

COSEWIC
Assessment and Status Report

on the

Virginia Goat's-rue
Tephrosia virginiana

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

Virginia Goat's-rue

Scientific name

Tephrosia virginiana

Status

Endangered

Reason for designation

A species of restricted geographical occurrence in Canada present as two remaining populations within remnant Black Oak savanna and Black Oak woodland habitats in southwestern Ontario. These habitats are globally rare and are one of the most threatened ecological communities in Canada. Most of the fewer than 600 plants are present as a single population within two nearby protected areas. Here the species is at risk from habitat degradation through successional changes. The very small second population, found on private land, is at risk of loss due to erosion of its sandy dune habitat.

Occurrence

Ontario

Status history

Designated Threatened in April 1996. Status re-examined and designated Endangered in May 2000 and November 2009.



COSEWIC
Executive Summary

Virginia Goat's-rue
Tephrosia virginiana

Species information

Virginia Goat's-rue (*Tephrosia virginiana*) is an erect perennial herb in the pea family (Fabaceae). Its stems generally reach 30 to 70 cm in height and arise from a branched woody crown and slender tough woody roots. Its stems, branches, and leaf stalks are densely covered with fine whitish hairs. The compound leaves are alternate, short-stalked, and bear an odd number of pinnately-arranged leaflets. Flowers are typical pea-like in appearance and bicoloured; the larger upper petal is yellow to cream-coloured, with the smaller lateral petals and lower keel being pink to pale purple. Fruits are hairy, flattened, linear pods ranging in size from 3.5 to 5.5 cm containing 6 to 11 kidney-shaped seeds.

Distribution

Virginia Goat's-rue is limited to eastern and central North America, centred in Tennessee and Kentucky, ranging as far south as Texas and Florida. It is found as far west as Nebraska and north to Minnesota. In Ontario, Virginia Goat's-rue is at the northern limit of its global range. It is limited to a small area of southern Ontario on the north shore of Lake Erie. The present range of Virginia Goat's-rue in Canada extends over an area of about 10 km². The actual area of habitat occupied is roughly 0.16 ha or 0.002 km². The Index of Area of Occupancy based on a 2x2 km grid is 20 km².

Habitat

Throughout its range, Virginia Goat's-rue is found in a variety of oak or pine woods, oak savanna, pine barrens, as well as sand prairies, sand dunes and open sand barrens. In Ontario, Virginia Goat's-rue is limited to acidic sand deposits of the Norfolk Sand Plain in remnant Black Oak savanna and open Black Oak woodland. Trends suggest overall habitat reductions throughout its range, including oak savanna in Ontario, one of the most endangered ecological communities in Canada.

Biology

Virginia Goat's-rue is a perennial flowering herb that produces flowers and fruit many times over the course of its lifetime; it flowers from late June through July in Ontario. The species may be self-pollinated but also appears adapted to bee pollination. Plant lifespan is not known, but the deep, woody taproots indicate longevity. Virginia Goat's-rue is drought and fire adapted, possessing deep woody roots most likely with nitrogen fixing abilities.

Population sizes and trends

Six populations of Virginia Goat's-rue have been documented in Canada. Of these, only two are extant. Based on most recent surveys, especially in 2008, a total of 567 patches (plants) with 7,058 stems are currently present. Each patch is considered to represent a single individual based on the presence of multiple stems originating from a single root crown. The largest population within the Turkey Point Natural Area consists of numerous scattered sub-populations within two protected areas, and consists of 6,958 stems likely representing 566 individuals. The smaller population at Vittoria Dune Ridge consists of a single patch (plant) on private land with roughly 100 stems. A lack of short and long-term population data limits accurate trend estimations. The Spooky Hollow population has recently been extirpated, several small patches in the Turkey Point Natural Area have been lost due to succession, and some plants likely have been lost at Vittoria Dune Ridge mainly from ongoing erosion of a steep sandy bank.

Limiting factors and threats

The main limiting factor affecting Virginia Goat's-rue in Canada is lack of suitable habitat. Direct threats are relatively minor and include trampling and mowing within the Turkey Point Natural Area, and erosion, a more serious threat, at Vittoria Dune Ridge. Indirect threats are more severe overall, and include habitat succession and lack of disturbance for many sub-populations. At present, invasive species are a minor threat, although in the long-term they could become a more serious threat.

Special significance of the species

Virginia Goat's-rue occurs in disjunct populations in Canada at the northern limit of its North American range. Like many other species in the genus *Tephrosia*, Virginia Goat's-rue produces the insecticide rotenone. But the rotenone occurs in concentrations too low for Virginia Goat's-rue to be a viable commercial source. Virginia Goat's-rue has diverse traditional First Nations uses.

Existing protection

Virginia Goat's-rue is not of high conservation concern throughout much of its U.S. range. In Canada, this species was assessed by COSEWIC as Endangered in May 2000. It is listed on Schedule 1 of the federal *Species at Risk Act*. In Ontario, it is listed as a regulated Endangered Species under the provincial *Endangered Species Act*, 2007. Both the species and its habitat are protected under this legislation. In Ontario, it is also listed as critically imperiled (S1) based on NatureServe criteria and its Ontario General Status listing is "at risk." The largest population exists within two adjoining 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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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

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2009

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SPECIES INFORMATION

Name and classification

Scientific Name: *Tephrosia virginiana* (L.) Pers.

Synonyms: *Cracca latidens* Small

Cracca virginiana L.

Tephrosia latidens (Small) Standl.

Tephrosia virginiana (L.) Pers. var. *glabra* Nutt. ex T. & G.

Tephrosia virginiana (L.) Pers. var. *holosericea* (Nutt.)

Torr. & A. Gray

Common Names: Virginia Goat's-rue, Goat's-rue, Cat-gut, Devil's Shoestring

Family: Fabaceae (Pea Family)

Major plant group: Eudicot flowering plant

Type specimen: Gray Herbarium photograph of Type specimen: Galega, Sheet 4, in the Linnaean herbarium, Linnaean Society of London.

Virginia Goat's-rue is a member of the Pea (Fabaceae) Family, a large group of 650 genera and nearly 20,000 species (Doyle 1994), many with ecological, scientific and economic importance. Of the three subfamilies within the Pea Family, the genus *Tephrosia* falls within the Papilionoideae subfamily. Within this subfamily, it is contained within the tribe Galegeae (Rydberg 1923), recognized by pinnately compound leaves with entire leaflets, and ten stamens. The genus *Tephrosia* contains roughly 250 species distributed in warm temperate and tropical regions, and is especially numerous in tropical Africa and Australia (Welsh 1960). There are 16 species and one hybrid limited to temperate North America, as well as three varieties within *T. angustissima* (NatureServe 2008). Virginia Goat's-rue is the only member of the genus represented in Canada's flora.

The taxonomy of *Tephrosia* was for many years under considerable confusion prior to Wood's (1949) monograph (Bowles 1994). There are two tribes of *Tephrosia*, one group with glabrous styles (subgenus *Tephrosia*), and the other, larger group, to which Virginia Goat's-rue belongs, with bearded or barbate styles (subgenus *Barbistyla*). Two varieties of Virginia Goat's-rue have been described previously based on variation in pubescence. *Tephrosia virginiana* var. *glabra* has been applied to plants with short and tightly appressed trichomes and to glabrous plants. *Tephrosia virginiana* var. *holosericea* has been applied to plants with the upper surfaces of the leaflets hairy, versus the typical form with upper leaf surfaces glabrous. However, these varieties are considered taxonomically insignificant by Wood (1949), the latest monographer of the species, who concluded *Tephrosia virginiana* is a single, widespread, genetically diverse species lacking distinct morphological and geographical variations. No infraspecific taxa are presently recognized for the species.

Morphological description

Virginia Goat's-rue is a 30 to 70 cm tall, erect perennial herb arising from a branched woody crown and slender tough woody roots. Stems, branches, and petioles are densely villose with fine whitish hairs. Leaves are alternate, short-stalked, odd-pinnately compound 5 to 14 cm long, ascending with mostly 15 to 25 elliptic to linear-oblong leaflets that are 1 to 3 cm long. Inflorescences are borne on racemes from short peduncles terminating from the principal stem or sometimes from axillary branches. Flowers are 1.5 to 2 cm, bicoloured, with the standard yellow to cream-coloured and the wings and keel pink to pale purple (Figure 1). Fruit are linear pods 3.5 to 5.5 cm, villous, flattened to slightly curved with 6 to 11 kidney shaped seeds that are 3.2 to 4.2 mm long, brown, variegated with black.



Figure 1. Flower and leaf form of Virginia Goat's-rue, Turkey Point Natural Area (photo credit S. Brinker).

According to Wood (1949), the species is particularly variable with regards to the type, length, and arrangement and density of hairs. He found a general but not consistent tendency for increasing number of hairy plants from the southeast, northward and westward, but not enough to warrant taxonomic recognition. As well, he found a general tendency for increasing length of hairs from south to north within its range, but many exceptions occurred. The calyx and leaflet shape have been used as specific and varietal characters, but Wood (1949) could not find consistency to segregate them.

Wood (1949) recognized two forms within populations noted by the presence or absence of hairs on the upper surfaces of the leaflets. However, proportions of hairy and glabrous plants varied greatly from colony to colony, seemingly by chance.

Population spatial structure and variability

The genetic structure of Virginia Goat's-rue has not been studied in Canada although nuclear DNA variation has been examined in species of *Tephrosia*, but this study excluded *T. virginiana* (Raina *et al.* 1986).

Designatable units

There is only one designatable unit based on the species' occurrence at several sites within a small geographical area of southwestern Ontario within the COSEWIC Great Lakes Plains Ecological Area.

DISTRIBUTION

Global range

Virginia Goat's-rue is the most widely distributed species of the genus *Tephrosia* in North America and is considered Globally Secure (G5) (NatureServe 2008). It occurs only in North America and ranges in the United States from Texas in the southwest to Florida in the east, north to Ontario, and west to Nebraska. Wood (1949) concluded after reviewing habitat descriptions of herbarium specimens from across its range that Virginia Goat's-rue is geographically limited by edaphic factors, requiring non-calcareous sandy soils, and is therefore generally absent from heavily glaciated regions with a predominance of calcareous till (Figure 2).

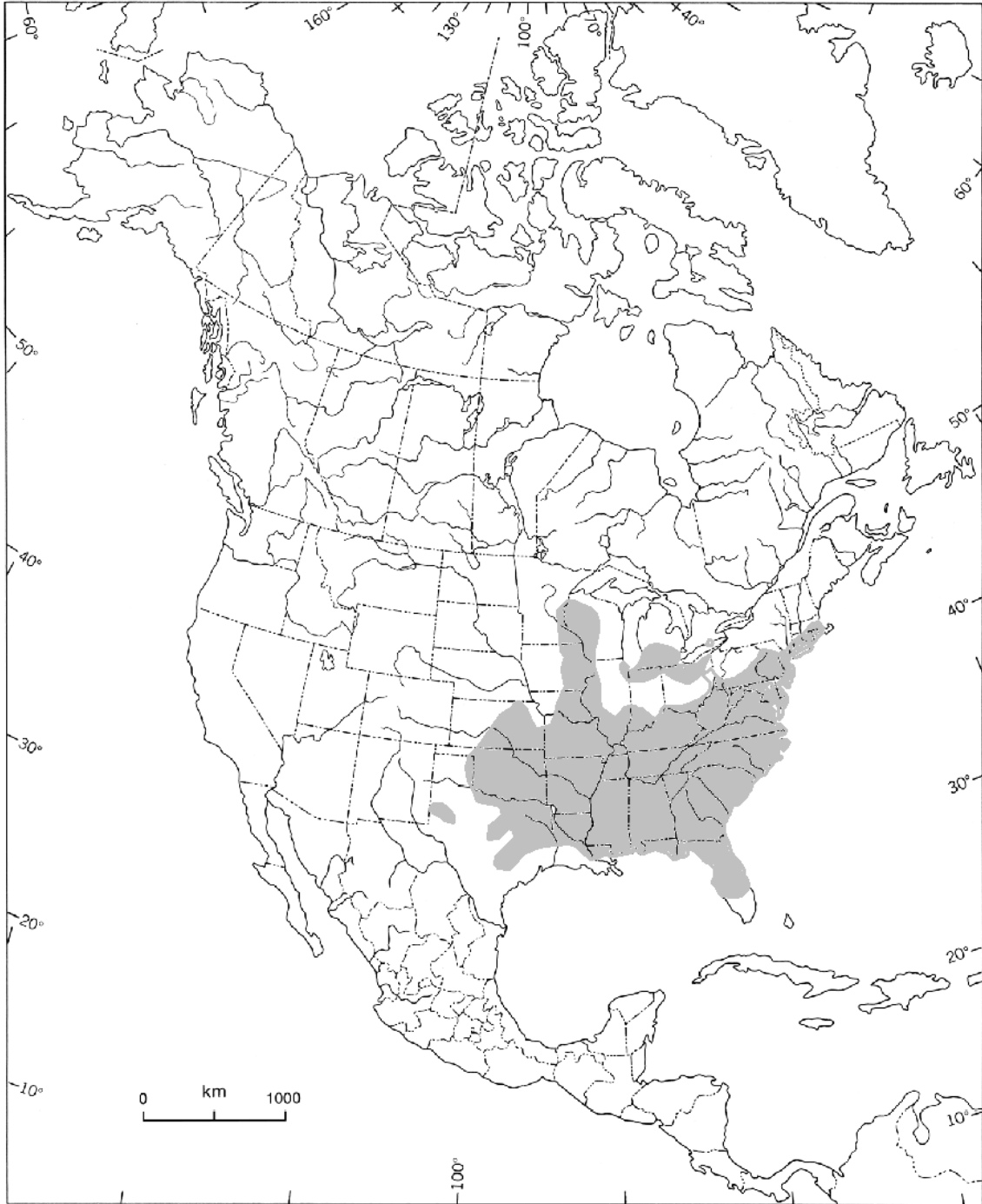


Figure 2. Global distribution of Virginia Goat's-rue (modified from Bowles 1994).

Canadian range

Virginia Goat's-rue was first collected in Canada in 1885 from Normandale and Turkey Point. Its known Canadian range has not changed substantially since it was first discovered, with a number of subsequent populations being documented within several kilometres of the original sites. Virginia Goat's-rue is known only from a small area of southwestern Ontario where it occurs in Norfolk County (Soper 1962). The two extant Canadian populations occur in the Carolinian Zone, part of the Great Lakes Plains Ecological Area recognized by COSEWIC. They are isolated, separate from the main U.S. range (Figure 3), and represent < 1% of the species' total distribution in North America.

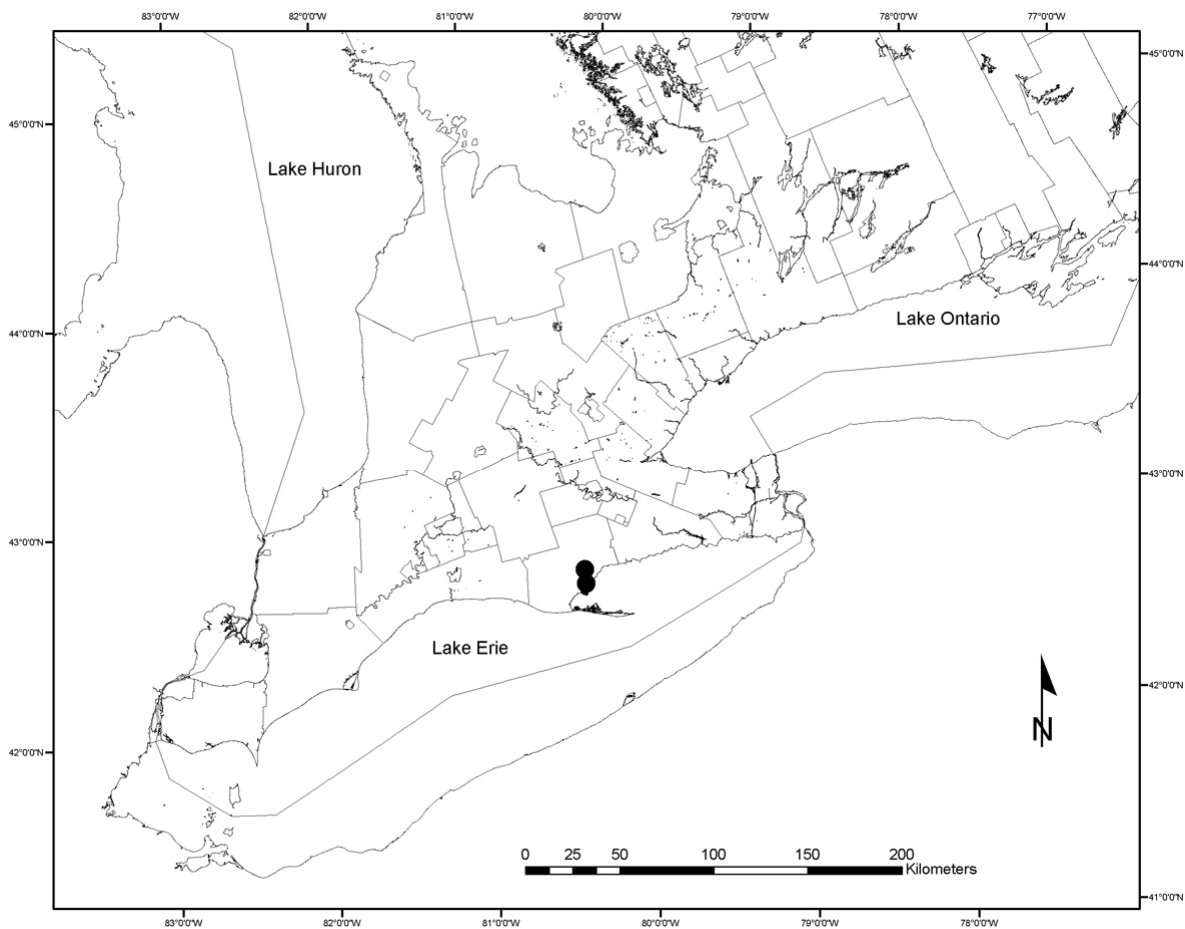


Figure 3. Range of Virginia Goat's-rue in Canada. Solid circles represent extant populations.

Extant populations

Virginia Goat's-rue is currently known from two extant populations including the Turkey Point Natural Area (Bowles 1994) and the Vittoria Dune Ridge (Sutherland 1987). These two populations represent two distinct locations as defined by the IUCN since they are separated by several kilometres within a fragmented landscape with the species having no long distance dispersal mechanisms and negative impacts on the two populations would affect the two areas independently.

Severe fragmentation, a factor used by COSEWIC in assessing conservation risk to a species, does not apply in this case. The Turkey Point Natural Area population consists of several sub-populations and with about 7000 individuals comprises over 95% of the total population size and area of habitat covered by the species at its two extant populations in Canada.

Introduced populations

A recent unsuccessful attempt was made to establish a population at the James Property, which is contiguous with Turkey Point Provincial Park. This property was formerly owned and managed by the Nature Conservancy of Canada, and was recently transferred to Ontario Parks. Due to the proximity of the site to existing Virginia Goat's-rue populations and the recent efforts to restore oak savanna habitat, it was deemed suitable to introduce the species, although there are no known previous records from the property. In 2004, seed was collected from the Turkey Point Natural Area and in 2005, 0.01 kilogram of seed was broadcast following a prescribed burn along a firebreak (Arnold, pers. comm. 2008). Despite independent searches in 2008 by Brinker and Graham Buck, who originally spread the seeds, no plants were found. The species' presence at this site is doubtful due to dense woody regeneration.

Extirpated populations

Seemingly four populations formerly occurred with virtually no likelihood of rediscovery, including Normandale, Simcoe, Walsh and Spooky Hollow. These populations have not been recorded in recent years despite considerable fieldwork in the area (e.g. Gartshore *et al.* 1987). Sutherland (1987) reported that Virginia Goat's-rue was first collected at Normandale in 1885 (Yates, CAN), and later on in 1936 (Marie-Victorin 46865), but has not been seen there since 1971 (Ball 45871, TRTE) and is presumed extirpated. A collection is known from "Simcoe" from 1915 (Williams, OAC), and later on in 1941 by Landon (HAM) at "Simcoe Woods," but has not been seen since and is presumed extirpated. Two specimens, mentioned by Soper (1962) and Cruise (1969) labelled "Walsh" (Brink) at OAC [without date] could not be located according to Sutherland (1987) who found no such specimen contained within the database of the Atlas of the Rare Vascular Plants of Ontario (Argus *et al.* 1982-1987). A third specimen labelled Walsh from 1950 exists (Cruise 1515, TRT, CAN, LKHD), but this population has not been seen since and is presumed extirpated, although it may coincide with the Vittoria Dune Ridge location, located several kilometres east of the hamlet of Walsh.

Four sub-populations first documented from Spooky Hollow in 1984 by Kirk (1986) and again confirmed in 1991 (Bowles 1994) have not been seen since despite numerous recent attempts. It has succumbed to gradual loss of habitat due to succession and a maturing pine plantation.

Erroneous reports

An erroneous report from “St. Williams” (*Marie-Victorin 45867*, MT) exists, although refuted by Sutherland (1987) who felt the record was inaccurately labelled and most likely represents a collection from the St. Williams crown block (Turkey Point Tract), since it has not been confirmed from the Nursery Tract or Manestar Tract at St. Williams, despite considerable fieldwork there (Gartshore *et al.* 1987, Draper *et al.* 2002) and the presence of sufficient suitable habitat.

Extent of occurrence and index of area of occupancy

The present extent of occurrence of Virginia Goat's-rue in Canada is about 10 square kilometres. This value was generated in a Geographic Information System (GIS) by drawing a polygon around the area contained within the shortest continuous imaginary boundary encompassing the two known occurrences. The Index of Area of Occupancy is 9 km² (based on a 1x1 km grid) and 16 km² (based on a 2x2 km grid). The actual area of habitat occupied is roughly 0.16 ha, or ~ 0.0016 km². This value was determined by visually estimating the individual size of each observed patch in square metres.

HABITAT

Habitat requirements

Across its range, Virginia Goat's-rue grows in dry, sterile, sandy, well-drained soils that tend to be circumneutral to acidic. It occurs in open oak (*Quercus* spp.) or pine (*Pinus* spp.) woods (Wood 1949), dry-mesic oak woodland and oak savanna (Sutherland 1987), sand prairies and open sand dunes (Bowles 1994) and sand barrens (Voss 1985), especially those with a history of frequent, low-intensity ground fires. Virginia Goat's-rue was reported to be a common component of sandplain grasslands and coastal heathlands in Massachusetts where soils are quite acidic, with a pH ranging from 3.34 to 4.69 (Dudley and Lajtha 1993). In southern New Hampshire, Virginia Goat's-rue has historically been known as a rare component of dry open woods and slopes with warm, protected, southern exposures (Crow and Storcks 1980), though not seen recently. In Georgia, Virginia Goat's-rue is one of the most abundant legumes in Longleaf Pine (*Pinus palustris*) – Wiregrass (*Aristida stricta*) communities (Hiers *et al.* 2003). Virginia Goat's-rue can occasionally be found along roadsides, in abandoned fields, and other semi-natural habitats where vegetation has been artificially managed to minimize woody species cover, though it appears to have difficulty surviving in degraded habitats at least at the northern edge of its range. Virginia Goat's-rue does

not appear to be able to withstand shading, and above-ground biomass growth is positively correlated with spring burns (Dudley and Lajtha 1993).

In Canada, all sites occur within one distinct physiographic region, the Norfolk Sandplain. The sands and silts of this region were deposited as a delta in glacial Lakes Whittlesey and Warren from a great discharge of meltwater from the Grand River area between ice fronts building a massive delta from west to east as the glacier lobes retreated (Chapman and Putnam 1984).

Soils at the Ontario sites are characterized by Brunisolic Gray Brown Luvisols consisting of lacustrine sands with wind-modified surfaces and duned eolian sands. At the Vittoria Dune Ridge site, soils are rapid to well drained fine sand of the Plainfield series with a low mean organic matter content (slightly less than 2%), and are relatively acidic (Presant and Acton 1984). At the Turkey Point Natural Area, soils consist of well-drained loamy fine sands and fine sandy loams of the Watford Series. Soil reactions of the surface horizons usually range between medium acidic and neutral (Presant and Acton 1984).

From an Eco-regional perspective, Virginia Goat's-rue is limited to the Carolinian Zone (Ecoregion 7E) of Ontario, within the climatic influence of Lake Erie. Typical habitat for the species is open mixed Black Oak (*Quercus velutina*) and White Oak (*Quercus alba*) woodland and savanna with occasional disturbance to limit excessive shading from encroaching trees and shrubs (Figure 4). Periodic groundfires likely maintained habitat historically, while currently, management through prescribed burns at the Turkey Point Natural Area have been occurring. Periodic disturbance, which removes or reduces the duff layer and scarifies the soil surface, is important in the maintenance of conditions suitable for seed germination and seedling establishment. Virginia Goat's-rue is often found in association with Bird's-foot Violet (*Viola pedata*), another federally endangered species having similar habitat requirements (Hutchison and Kavanagh 1994).



Figure 4. A managed (previously burned) Black Oak savanna at Turkey Point Provincial Park where Virginia Goat's-rue forms a frequent component of the groundcover (photo credit S. Brinker).



Figure 5. Unregulated ATV use resulting in damage to Virginia Goat's-rue habitat in the St. Williams Conservation Reserve (Turkey Point Tract) (photo credit S. Brinker).

Habitat trends

Although this species is not actively tracked in most U.S. states, habitat trends have been quantified for several associated ecosystems throughout its range. Recent assessments of tallgrass prairie and oak savanna communities in North America indicate these habitats are in peril. Historically, these vegetation communities covered large expanses of central and eastern North America extending from southern Manitoba and Ontario, south to northeastern Texas and east to Ohio. For example, according to Nuzzo (1986) at the time of settlement in the U.S. Midwest, oak savanna covered between 11 and 13 million hectares (ha). In 1985, a survey identified 113 remnant sites totalling roughly 2,600 ha, representing 0.02 percent of its former extent. Recently, more liberal estimates suggest several hundred thousand hectares of degraded but potentially recoverable oak ecosystems remain, although these have lost both biological diversity and functions, but tend to respond positively to restoration efforts (Leach and Ross 1995). Meanwhile, Longleaf Pine forests and savannas in the southeastern coastal plain of the U.S. have declined by 98% (Noss 1989), leading to their listing as the second most endangered ecosystem in the United States (Noss *et al.* 1995). Elsewhere, sandplain grassland habitat occupied by Virginia Goat's-rue near the edge of its range in the northeastern U.S. area of New England is being lost at a rapid rate (Dudley and Lajtha 1993). Disappearance of these ecosystems was at first the result of their suitability for agriculture and of the deliberate suppression of ground fires. Later, residential and commercial development and invasion by exotic species became important contributing factors. It is not known, however, to what extent this has impacted populations of Virginia Goat's-rue.

In Ontario, similar habitat trends have occurred. Oak savanna and oak woodland, preferred Virginia Goat's-rue habitat in Ontario, were formerly quite extensive on a local basis prior to European settlement (Rodger 1998). Over the past century, these habitats have been converted to agriculture, lost to urban and commercial development, and degraded by suppression of ground fires and non-native invasive species. In the Norfolk County area where Virginia Goat's-rue is found, original survey notes suggest this area formerly supported one of the most extensive areas of dry and dry-mesic prairie and savanna complexes in southern Ontario according to Bakowsky and Riley (1994). Evidence of fires of natural origin were recorded at the Turkey Point tract at the beginning of the 19th century by Zavitz (1909), a founding member of the original St. Williams Forestry Station who reported that "...ground fires periodically burn over this land" and in 1928 he observed "...90 percent of the trees [in the Turkey Point tract] are fire-scarred or diseased." Years of fire suppression and forest management since then has almost eliminated this natural process, leading to the reduction of open savanna conditions. Currently in this region, most remnants exist as small, isolated degraded fragments of less than 2 ha. However, the St. Williams Conservation Reserve and Turkey Point Provincial Park together contain one of the largest tracts of remaining ingrown oak savanna and oak woodland over drought-prone sand soils in Ontario, totalling over 700 ha (Draper *et al.* 2002). Much of this habitat currently is degraded, either under-planted with pine or closed in with excessive woody vegetation however.

The Ontario Natural Heritage Information Centre (NHIC) recognizes three dry Black Oak savanna and woodland vegetation types (based on vegetative composition and community structure) that are associated with Virginia Goat's-rue habitat in Ontario: Dry Black Oak Tallgrass Savanna Type, Dry Black Oak-Pine Tallgrass Savanna Type, and Dry Black Oak - White Oak Tallgrass Woodland Type. Currently, the Dry Black Oak Tallgrass Savanna Type is considered globally rare by the Nature Conservancy (NatureServe 2008), and all three are considered provincially rare by the Ontario Natural Heritage Information Centre (Bakowsky 1996).

Habitat protection/ownership

The largest populations at the Turkey Point Natural Area are protected, contained within Turkey Point Provincial Park and the St. Williams Conservation Reserve (Turkey Point Tract), owned and managed by the provincial government. The designation of the Turkey Point Tract as a "Conservation Reserve" and the park being zoned "Recreational Class" has not ensured full protection of these populations however. While ecological integrity and protection of significant natural heritage is part of the mandate of these protected areas, both Turkey Point Provincial Park and the St. Williams Conservation Reserve are also mandated to provide a wide variety of compatible outdoor recreational opportunities and appropriate levels of day use and facility-based camping opportunities. Hence a number of pressures such as unregulated ATV use and excessive visitation along with habitat loss through development of park facilities and fire suppression continue to threaten some Virginia Goat's-rue populations despite the protected area designations.

The Vittoria Dune Ridge site is on private land and is part of a provincial Earth Science ANSI as well as a designated Significant Site in the Natural Areas Inventory of the Regional Municipality of Haldimand-Norfolk (Gartshore *et al.* 1987), though the latter was never adopted into the region's official plan and neither designations have any legal protective status.

BIOLOGY

The biology of Virginia Goat's-rue does not appear to have been well studied, as there are few data in the scientific literature. The monograph by Wood (1949) remains the most important published work. The information summarized below is based on Woods and a variety of published and unpublished accounts.

Life cycle and reproduction

Virginia Goat's-rue is a perennial flowering herb (forb) that produces seeds many times over its lifetime. It flowers from late June through July in the northern portion of its range. The plant may be self-pollinated, as suggested for the related *T. vogelii* (McGregor 1976), but this has not been confirmed. Effective pollinators are not well documented, though floral structure appears adapted for bee pollination. In a study of

native bee communities in Indiana Black Oak savannas, over 70 percent of pollinators of *Tephrosia* were species of solitary bees in the genus *Megachile* (Jean *et al.* 2002). Although no documented observations of *Megachile* pollination of *Tephrosia* have been made for Canadian populations, a recent insect survey of tallgrass ecosystems in southern Ontario (Packer *et al.* 2002) identified six species of *Megachile* present at the St. Williams Forest Conservation Reserve. According to Sutherland (pers. comm. 2009), *Tephrosia* is known to be a floral host/nectar source for two *Megachile* species collected by Packer *et al.* (2002) from within the conservation reserve: *M. mendica* and *M. mucida*. Although the former is a widespread species with many floral hosts, the latter has a more southern distribution with the next nearest occurrences in New Jersey (Packer *et al.* 2002). The St. Williams Conservation Reserve represents the only known site of occurrence for *M. mucida* in Canada, although similar insect surveys in the Turkey Point vicinity might reveal its presence there as well.

Seed production has not been empirically studied, though Bowles (1994) examined a subset of pods in the three Ontario populations and found a mean production of 0.99 mature seeds per pod, while 55 percent of pods contained no viable seeds.

Dispersal timing is not known, but likely commences in August and extends into October. Germination rates are reported to be relatively high, and Wood (1949) found that fresh collected seeds had almost a 100 percent germination rate, and high germination rates were also found for related species after seeds had been stored in herbaria for several years. The timing of germination is not known, but presumably occurs in the spring, following periodic ground fires that expose mineral soil. Plant lifespan is not known, but the deep, woody taproots indicate longevity with the generation time likely in the order of at least several years. Age at first reproduction is unknown.

Herbivory

Weevils and other unidentified insect larvae have been observed feeding on seeds in Ontario (Bowles 1994). Damage from herbivores was reportedly heavy in the main Turkey Point Natural Area population, but not consistently documented at all sites. According to Sutherland (pers. comm. 2009), it is quite likely that the weevil species involved is *Apion segnipes*, though this requires further study. This species is known in Ontario (and Canada) only from Turkey Point. Adults are known to visit flowers of *Tephrosia virginiana* elsewhere in its range and the larvae have been collected from its seed pods. *Tephrosia* is the only documented host for this weevil and no other Canadian weevils are known to share the host. No signs of herbivory were noted during surveys in 2008, since surveys were conducted prior to the development of seeds.

Physiology

There are no data beyond the species' habitat preferences and its ability to fix atmospheric nitrogen.

Dispersal

Seed dispersal is likely limited to a few metres from the parent plant as the seeds are ejected from the dehiscing seed pods.

Interspecific interactions

Solitary bees in the genus *Megachile* are important pollinators of *Tephrosia* in Indiana. In Michigan and Indiana, Virginia Goat's-rue is reported as a nectar source for the endangered Karner Blue Butterfly, *Plebejus melissa samuelis* previously treated within the genus *Lycaeides* (Grundel and Pavlovic 2000). Karner Blue Butterfly is considered to be extirpated in Canada (Species at Risk 2009). It is unknown if Canadian populations are pollinator limited.

While no definite nitrogen-specific symbionts have been identified for Virginia Goat's-rue, like most other species in the subfamily Papilionoideae, it is expected to have nitrogen-fixing abilities. Dudley *et al.* (1996) found much higher concentrations of nitrogen in *Tephrosia virginiana* tissue compared to other plants (including a known nitrogen-fixing species, Northern Bayberry, (*Myrica pensylvanica*), in coastal grassland-heathland in Nantucket and concluded it was a nitrogen fixing species. Legumes are prominent components of many fire-dependant ecosystems (Dudley and Lajtha 1993; Hains *et al.* 1999; Hiers *et al.* 2003), often playing a key functional role in replacing volatilized nitrogen following frequent fires via fixation of atmospheric nitrogen through symbioses with nitrogen-fixing bacteria. In addition, legumes may further affect nitrogen cycling by direct transfer of nitrogen to co-occurring plants without such symbioses (Mallarino *et al.* 1990). However, associated species with Virginia Goat's-rue in coastal heathland habitat of Nantucket did not receive any detectable nitrogen benefit from proximity to Virginia Goat's-rue. Furthermore, nitrogen availability was not any higher in soils beneath *Tephrosia* plants than in surrounding reference soil (Dudley *et al.* 1996). Dudley *et al.* concluded that Virginia Goat's-rue did not play an important role in successional processes like other nitrogen-fixing species in other ecosystems.

The preference for relatively open, fire-prone habitat suggests that Virginia Goat's-rue may be intolerant of competition, although this has not been substantiated.

Adaptability

Virginia Goat's-rue is drought and fire adapted, possessing deep woody roots most likely with nitrogen fixing abilities for nitrogen-limited environments.

POPULATION SIZES AND TRENDS

Search effort

Historical collections of Virginia Goat's-rue suggest it was always rare in Ontario. In addition, Virginia Goat's-rue has distinctive, showy yellow and pink flowers and characteristic upright villose stems, branches and petioles that make it difficult to overlook. It also occurs within distinctive and well-botanized habitat that was intensively surveyed in the mid-1980s during a comprehensive natural areas inventory of Haldimand and Norfolk Counties (Gartshore *et al.* 1987). Field studies on private and public land were carried out between 1985 and 1986 at candidate significant natural areas and sites, as well as numerous incidental surveys in many other areas where significant species have been previously reported. During these surveys, a new population of Virginia Goat's-rue was discovered at Vittoria Dune Ridge. Also, a detailed life science inventory of Spooky Hollow was conducted by Kirk (1986), which documented another new population. Fieldwork has also been undertaken to complete a status report on Virginia Goat's-rue between 1991 and 1994 (Bowles 1994) where populations were assessed at Turkey Point, Spooky Hollow and Vittoria Dune Ridge. More recently, large areas of suitable habitat have been surveyed (Draper *et al.* 2002) as part of a detailed life science inventory of the St. Williams Crown Forest, where several additional sub-populations of Virginia Goat's-rue were discovered or relocated. Since then, Ron Gould of the Ministry of Natural Resources has been monitoring existing sub-populations at the St. Williams Conservation Reserve (Turkey Point Tract), part of the Turkey Point Natural Area population (R. Gould pers. comm. 2008).

In 2008, detailed follow-up surveys were conducted at one of the two extant populations, the Turkey Point Natural Area, to census all sub-populations, assess threats and to search for additional, undiscovered patches. As well, aerial photographs were examined to identify additional suitable habitat where the species may have been overlooked. Surveys were also conducted within the Spooky Hollow ANSI to confirm the extirpated status of this population. Surveys were conducted over four days between July 12 and 14, and October 11, 2008. A total of 28 hours were logged with roughly 19 hours spent in Turkey Point Provincial Park where recent detailed surveys were most lacking, six hours at St. Williams Conservation Reserve and 3 hours at Spooky Hollow ANSI. Access was not granted at the Vittoria Dune Ridge population, though the area was casually censused in 2001 by Brinker and was visually scanned with binoculars from the roadside in 2007 and 2008.

No searches were conducted at the three other extirpated sites including Normandale, Simcoe, or Walsh.

Abundance

Unfortunately, specific knowledge of dispersal patterns and genetic connectedness of individual patches for Virginia Goat's-rue is lacking for Canadian populations. In lieu of this, methods to delineate individual populations follow the Habitat-based Plant Element Occurrence Delimitation Guidance produced by NatureServe (2008) and used by most state and provincial conservation data centres, including the NHIC, Peterborough, Ontario. This widely accepted convention states any patch or individual plant separated by >1 km, but not along a riparian or shore system, be considered a unique population or Element Occurrence (EO). Following the NatureServe convention, the NHIC has identified six separate occurrences of Virginia Goat's-rue in Canada, of which four populations are extirpated – Simcoe, Walsh, Normandale, and Spooky Hollow ANSI; leaving two extant populations – Turkey Point Natural Area and Vittoria Dune Ridge.

The original status report estimated the Canadian population at roughly 250 patches (250 plants with an undetermined number of stems) within the Turkey Point Natural Area, Vittoria Dune Ridge and Spooky Hollow ANSI, although the total number of mature individuals capable of reproduction was unknown (Bowles 1994).

Of the two remaining extant Canadian populations, the Turkey Point Natural Area EO consists of roughly 566 scattered patches (plants counted in 2008 with 6,958 mature stems). Since the multiple stems within each patch appear to originate from a single root crown, each patch was considered to represent a single plant. An assumption was made that most plants tallied within the surveys were sufficiently well established to be classified as “mature,” and that many non-flowering plants existed due to over-shading. The Vittoria Dune Ridge EO consists of one patch with roughly 100 stems (based on a 2001 estimate). Therefore, the entire Canadian population contains about 567 plants with 7,058 stems.

Fluctuations and trends

Overall, there is a paucity of population data to adequately assess or compare temporal trends or declines. Although Virginia Goat's-rue has been coveted as a rare, showy, native species and frequently observed over the years, detailed population data have not been gathered using standardized methods. Table 1 summarizes the localities, population and land ownership for all known previously documented Virginia Goat's-rue sites. Few sites have detailed stem counts to permit any comparisons. As well, definitions of what constitutes individuals vs. plants vs. stems may vary by observer further limiting the comparison of counts.

Table 1. Localities, population and land ownership for Virginia Goat's-rue.

Location	Year	Collector/Observer/ Herbarium	Number of plants/area	Land ownership
Normandale	1885	Yates (CAN)	Unknown	Unknown
	1936	Marie-Victorin (MTMG)	Unknown	
	1971	Ball (TRTE)	Unknown	
Simcoe	1915	Williams (OAC)	Unknown	Unknown
	1941	Landon (HAM)	Unknown	
Spooky Hollow ANSI	1984	Kirk	Unknown	Long Point Region Conservation Authority
	1991	Bowles	Unknown	
	2007	Gould	None observed	
	2008	Brinker	None observed	
Turkey Point Natural Area	1885	Yates (MTMG)	Unknown	Provincial Park; Crown Land
	1932	Marie-Victorin (MT)	Unknown	
	1934	Stroud (TRT)	Unknown	
	1934	Brown (TRT)	Unknown	
	1935	Bowden (HAM)	Unknown	
	1938	Soper (HAM)	Unknown	
	1939	Brown (TRT)	Unknown	
	1948	Landon (CAN)	Unknown	
	1955	Campbell (OAC)	Unknown	
	1957	Cruise (TRT)	Unknown	
	1957	Dore (DAO)	Unknown	
	1958	Maycock (DAO)	Unknown	
	1960	Soggan (TRT, CAN)	Unknown	
	1961	Bowden (DAO)	Unknown	
	1963	Zavitz (OAC, QK)	Unknown	
	1967	Montgomery (OAC)	Unknown	
	1979	Crins (TRTE)	Unknown	
	1987	Oldham, Sutherland & Gartshore	Unknown	
	1991	Bowles	Unknown	
	2000	Bakowsky & Kirk	Unknown	
	2001	Gould	1,044 plants (SWCR*)	
	2002	Eccles and Findlay	Unknown	
	2006	Gould	1,807 plants (SWCR*)	
Vittoria Dune Ridge	2008	Brinker	6,958 plants	Private
	1985	Gartshore	Unknown	
	1986	Gartshore	Unknown	
	2001	Brinker	100 plants	
	2007	Brinker	Unknown	
Walsh	2008	Brinker	Unknown	Unknown
	no date	Brink (OAC)	Unknown	
	1950	Cruise (TRT, CAN, LKHD)	Unknown	

*SWCR – St. Williams Crown Reserve, part of the Turkey Point Natural Area population

Since the original status report, one population, Spooky Hollow ANSI, has been lost due to habitat succession. Meanwhile, the status of the three other extirpated populations at Normandale, Simcoe and Walsh remains unchanged.

For the Turkey Point Natural Area, there is a partial set of counts. Plants at the St. Williams Conservation Reserve have been censused three times in the last 10 years. A total of 1,044 plants were counted by R. Gould in 2001 and 1,807 in 2006, but these numbers do not reflect a count of all known subpopulations. In 2008, 2,267 stems were counted. At least one small sub-population in the St. Williams Conservation Reserve has been reduced in size 10-fold, and at least two more small ones have been entirely lost (Gould pers. comm. 2008), likely stemming from indirect threats associated with habitat succession. Within Turkey Point Provincial Park, the current scenario is equally unclear. Detailed mapping of populations in Turkey Point Provincial Park produced by the Ontario Ministry of Natural Resources in 1987 identified precise locations though no detailed counts were undertaken. This map was used to relocate sub-populations in 2008. Of the 47 dots originally mapped by OMNR (1987), only 29 were relocated, and it was apparent the habitat at many sites lacking plants was no longer suitable, suggesting definite declines from within the park.

At the writing of the original status report, the total Canadian population was estimated to consist of roughly 250 mature individuals at three populations. In 2008, a total of 567 patches were confirmed from two populations with a total of 7058 stems. It is unclear if the resulting increases in the Canadian population are the result of more intensive search effort, a real population increase, or some combination of both. Regardless, Virginia Goat's-rue remains a rare species restricted to specific habitat in a limited geographic area.

Rescue effect

Recruitment of plants from the next nearest populations in Michigan, Ohio and Pennsylvania is extremely unlikely. The distances are large, and the intervening terrain includes extensive areas of unsuitable substrate including non-acidic calcareous tills and clays, unsuitable land use including large tracts of agricultural and urban areas, as well as significant stretches of open water (Lake Erie, Lake St. Clair and the St. Clair and Detroit Rivers). The dry pods or seeds have no adaptations for dispersal over long distances. The nearest population, in Venango County, PA, is over 100 km from the Ontario sites. The continued existence of Virginia Goat's-rue in Canada depends, therefore, on the maintenance of the two extant populations.

LIMITING FACTORS AND THREATS

The main limiting factor affecting Virginia Goat's-rue appears to be lack of suitable habitat. It requires acidic sand deposits vs. calcareous sands, the former being uncommon and local within its current southern Ontario range, the latter being much more widespread. Virginia Goat's-rue also prefers oak savanna or oak woodland that were likely never all that common and now constitute provincially rare vegetation types (Bakowsky 1996).

Direct threats are rather minimal to populations at the Turkey Point Natural Area since these are contained within a provincial park and conservation reserve. Several patches occur adjacent to campsites that are frequently used and occasional trampling was observed, though overall this threat is minor. Although it is not clear how much actual impact mowing has other than perhaps removal of above-ground biomass, it is a minor threat at several patches within the park, along roadside verges, as well as one patch along a municipal road allowance. Mown areas tend to have more direct light and plants appear vigorous, and this practice may have indirectly maintained the integrity of these plants by stopping the encroachment of woody shrubs. Park staff are aware of the populations where mowing occurs, and inform seasonal staff to avoid mowing the plants (Postma pers. comm. 2008). ATVs have been a threat in the past to most patches within the St. Williams Conservation Reserve (Turkey Point Tract), although these impacts have been reduced recently since the conservation reserve designation in 2002. Visible signage and fencing have been erected to deter ATV traffic in some areas and have eliminated this threat in other areas. The MNR also maintains an enforcement presence to monitor and deter ATV use.

Several patches in Turkey Point Provincial Park and one in St. Williams Conservation Reserve occur under hydro corridors, the subject of repeated mechanical clearing and plants have the potential to be physically damaged by this practice. Again, this activity has created an artificial disturbance regime that has maintained the open habitat. The creation of several firebreaks in the park has resulted in the elimination of at least one small patch of Virginia Goat's-rue. These areas were scarified with a disc in preparation for prescribed burns, and plants were absent in one of these firebreaks where they had been reported in the past.

Conversely, direct threats are more of a serious concern at the Vittoria Dune Ridge population. This small patch occurs near an existing road allowance at the edge of an unstable and precipitous sand ridge that is slowly eroding. Plants have likely been lost over the years as the slope recedes. The erosion of the bank has been further accelerated by local sand extraction activities. The continued existence of this population in the long-term is doubtful.

Indirect ongoing habitat threats are likely more serious in the long term, namely habitat succession and lack of disturbance. Fire suppression over the last century has had a negative impact by allowing succession of habitat and increased build-up of duff layers inhibiting seed germination. Historically, low intensity groundfires likely played a significant role in maintaining open stand structures, and limiting litter buildup. Succession has been noted to be a major threat by several observers and was discussed in the original status report (Bowles 1994). Indeed, habitat succession has most likely eliminated the Spooky Hollow population in recent years based on the degree of cover and density of woody encroachment observed in 2008, although it is unknown if a viable seedbank could persist and for how long at the site, given the unsuitable conditions. In 2008, many sub-populations appeared suppressed and lacked vigour, faced with competition from prostrate woody vines, namely Poison Ivy (*Rhus radicans* ssp. *negundo*), Riverbank Grape (*Vitis riparia*), Northern Dewberry (*Rubus flagellaris*), and dense sapling regeneration from Black Cherry (*Prunus serotina*). The situation has improved slightly for some sub-populations however. The MNR has conducted several prescribed burns in portions of both the park and conservation reserve in order to improve the quality of representative oak savanna remnants and to encourage the expansion of rare species tolerant of such disturbance. Within the park, prescribed spring burns have been conducted on a rotational basis in about 6-7 blocks in 1994, 1999, 2001, 2004, 2005, 2007, 2008 and 2009 (Postma pers. comm. 2008 and Dobbyn pers. comm. 2009). Compared to the control block where no burns have been conducted, habitat in the burned blocks appears much more open and suitable for Virginia Goat's-rue, and is still occupied by plants that were observed there in the past. However, the control block that had several patches of plants recently does not contain any plants, and habitat is extremely overgrown and unsuitable. Controlled burns have been initiated in the St. Williams Conservation Reserve in 2006, and plants have apparently responded in the short-term with more vigorous growth (Gould pers. comm. 2008).

Invasive species pose another indirect threat to Virginia Goat's-rue at the Turkey Point Natural Area population. Two invasives, Periwinkle (*Vinca minor*) and Oriental Bittersweet (*Celastrus orbiculata*) were observed at several patches of Virginia Goat's-rue in the park. Recently, Periwinkle was observed in a section of high-quality oak savanna where it covered a 20x30 m area of ground eliminating all other herbs. Several Virginia Goat's-rue plants were growing in the dense patch, although they appeared less vigorous than adjacent plants. Oriental Bittersweet poses a much greater problem if it is not controlled as it can spread more quickly and alter habitat structure more extensively. At present, only one patch of Virginia Goat's-rue is in direct proximity of Oriental Bittersweet in the northeast portion of the park, where it is still fairly contained.

SPECIAL SIGNIFICANCE OF THE SPECIES

Virginia Goat's-rue forms disjunct populations in Canada at the northern limit of its North American range. A number of other species found in southern Ontario share similar patterns of distribution and are of conservation concern. Populations at the edge of a species range may be genetically distinct and are important to the diversity of the species.

Virginia Goat's-rue has been studied for its economic potential as an important source of insecticides. Virginia Goat's-rue, like other species in the genus *Tephrosia*, produces rotenone, an odourless chemical often used in broad-spectrum insecticides and pesticides because of its poisonous properties. However, several studies conducted by the U.S. Department of Agriculture found that only a few plants in certain areas possess rotenone in measurable quantities, limiting its commercial usefulness (Crooks 1948).

Virginia Goat's-rue is purported to have diverse traditional First Nations uses, though none of these have been recorded within Ontario. According to Moerman (2003), across its core U.S. range, roots, leaves, and infusions of the plant are used to treat a wide array of symptoms from coughs, rheumatism, irregular menstruation, fevers, bladder trouble, as well as to prevent hair loss and to toughen and strengthen children. It has also been used by Seminole hunters to poison fish.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Virginia Goat's-rue is currently listed as a regulated Endangered Species under Ontario Regulation 230/08 of the new *Endangered Species Act*, 2007. Its provincial Srank is S1 (critically imperiled) and its Ontario General Status listing is "at risk" (<http://www.wildspecies.ca/>). COSEWIC assessed this species as Endangered in Canada in May 2000, and is listed on Schedule 1 of the federal *Species at Risk Act*. The species receives protection in Turkey Point Provincial Park under the *Provincial Parks and Conservation Reserves Act*.

The conservation status of Virginia Goat's-rue in the United States is given in Table 2. It generally is not considered of high conservation concern across much of its range in the U.S., though it is considered possibly extirpated in New Hampshire, critically imperiled in Nebraska and Rhode Island, and rare in Minnesota and Iowa. These states represent range limits, however, and it is not currently of conservation concern throughout its core range.

Table 2. Status of Virginia Goat's-rue in jurisdictions of the United States.

Status	Jurisdiction	Source
SH Possibly Extirpated	New Hampshire	NatureServe (2008)
S1 Critically Imperiled	Nebraska, Rhode Island	NatureServe (2008)
S3 Vulnerable	Minnesota, Iowa	NatureServe (2008)
S4 Apparently Secure	New York, New Jersey, Delaware	NatureServe (2008)
S5 Secure	Kentucky, Virginia, West Virginia, North Carolina	NatureServe (2008)
Not Ranked or under review	Michigan, Wisconsin, Massachusetts, Connecticut, Pennsylvania, Maryland, D.C. Ohio, Indiana, Illinois, Missouri, Arkansas, Texas, Louisiana, Tennessee, Georgia, South Carolina, Alabama, Florida, Mississippi	NatureServe (2008)

TECHNICAL SUMMARY

Tephrosia virginiana

Virginia Goat's-rue

Téphrosie de Virginie

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

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)	Likely several yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? Observed decline in several sub-populations at Turkey Point Natural Area and declines anticipated at the Vittoria Dune Ridge site but monitoring of individuals has not been done consistently.	Unknown
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]. Unknown due to lack of counts of individuals during previous years of monitoring and therefore unknown actual declines due to loss of patches of plants at the two extant locations.	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? Losses due to succession are known but uncertain if trends can be reversed and all threats completely eliminated.	No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	10 km ²
Index of area of occupancy (IAO) 16 km ² (2x2 km grid); 9 km ² (1x1 km grid)	<20 km ²
Is the total population severely fragmented? Only two populations extant but with the largest comprising >95% of the total population size and area of habitat occupied.	No
Number of "locations" (as per definition, in relation to threat)	2
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Observed and projected decline
Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? (Decline based on loss of 3 old historic populations and the Spooky Hollow population lost in the 1990s or early 2000s)	Observed decline
Is there an [observed, inferred, or projected] continuing decline in number of populations? (Projected loss of the small Vittoria Dune Ridge pop.)	Yes
Is there an [observed, inferred, or projected] continuing decline in number of locations? (Projected loss of the Vittoria Dune Ridge location)	Yes

Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? (Observed and projected decline due to invasive plants.)	Yes
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
Turkey Point Natural Area	566 plants (with 6958 stems)
Vittoria Dune Ridge	1 plant with ~100 stems
Total	567 plants (with ~7058 stems)

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Unknown
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Threats (actual or imminent, to populations or habitats)

Main threat: Successional change and lack of fire disturbance over time Also: Limited habitat; spread of exotics (minor threat); potential insect herbivory of seeds

Rescue Effect (immigration from an outside source)

Status of outside population(s) USA: Not currently of conservation concern throughout its core range.	
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Very limited
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered (November 2009) Ontario: Endangered
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Status and Reasons for Designation

Status: Endangered	Alpha-numeric code: B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(ii)
Reasons for designation: A species of restricted geographical occurrence in Canada present as two remaining populations within remnant Black Oak savanna and Black Oak woodland habitats in southwestern Ontario. These habitats are globally rare and are one of the most threatened ecological communities in Canada. Most of the fewer than 600 plants are present as a single population within two nearby protected areas. Here the species is at risk from habitat degradation through successional changes. The very small second population, found on private land, is at risk of loss due to erosion of its sandy dune habitat.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Unknown % decline due to lack of monitoring data.
Criterion B (Small Distribution Range and Decline or Fluctuation): Meets Endangered B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v) with both EO and IAO within criterion limits; two locations are known based on differing threats and loss of several sub-populations at the Turkey Point Natural Area; a further decline is also inferred for the Vittoria Dune Ridge site due to habitat erosion; loss of area of occupancy, area and quality of habitat, number of locations and individuals has occurred within the two populations and in regard to the loss of the Spooky Hollow population.
Criterion C (Small and Declining Number of Mature Individuals): Meets Endangered C2a(ii) based on the continuing loss observed and projected for the total population numbering <2500 plants with one population having >95% of all individuals.
Criterion D (Very Small Population or Restricted Distribution): Meets Threatened D1 with <1000 individuals.
Criterion E (Quantitative Analysis): None available.

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Samuel R. Brinker received a Bachelor of Environmental Studies (BES) from the University of Waterloo. He has held a number of positions for the Ontario Ministry of Natural Resources focusing on species at risk assessments, vegetation mapping, as well as inventory and monitoring. He has also worked as a consulting biologist for municipalities, conservation authorities and government agencies conducting inventories and assessments of natural areas and species at risk mapping projects. Sam is currently a botanist with the provincial conservation data centre at the Natural Heritage Information Centre, where he provides botanical expertise, analysis and reporting on plant species and communities of conservation concern in Ontario.

COLLECTIONS EXAMINED

No herbarium collections were examined for this update report.