is 9 km². The Canadian populations are spread over a total area of 4 km² determined using a convex polygon to include all occurrences, with areas of water excluded. By COSEWIC convention, when the extent of occurrence (EO) is less than the IAO, the EO is increased to match the value of the IAO. Therefore, the EO is also 24 km².

Search effort

At least 15 other threatened or endangered plants and a number of provincially rare plants have similar ranges and habitats to *Lotus formosissimus*. Because of this, seepage sites and vernal moist habitats along the shoreline of southern Vancouver Island and adjacent islands have been surveyed extensively over the last several decades. Hundreds of suitable sites have been surveyed repeatedly since the early 1980s in projects designed to document the distribution of rare plants of seepage sites and vernal pools on southeast Vancouver Island and the Gulf Islands. Most surveys have coincided with the flowering period of *Lotus formosissimus*. In spite of this extensive survey effort, no new populations of *Lotus formosissimus* have been discovered in Canada since the early 1990s (BC Conservation Data Centre 2009).

HABITAT

Habitat requirements

In Canada, *Lotus formosissimus* occurs in the Coastal Douglas-fir Biogeoclimatic Zone. This zone is characterized by mild, wet winters and warm, dry summers with a pronounced moisture deficit (Green and Klinka 1994). Within this area, the species is found in seasonally wet habitats, usually within 50 m of the seashore, in maritime meadows and open woodlands. These vernal pools and seepage areas are often in pockets of soil between outcroppings of bedrock. The tree canopy ranges from moderately closed to almost absent. *Lotus formosissimus* appears to require a high-light environment, and produces few shoots and no flowers under relatively closed canopies. Typical canopy species are Garry Oak (*Quercus garryana*), Douglas-fir (*Pseudotsuga menziesii*), and Shore Pine (*Pinus contorta* var. *contorta*). Shrubs that are commonly present include Nootka Rose (*Rosa nutkana*), willows (*Salix* spp.), and Salal (*Gaultheria shallon*). Common Camas (*Camassia quamash*), Pacific Sanicle (*Sanicula crassicaulis*), and Yellow Monkey Flower (*Mimulus guttatus*) are commonly co-occurring forbs. Many grass species may be present, including California Oatgrass (*Danthonia californica*), Red Fescue (*Festuca rubra*), and non-native Velvet Grass (*Holcus lanatus*) and Orchard Grass (*Dactylis glomerata*). Some plants grow near the high tide line where there is little other vegetation. One patch of plants at Rocky Point is anomalous, growing in a small wetland in Garry Oak woodland at least 350 m from the seashore. Associated species at this site are Slough Sedge (*Carex obnupta*), Dewey's Sedge (*Carex deweyana*), Cooley's Hedge-nettle (*Stachys cooleyi*), and non-native Creeping Buttercup (*Ranunculus repens*) and Velvet Grass.

In the United States, *Lotus formosissimus* is considered a facultative wetland species (US Department of Agriculture 2009). It occurs in a variety of wet habitats, including maritime meadows, wet prairie, stream banks, and bogs, but also occurs less often in non-wetland habitats.

Habitat trends

Ninety percent of the extent of Garry Oak ecosystems that occurred in Canada at the time of Euro-Canadian colonization had been destroyed by 2006 (Lea 2006). Conversion of Garry Oak ecosystems to residential and commercial uses continues today, and development pressures outside protected areas are high. The coastal habitats favoured by *Lotus formosissimus* are probably even more reduced than Garry Oak ecosystems as a whole, as shoreline areas face the highest development pressures. In addition, coastal meadows have declined in extent through encroachment by shrubs and trees (Fuchs 2001). Many of these ecosystems were regularly burned by pre-contact First Peoples to maintain various food resources, especially *Camassia* bulbs (Turner and Bell 1971). These practices were terminated with Euro-Canadian settlement in the 1800s, resulting in woody plant encroachment into formerly fire-maintained meadows. The habitats of *Lotus formosissimus* may be especially susceptible to woody plant encroachment, as they are often less prone to drought than

surrounding meadows. Gedalof *et al.* (2006) found that ephemeral waterways in meadows at Rocky Point were the first areas to succeed to woodlands following the cessation of burning. Habitat at the sites currently occupied by *L. formosissimus* have declined in quality and area.

BIOLOGY

Limited information is available on the biology of this species. Most information on life cycle and reproduction comes from recent studies of the Canadian populations (Fairbarns 2005, 2009).

Life cycle and reproduction

Shoots often begin growing from the perennial root crown during mild, wet weather in fall, but do not emerge from the surface of the substrate until spring (Fairbarns pers. comm. 2009). Flowering occurs in May and June and seed is released in June and July. Most stems die back to the root crown during dry summer weather, but some remain green until the fall (Ryan and Douglas 1996). Although stems may branch below the surface of the substrate, there are no true rhizomes and vegetative reproduction does not occur.

Zandstra and Grant (1968) suggested that *Lotus formosissimus* depended on cross-pollination to produce viable seeds. In the related *Lotus corniculatus*, which is not native to BC, 12 to 25 visits by bees to each flower are required for maximum seed set (Morse 1956). One study of five *Lotus* species found a great diversity of breeding systems, including flowers that could only be self pollinated, flowers that could only be pollinated by other flowers from the same inflorescence, and flowers that could only be pollinated by other individuals (Richards and Friesen 2001). During 2009 fieldwork, pollinator visits to *L. formosissimus* were observed only four times, despite appropriate weather conditions and a deliberate effort to record these visits. Two of these visits were by bumblebees (*Bombus* sp.) and two were by Propertius Duskywing Butterflies (*Erynnis propertius*). However, despite the apparent lack of pollinator visits, seeds are produced abundantly at both Trial Island and Rocky Point (Fairbarns 2009).

In one greenhouse trial, germination success varied from 7% to 30% (Trehearne pers. comm. 2009). However, seeds of *Lotus formosissimus* appear to germinate poorly under natural conditions. Few seedlings were observed during 2009 fieldwork. One series of field experiments found germination success between 0% and 6.5% (Fairbarns 2009). Seeds of *L. formosissimus* germinated only in the first and second years after sowing (Fairbarns 2009). Many legume seeds exhibit dormancy and it is possible that the seeds that did not germinate remained viable in the soil. Seeds of *L. formosissimus* exhibit physical dormancy and remain viable in the soil for at least two years (Fairbarns 2005). The few seedlings that have resulted from *in situ* studies have exhibited high survival but slow growth. Although some plants flower in the second year after germination, most were not flowering even in the third year (Fairbarns 2009). *Lotus*

formosissimus is probably a long-lived species that successfully reproduces rather rarely (Ryan and Douglas 1996).

Physiology and adaptability

No information is available on the physiology of *Lotus formosissimus*. Like many other legumes, this species is associated with nitrogen-fixing bacteria in the genus *Rhizobium* that increase the available nutrients around the roots (Fairbarns 2005).

The fact that *Lotus formosissimus* is a popular garden plant in the southern portion of its range in the U.S. suggests that it is adaptable to conditions not typical of current habitats. However, the species' low rates of dispersal and germination and apparent sensitivity to competition and climatic changes (see **Threats and Limiting Factors**) suggest that it would not adapt readily to changing conditions in the wild.

Dispersal

Seeds are released explosively as the pods dry. Seeds released this way may be thrown several metres. Other species of *Lotus* are known to be occasionally dispersed by ungulates feeding on the seed pods and depositing viable seeds in their droppings (Sevilla *et al.* 1996, Myers *et al.* 2004). However, this is unlikely to be an important dispersal mechanism in Canada, as browsing damage to *L. formosissimus* from deer has never been reported in Canada.

Interspecific interactions

Important interspecific interactions relate to pollination, competition, and herbivory. These are discussed above under **Life Cycle and Reproduction** and below under **Threats and Limiting Factors**.

POPULATION SIZES AND TRENDS

Sampling effort and methods

All sites where *Lotus formosissimus* is known to have occurred in Canada were searched by J. Miskelly in 2009 for this report. At each site, areas of potential habitat were systematically searched. When the target species was detected, an estimate was made of the number of mature individuals and habitat information was recorded. All individuals bearing flowers or fruits were considered mature, even if the flowers or fruits were aborted. Also counted as mature were individuals with long or multiple vegetative stems that may not have been flowering due to reduced vigour from shading. Because stems branch from the root crown below the surface of the substrate, individuals were recognized as groups of stems arising from a common point. Periodically, the substrate was teased back for confirmation that estimates were accurate. Because individuals were not unequivocally identified, population counts are estimates and include a range.

At sites where multiple subpopulations were known to occur, surveys also targeted areas between the known subpopulations. Further information on sampling effort is given under **Search effort**.

Abundance

Lotus formosissimus is known from four extant populations in Canada (Figure 3). One of these (William Head) was believed extirpated in 1996 (Ryan and Douglas 1996), but has since been relocated due to more intensive search effort. This population consisted of only three mature individuals in 2009. The other three extant populations include multiple subpopulations, each ranging from as few as one mature individual to more than one hundred. The total number of mature individuals in Canada is estimated at 658 – 968 (Table 1).

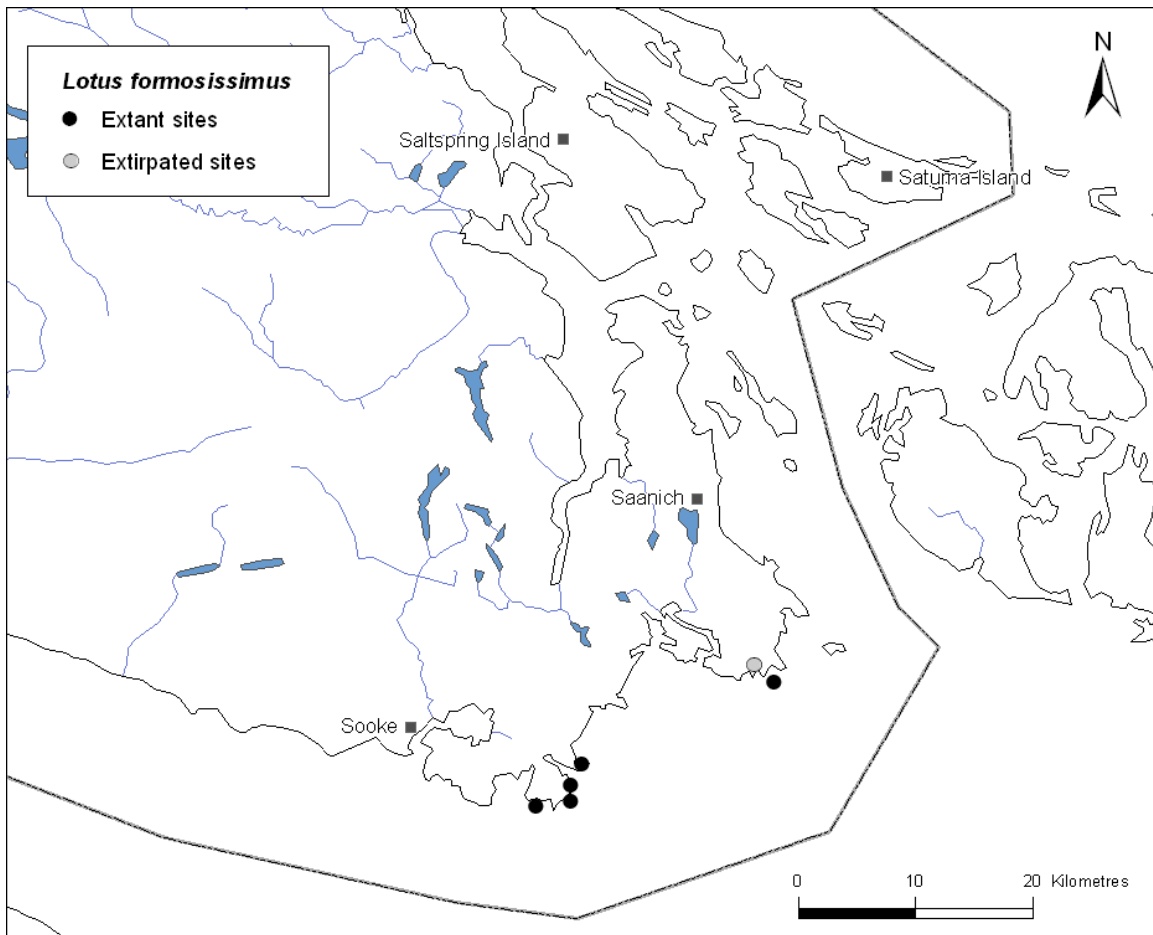


Figure 3. Southern Vancouver Island showing Canadian range of Seaside Birds-foot Lotus, *Lotus formosissimus*. Extant sites represent locations as defined by COSEWIC.

Table 1. Estimated size of known populations of *Lotus formosissimus* in Canada.

Location and first report	Estimated number of mature individuals	Most recent observation
Foul Bay (1912)	Extirpated	Macoun 1912
Trial Island (1953)	400 – 600	Miskelly 2009
William Head (1953)	3	Miskelly 2009
Rocky Point; east shore* (1993)	65 – 85	Miskelly 2009
Rocky Point; east shore (Bentinck Island)* (1993)	50 – 60	Miskelly 2009
Rocky Point: Church Hill (1977)	140 – 220	Miskelly 2009

*Note that the Rocky Point east shore and Bentinck Island plants are separated by less than 1 km and are considered a single population but separate locations based on threat.

The populations on Trial Island and Rocky Point (Church Hill) are clearly viable and comprise over 80% of the total number of mature individuals of the four populations recognized based on spatial separations that are greater than their long-term dispersal potential. The Rocky Point (East Shore) population, consisting of two subpopulations, is also likely viable. Additionally, considering that no declines in mature individuals have been documented for the species as a whole *L. formosissimus* populations are not severely fragmented as defined by COSEWIC.

The four Canadian populations of *L. formosissimus* represent five locations based on the definition of location (see **Threats and Limiting Factors**).

Fluctuations and trends

Lotus formosissimus is known to be extirpated from one site in Canada (Table 1). The most recent record of this population is from 1912 and any potential habitat for *L. formosissimus* at the site has been eliminated by residential development. Due to the extent and rapidity of shoreline development in the Victoria area, it is likely that other populations were eliminated without being recorded. A specimen collected in 1908 and labelled “Oak Bay” is not considered to represent an additional extirpated population because the location could refer to the Foul Bay or Trial Island populations.

The total estimated number of mature individuals in Canada is at least three times higher than in 1996 (Ryan and Douglas 1996). In 1996, the William Head population was believed to be extirpated. The Trial Island population was estimated at 28 individuals and the Rocky Point population was estimated at 165 individuals. The Church Point population was not surveyed and the Bentinck Island subpopulations were not located (Ryan and Douglas 1996). Therefore, the higher numbers recorded in 2009 result from more complete survey coverage and not an actual increase in number of individuals. Inconsistencies in the area surveyed make it impossible to determine trends in the entire Canadian range. However, populations and subpopulations that have been surveyed repeatedly appear stable (BC Conservation Data Centre 2009). Some subpopulations may be declining because of woody plant encroachment (see **Threats**), while others may be increasing because of recovery actions (see **Habitat protection and ownership**). There is no evidence that the species is declining in Canada. There is

also no evidence of major fluctuations in populations. This is consistent with the presumed long life and low reproductive rate of the species (Ryan and Douglas 1996).

Rescue effect

The closest population outside of Canada is in Mason County, Washington, at least 70 km from Canadian populations (Burke Museum 2009). The likelihood of seed moving naturally across this distance is negligible. The Canadian populations are also separated from each other by distances greater than the species' normal dispersal abilities except over long periods of time and under conditions of greater availability of more continuous suitable habitat.

THREATS AND LIMITING FACTORS

With the exception of a portion of Trial Island, all known populations occur either on federal lands or in provincial protected areas, where habitat destruction is not a significant threat. More significant threats appear to be competition from woody plants and invasive grasses and herbivory by non-native vertebrates.

Lotus formosissimus may be threatened in Canada by encroachment of woody vegetation. At Rocky Point, many subpopulations are shaded by Douglas-fir and Shore Pine. Many individuals of *L. formosissimus* under these conditions are producing fewer stems and fewer flowers than those in more open locations. Apparently suitable habitat adjacent to some subpopulations is dominated by small conifers to the complete exclusion of herbaceous species. These may represent areas where *L. formosissimus* has already been eliminated. Large areas of open meadow have undergone successional changes to forest at Rocky Point since 1850, and succession was most rapid in the seasonally wet habitats favoured by *L. formosissimus* (Gedalof *et al.* 2006). Dense conifer stands now limit the ability of the plants to colonize additional suitable habitat.

Some subpopulations at Rocky Point and Trial Island are confined to narrow bands of habitat between rock outcrops and dense thickets of willow or Salal. It is unknown whether this is a stable condition, or whether the thickets have encroached into areas formerly occupied by *L. formosissimus*. It is possible that these thickets are limiting the ability of the populations to expand. Limits may also be imposed by non-native shrubs, including English Ivy (*Hedera helix*), Gorse (*Ulex europaeus*), and Scotch Broom (*Cytisus scoparius*). At least one of these species was present at half of the subpopulations surveyed during 2009 fieldwork.

Lotus formosissimus is believed to be a poor competitor with non-native grasses. Non-native grasses are generally abundant in Garry oak ecosystems (Fuchs 2001). The three most problematic invasive grasses are Orchard Grass, Velvet Grass, and Sweet Vernalgrass (*Anthoxanthum odoratum*) (GOERT 2007). At least one of these species was present at two thirds of the subpopulations surveyed during 2009 fieldwork.

Two subpopulations observed during 2009 fieldwork showed damage from herbivores. One of these is on the edge of an area that is heavily grazed by non-migratory Canada Geese (*Branta canadensis*). Non-migratory Canada Geese are not native to this area and were introduced in the late 1960s (Smith 2000). Damage to existing plants from geese appeared light, but the area that is heavily grazed appears to be suitable habitat. It is possible that *L. formosissimus* has already been eliminated from this area. Another subpopulation experiences heavy grazing by non-native Eastern Cottontail Rabbits (*Sylvilagus floridanus*). Previous studies found no flowering in this subpopulation until small grazing exclosures were established (Byrne *et al.* 2007). Once exclosures were installed, plants within them flowered and produced 50% more stems than those outside the cages.

In California, populations of *L. formosissimus* have declined drastically under drought conditions (US Fish and Wildlife Service 1985). Changes to climate or hydrology that result in early drying of vernal pools and seepage sites would likely cause declines in Canadian populations.

All four Canadian populations experience some degree of threat by woody encroachment and non-native grasses. The Rocky Point (East) population includes subpopulations on Vancouver Island and Bentinck Island that are within 1 km of each other. These two subpopulations experience different threats because of the grazing by Eastern Cottontails on Bentinck Island (Schiller pers. comm. 2009). These subpopulations may be considered separate locations according to the COSEWIC/ IUCN definition of location. Overall, the four Canadian populations represent five locations based on their separation beyond the normal, short-term dispersal distances, their different rates of encroachment of woody vegetation at four sites and threat of herbivory at the Bentinck Island site.

PROTECTION, STATUS, AND RANKS

Legal protection and status

Lotus formosissimus was previously designated as Endangered in Canada by COSEWIC in May 2000 and is currently listed on Schedule 1 of the *Species at Risk Act*. It is unlawful to harm this species on federal land. Two of the Canadian populations are located entirely on federal lands. The Trial Island population is located partly on federal lands, partly in a provincial Ecological Reserve, and partly on provincial Crown land. It is unlawful to damage plants within the ecological reserve. However, there is currently no legislation to protect the species on provincial Crown land. This species is a candidate for listing under the provincial *Wildlife Amendment Act, 2004*, which could provide such protection.

Non-legal status and ranks

Lotus formosissimus is listed by NatureServe (2010) as S1 (critically imperilled) in British Columbia, S3 (vulnerable) in California, and has not been ranked in Washington or Oregon. Its global rank is G4 (apparently secure) and the national rank for the U.S. is N3N4 (vulnerable to apparently secure) and for Canada is N1 (critically imperilled). None of these designations provides legal protection.

Habitat protection and ownership

The William Head population is located on federal land owned by Corrections Canada. The Rocky Point population is located on federal land owned by the Department of National Defence. The Trial Island population is located partly on federal land owned by Canada Coast Guard, partly in a provincial Ecological Reserve, and partly on provincial crown land.

In accordance with the federal *Species at Risk Act*, a recovery strategy has been prepared for *Lotus formosissimus* (Parks Canada Agency 2006). Habitat management and recovery actions are underway at all Canadian populations as per recommendations in the recovery strategy. At the site of the William Head population, invasive shrubs have been removed and foot traffic in the occupied area is prohibited, except during shrub removal (Trehearne pers. comm. 2009).

Invasive species removal has been taking place at Rocky Point since 2002 (Byrne *et al.* 2007). Scotch Broom, Bull Thistle (*Cirsium vulgare*), and Common Tansy (*Tanacetum vulgare*) have been the primary targets. A small number of encroaching conifers have also been removed. These actions appear to have resulted in an increase in area covered by *Lotus formosissimus* at both the Rocky Point (east) and Rocky Point (Church Point) populations, although no formal monitoring has been done (Schiller pers. comm. 2009). Foot traffic is prohibited in all areas occupied by *L. formosissimus* at Rocky Point to prevent damage to the plants and their habitat (Schiller pers. comm. 2009). The Department of National Defence is currently preparing a long-term management plan for this species at Rocky Point (Cornforth pers. comm. 2009).

An invasive shrub removal program has been active at Trial Island since 2005 (Fairbarns pers. comm. 2009). This program has eliminated mature Gorse and Scotch Broom on the island, and has reduced English Ivy in some areas. English Ivy was still a dominant component of the vegetation at several *Lotus formosissimus* subpopulations during 2009 fieldwork, and seedlings of Gorse and Scotch Broom are still present. No detailed monitoring has been done to determine the effect of these actions on populations of rare species. If this program were terminated, invasive shrubs would likely rebound to original levels.

Parks Canada is working towards an experimental translocation of *Lotus formosissimus* at Fort Rodd Hill National Historic Site (Webb pers. comm. 2009). Fort Rodd Hill is located between extant populations, but is not known to have been historically occupied by the species. As of December 2009, a translocation plan has been drafted, a site has been selected, and seed has been collected from natural populations for propagation.

Critical habitat for this species has been proposed but not designated.

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

The original 1996 status report was prepared by Mike Ryan and George Douglas. Site access for 2009 fieldwork was facilitated by Anne Anderson, Meredith Dickman, Matt Fairbarns, Andrea Schiller, Fraser Thompson, and Chris Trehearne. Justine McCulloch assisted with fieldwork on Trial Island. University of Washington Press granted permission to reproduce the line drawing of *Lotus formosissimus*.

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INFORMATION SOURCES

Bentham, G. 1837. Observations on the genus *Hosackia* and the American *Loti*. Transactions of the Linnaean Society of London. 17:363-368.

BC Conservation Data Centre. 2009. Collected records of *Lotus formosissimus* in Canada. Compiled for James Miskelly, May 2009.

Burke Museum. 2009. Species description for *Lotus formosissimus*. Web site: <http://biology.burke.washington.edu/herbarium/imagecollection.php?Genus=Lotus&Species=formosissimus> [accessed September 2009].

Byrne, L., Askew, S. Schiller, A. and A. Robinson. 2007. Adaptive management of species at risk in the Garry oak ecosystem. Natural Resources Canada, Victoria. 28 pp.

Cornforth, T. pers. comm. 2009. *Conversation with J. Miskelly*. August 2009. Environment Officer, Formation Safety and Environment. Department of National Defence. Victoria, British Columbia.

- Douglas, G.W., G.D. Straley, and D. Meidinger, eds. 1998. Illustrated Flora of British Columbia, Vol. 3, Dicotyledons (Diapensiaceae through Onagraceae). British Columbia Ministry of Environment, Lands and Parks, Wildlife Branch, and British Columbia Ministry of Forests Research Program, Victoria. 436 pp.
- Fairbarns, M. 2005. Demographic and phenological patterns of *Lotus formosissimus* (Seaside Bird's-foot Trefoil). Natural Resources Canada, Victoria. 26 pp.
- Fairbarns, M. 2009. Population restoration studies of plant species at risk. Natural Resources Canada, Victoria. 29 pp.
- Fairbarns, M. pers. comm. 2009. *Conversation with J. Miskelly*. September 2009. Botanist. Aruncus Consulting. Victoria, British Columbia.
- Fuchs, Marilyn A. 2001. Towards a Recovery Strategy for Garry Oak and Associated Ecosystems in Canada: Ecological Assessment and Literature Review. Technical Report GBEI/EC-00-030. Environment Canada, Canadian Wildlife Service, Pacific and Yukon Region, Vancouver. 106 pp.
- Gedalof, Z., M. Pellatt, and D. J. Smith. 2006. From prairie to forest: Three centuries of environmental change at Rocky Point, Vancouver Island, British Columbia. *Northwest Science* 80(1):34-46.
- GOERT. 2007. General Decision process for managing invasive plant species in Garry oak and associated ecosystems. Web site: http://www.goert.org/documents/General_Decision_Process_revised.pdf [accessed September 2009].
- Green, R. N. and K. Klinka. 1994. A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region. British Columbia Ministry of Forests, Research Branch, Victoria. 285 pp.
- Greene, E. 1890. Enumeration of the North American Loti. *Pittonia*. 2(10):133-150.
- Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest: An Illustrated Manual. University of Washington Press. 730 pp.
- Lea, T. 2006. Historical Garry Oak Ecosystems of Vancouver Island, British Columbia, pre-European Contact to the Present. *Davidsonia* 17(2):34-50
- Morse, R.A. 1956. The pollination of birdsfoot trefoil (*Lotus corniculatus* L.) in New York State. *Proceedings of the Tenth International Congress of Entomology* 4:951-953.
- Myers, J.A., M. Velland, S. Gardescu, and P.L. Marks. 2004. Seed dispersal by white-tailed deer: implications for long-distance dispersal, invasion and migration of plants in eastern North America. *Oecologia* 139:35-44.
- NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, VA. U.S.A. Available <http://www.natureserve.org/explorer> [Accessed: Sept. 2010].

- Parks Canada Agency. 2006. Recovery Strategy for Multi-species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems in Canada. In *Species at Risk Act Recovery Strategy Series*. Ottawa: Parks Canada Agency. 93 pp.
- Richards, K.W. and K.R.D. Friesen. 2001. Basic pollination requirements of five *Lotus* species. *Acta Horticulturae*. 561:133-337.
- Ryan, M. and G.W. Douglas. 1996. COSEWIC status report on seaside birds-foot lotus *Lotus formosissimus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 18 pp.
- Schiller, A. pers. comm. 2009. *Conversation with J. Miskelly*. June 2009. Federal Lands Natural Resources Specialist, Natural Resources Canada. Canadian Forest Service. Victoria, British Columbia.
- Sevilla, G.H., O.N. Fernandez, D.P. Minon, and L. Montes. 1996. Emergence and seedling survival of *Lotus tenuis* in *Festuca arundinacea* pastures. *Journal of Range Management* 49:509-511.
- Smith, D.W. 2000. Management of Canada Geese in the lower Fraser valley, southwestern British Columbia. Pp. 151-158 In: Dickson, K.M. (ed.). Towards conservation of the diversity of Canada Geese (*Branta canadensis*). Occasional Paper Number 103, Canadian Wildlife Service – Environment Canada, Ottawa, ON.
- Trehearne, C. pers. comm. 2009. *Email correspondence with J. Miskelly*. September 2009. Horticulture Instructor, William Head Institution. Correctional Services Canada, Victoria.
- Turner, N. and M. A. M. Bell. 1971. The ethnobotany of the coast Salish Indians of Vancouver Island. *Economic Botany* 25:63-104.
- United States Department of Agriculture. 2009. PLANTS profile for *Lotus formosissimus*. Web site: <http://plants.usda.gov/java/nameSearch?keywordquery=LOFO2&mode=symbol> [accessed September 2009].
- United States Fish and Wildlife Service. 1985. Draft lotus blue butterfly recovery plan. US Fish and Wildlife Service, Portland, OR. 46 pp.
- Webb, C. pers. comm. 2009. *Phone conversation with J. Miskelly*. September 2009. Ecosystem Scientist. Parks Canada. Victoria, British Columbia.
- Zandstra, I.I. and W.F. Grant. 1968. The biosystematics of the genus *Lotus* (Leguminosae) in Canada. I. Cytotaxonomy. *Canadian Journal of Botany* 46:557-583.

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James Miskelly has worked on a variety of projects related to the ecology of Garry Oak ecosystems since 2000. He serves on several subcommittees of the Garry Oak Ecosystems Recovery Team. James received his Master of Science in biology from the University of Victoria in 2005. He previously prepared an update status report for *Sericocarpus rigidus*.

COLLECTIONS EXAMINED

No collections were examined in the preparation of this report.