COSEWIC
Assessment and Update Status Report

on the

Small-flowered Sand-verbena
Tripterocalyx micranthus

in Canada

ENDANGERED
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE IN
CANADA

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AU CANADA

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Previous report:

Smith, B., and C. Bradley. 1992. COSEWIC status report on the sand verbena *Abronia micrantha* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 34 pp.

Production note:

1. Small-flowered sand-verbena *Tripterocalyx micranthus* was formerly listed by COSEWIC as sand verbena *Abronia micrantha.*
2. Finalized report to be circulated only with the accompanying addendum.

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Small-flowered Sand-verbena — provided by the author.

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COSEWIC
Assessment Summary

Assessment Summary – November 2002

Common name
Small-flowered sand-verbena

Scientific name
Tripterocalyx micranthus

Status
Endangered

Reason for designation
An annual of a few widely dispersed sand hill habitats where populations occupy very small sites and consist of low numbers that fluctuate greatly with precipitation levels.

Occurrence
Alberta and Saskatchewan

Status history
Designated Threatened in April 1992. Status re-examined and uplisted to Endangered in November 2002. Last assessment based on an update status report.

COSEWIC
Executive Summary

Small-flowered Sand-verbena
Tripterocalyx micranthus

Species information

Small-flowered sand-verbena *Tripterocalyx micranthus* (Torr.) Hook. is an annual species and a member of the four o'clock family (Nyctaginaceae). It is a much-branched plant, 2-5 dm high with trailing branches, up to 6 dm long, with ascending tips. The succulent, pale stems are enlarged at the nodes. The paired leaves are entire, somewhat round, and have prominent veins. Leaf blades are 2-6 cm long, 1-3 cm wide. The tiny greenish-white flowers are quite showy as they are arranged in dense clusters with a ring of bracts underneath. Flowers lack petals but have 5 petal-like lobes formed into a long tube, 5 mm in width. When the ovary ripens into the fruit, the base of the calyx tube becomes transformed into a winged structure, closely enclosing the fruit and aiding in its dispersal. These winged fruits are pale green with a pink blush. The fruit is about 2 cm long with 2-3 thin, papery, strongly veined nerves.

Distribution

Small-flowered sand-verbena is confined in the wild to western North America. In Canada the species is restricted to southeastern Alberta (6 sites) and southwestern Saskatchewan (1 site) near the Alberta border along the South Saskatchewan River.

Habitat

Small-flowered sand-verbena is found in dry habitats, particularly in loose sands of dune and sand hill areas. Some element of active sand is usually required. Common species associated with small-flowered sand-verbena are spear grass (*Stipa comata*), sand grass (*Calamovilfa longifolia*), buckbrush (*Symphoricarpos occidentalis*), rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), silverberry (*Elaeagnus commutata*), Indian rice grass (*Oryzopsis hymenoides*), scurf pea (*Psoralea lanceolata*), June grass (*Koeleria macrantha*), sand dropseed grass (*Sporobolus cryptandrus*), golden aster (*Heterotheca villosa*) and petiolate sunflower (*Helianthus petiolaris*).

Biology

Small-flowered sand-verbena is an ephemeral species. Flowering occurs mostly in middle June with fruit set in middle July at Canadian sites. Seeds are disseminated by

wind or water. Since the species is an annual, establishment of seedlings can be expected downwind or downstream from the original population. This assumption can be useful in relocating old populations.

Small-flowered sand-verbena is superbly adapted for survival within its sand dune habitat. Adaptation of annuals in arid conditions requires prompt response to irregularly occurring favorable growth periods, rapid completion of the reproductive process, and production of massive numbers of durable seeds that can survive long periods of unfavorable environment. The formation of a viable seed bank is vital for the future survival of the species within its sandy habitat.

Population sizes and trends

Only one plant was found at the Bow Island site in Alberta during the 2001 survey of all known Canadian sites. In 1994, 1 plant was found at the Suffield National Wildlife Area site. Population numbers have crashed from the 1000 plant total population reported in the previous status report for the species (1992). Habitat loss due to dune stabilization and severe drought conditions are the most likely primary factors contributing to the population crash.

Limiting factors and threats

There has been a major loss of habitat over the Canadian range of small-flowered sand-verbena as a result of dune stabilization. Small-flowered sand-verbena requires some element of active sand for its survival. No suitable habitat remains at two of the five known Alberta sites. Little suitable habitat remains at any of the other Alberta sites or the single Saskatchewan site. The likely factors contributing to dune stabilization are the discontinuation of historical fire and browsing patterns. Also, the potential spread of the species has been limited by historical and recent changes in land use. The cultivation of lands surrounding the sites limits potential habitat. The primary Canadian site is located in a major oil and gas field. Finally, the spread of weedy species into dune areas may contribute to the process of dune stabilization.

Special significance of the species

Small-flowered sand-verbena has no known commercial uses. It has limited horticultural uses as a result of its preference for drifting sand.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* 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.

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.

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

Update
COSEWIC Status Report

on the

Small-flowered Sand-verbena
Tripterocalyx micranthus

in Canada

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2002

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TABLE OF C0NTENTS

List of figures

SPECIES INFORMATION

Name and classification

Scientific Name: *Tripterocalyx micranthus* (Torr.) Hook.
Formerly: *Abronia micrantha* Torr.
Common Name: Small-flowered sand-verbena
Family: Nyctaginaceae; four-o'clock family
Major Plant Group: Dicot flowering plant

Description

Small-flowered sand-verbena *Tripterocalyx micranthus* (Torr.) Hook. (formerly *Abronia micrantha* Torr.) is a member of the Nyctaginaceae, the four-o'clock family so named because the flowers tend to open in the late afternoon. Small-flowered sand-verbena (Figure 1) is an annual, from a taproot, much-branched plant, 2-5 dm high with trailing branches up to 6 dm long, the tips ascending. The succulent, pale stems are enlarged at the nodes. The paired leaves are entire, somewhat round, and have prominent veins. Leaf blades are 2-6 cm long, 1-3 cm wide. Unlike the similar sand dock (*Rumex venosus*), small-flowered sand-verbena has no sheathing stipules. The tiny greenish-white flowers are quite showy as they are arranged in dense clusters with a ring of bracts underneath. Flowers lack petals but have 5 petal-like lobes formed into a 5 mm broad long tube. There are five stamens, one style, and one superior pistil.

Figure 1. Small-flowered sand-verbena.

When the ovary develops into the fruit (Figure 2), the base of the calyx tube becomes transformed into a winged structure, closely enclosing the fruit and aiding in its dispersal. These winged fruits are characteristic and look quite attractive as they are pale green with a pink blush. The fruit is about 2 cm long with 2-3 thin, papery, strongly veined nerves.

Figure 2. Small-flowered sand-verbena fruit.

Only one other species of the genus *Tripterocalyx* (formerly *Abronia*) occurs in Canada, namely, *Abronia latifolia* Eschsch, the yellow small-flowered sand-verbena. Because, this species is restricted to southwestern British Columbia it cannot be confused in the field with small-flowered sand-verbena.

Small-flowered sand-verbena superficially resembles wild begonia (*Rumex venosus*), but wild begonia is a perennial plant with stout (not brittle), erect stems; its flowers are borne in leafy, branched clusters at the stem tips. Young small-flowered sand-verbena plants sometimes resemble members of the goosefoot family in shape, colour and mealiness (of the underside of the leaves) (Alberta Native Plant Council 2001).

DISTRIBUTION

Global range

Small-flowered sand-verbena is a species of western North America (Figure 3). In Canada, it is distributed in widely scattered localities from southeastern Alberta, as well as at one southwestern Saskatchewan locality. In the United States, small-flowered sand-verbena is distributed in eastern Montana, Nebraska, Wyoming, Utah, Colorado, Nevada, eastern California, northern Arizona, New Mexico, North Dakota, South Dakota, western Kansas and northern Texas.

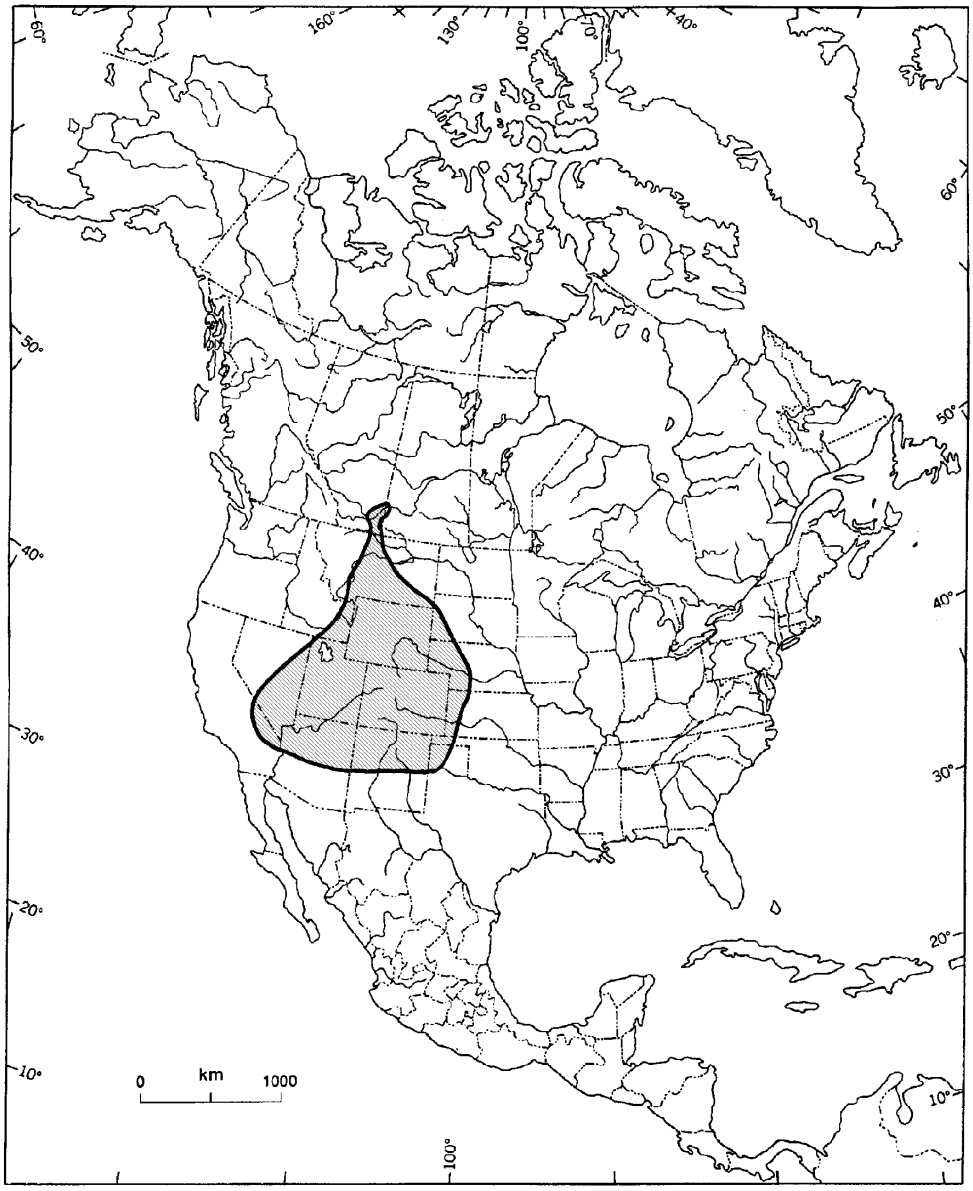

Figure 3. North American distribution of small-flowered sand-verbena.

Canadian range

In Canada, the species is restricted to southeastern Alberta (6 sites) and southwestern Saskatchewan (one site near the Alberta border) (Figure 4). Small-flowered sand-verbena is considered rare in Canada and in Alberta and Saskatchewan.

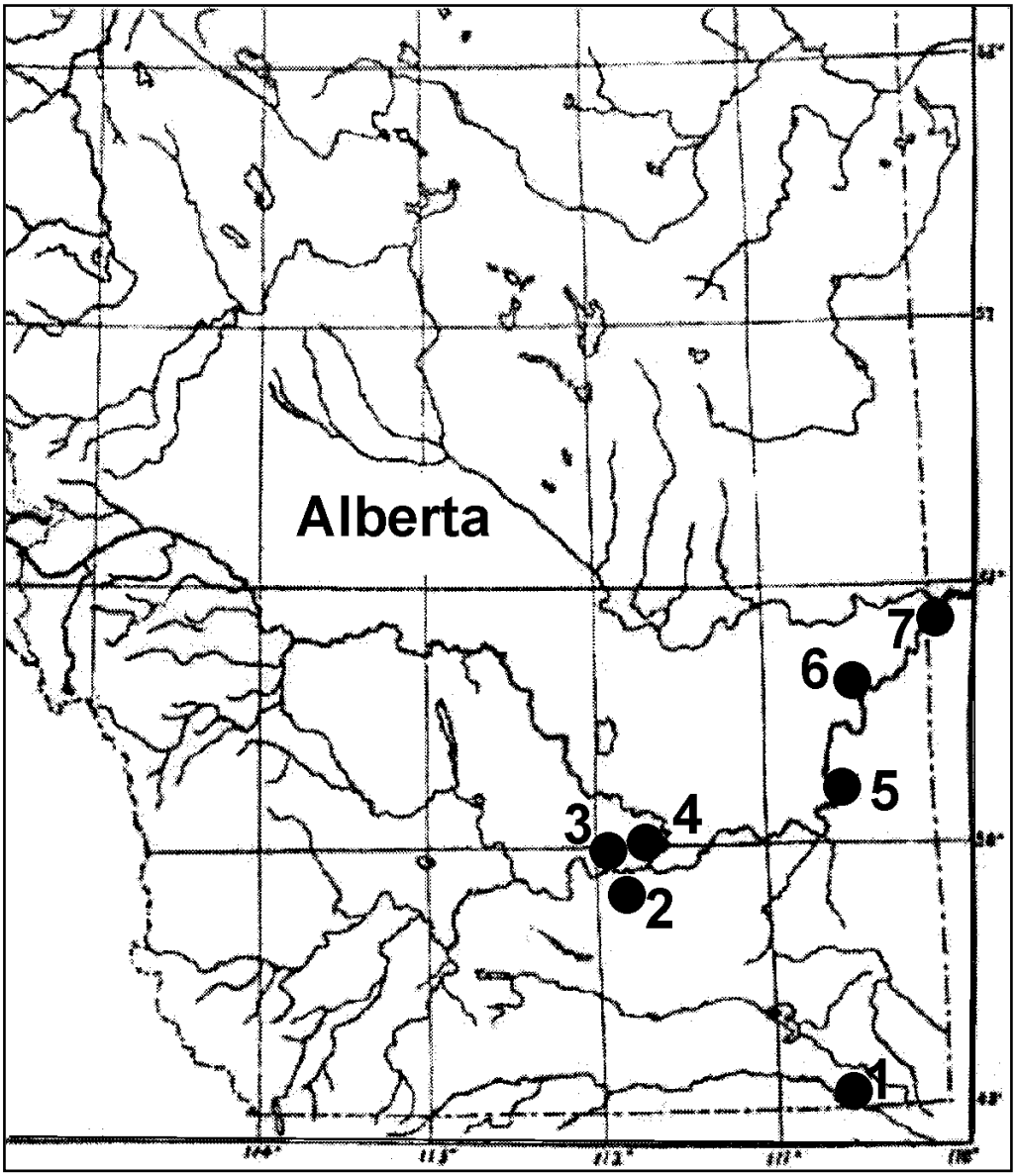

Figure 4. Canadian distribution of small-flowered sand-verbena.
Alberta:
1) Lost River; 2) Purple Springs; 3) Wolf Island; 4) Bow Island; 5) Bull Pound, South Saskatchewan River; 6) Suffield National Wildlife Area Saskatchewan; 7) South Saskatchewan River, east of Alberta border

Alberta: Small-flowered sand-verbena has been found in southeastern Alberta at six locations; namely, Lost River, Bow Island, Purple Springs, Bull Pound, Suffield National Wildlife Area, and Wolf Island. These sites all occur within an area northeast of Bow Island (at the confluence of the Bow, Oldman and South Saskatchewan Rivers), west to the Saskatchewan border and south to the Montana border at widely scattered localities. Small-flowered sand-verbena is always associated with a river system. Five of the sites are associated with the South Saskatchewan River. One site is associated with the Lost River near the border with Montana. Historically, small-flowered sand-verbena has been located near Milk River (1895) by John Macoun.

Saskatchewan. In Saskatchewan the species occurs only at one site just east of the Alberta border, south of Empress, Alberta where the South Saskatchewan River bends into Saskatchewan and out again to join the Red Deer River (Hudson 1982).

Small-flowered sand-verbena may not now occur at the previously known sites in Canada. In the past ten years, the species has only been found at the Bow Island and Suffield National Wildlife Area sites. Small-flowered sand-verbena may be present in the seed bank at its other locations.

HABITAT

Habitat requirements

Small-flowered sand-verbena is found in dry habitats, particularly in loose sands of dune and sandhill areas. Some element of active sand is usually required. The largest populations are on hard packed finer sand on level terrain but it also occurs on south, west, and east-facing slopes and along dune ridge tops. Most sites are on the uplands but the species may also occur in the valleys of the Lost and South Saskatchewan Rivers where sand dunes extend down into the valleys. Common species associated with small-flowered sand-verbena area spear grass (*Stipa comata*), sand grass (*Calamovilfa longifolia*), buckbrush (*Symphoricarpos occidentalis*), rose (*Rosa acicularis*), chokecherry (*Prunus virginiana*), silverberry (*Elaeagnus commutata*), Indian rice grass (*Oryzopsis hymenoides*), scurf pea (*Psoralea lanceolata*), June grass (*Koeleria macrantha*), sand dropseed grass (*Sporobolus cryptandrus*), golden aster (*Heterotheca villosa*) and petiolate sunflower (*Helianthus petiolaris*).

Bow Island, Alberta site - one plant found on a road cut (Figure 5) that has exposed actively blowing sand. At this particular site, the specimen of small-flowered sand-verbena was located on open sand mostly devoid of any other vegetation. The occasional scurf pea, prostrate Amaranth (*Amaranthus graecizans*), and Indian rice grass were located in the same area. Formerly, this site had supported the largest Canadian population of small-flowered sand-verbena.

Figure 5. Small-flowered sand-verbena habitat at the Bow Island site. This site formerly supported the largest population.

Trends

In Alberta, about 20% of the rare plants in the grassland and parkland regions are found in sandy soils, principally in sand hill areas. Sand hill areas are locally distributed, and diverse sand hill areas are rare.

There has been a substantial decrease in suitable habitat for small-flowered sand-verbena over its Canadian range. Sand dune stabilization has resulted in a considerable and sometimes total loss of active sand deposition required by the species. Dune stabilization has resulted in the loss of two of the six known Canadian sites. Little active sand remains at any of the sites. The process of dune stabilization has allowed various prairie and weedy species to overtake the open sandy habitat necessary for the survival of small-flowered sand-verbena.

Protection/ownership

All Alberta sites occur on crown land presently held under grazing (Wolf Island, Purple Springs, Bull Pound) or oil/gas leasehold (Bow Island). The Lost River site is located on Dominion Experimental Farm land presently used for grazing cattle. The Suffield site is located within the Suffield National Wildlife Area along the eastern end of Whitco Road. No information on land use was presented by Macdonald (1997) in his report on the wildlife area.

The Saskatchewan site occurs on crown land used for grazing cattle.

BIOLOGY

General

Normally closed perennial plant communities of the desert become open to invasion by annuals during brief periods of excess soil moisture. To be successful in the desert, an annual plant must promptly respond to favorable growing conditions, reproduce itself abundantly, and return to a dormant state (seed) awaiting the next opportunity. Warm spring temperatures, coupled with favorable soil moisture conditions resulting from snow melt and seasonal precipitation, bring on rapid phenological development to maturity. Death of the mature plant ensues when summer temperatures and surface soil moisture conditions become critical (Evans and Thames 1981).

Reproduction

Ephemerals such as small-flowered sand-verbena usually germinate in the spring. They grow quickly, flower and produce seeds before dying and scattering their progeny to the desert floor. This is a very successful adaptation to desert conditions as the plants survive the torrid heat, and often drought, of midsummer as dormant seeds. These seeds are extremely hardy. The plants survive in this way until the following spring, sometimes two or three springs, when they repeat the cycle (Danin 1996).

With all annuals there is an ever-present danger that germination may be triggered by precipitation from a storm of short duration and the resulting highly vulnerable seedling crop killed in a subsequent hot, dry period. Germination of seeds of most annuals is inhibited by biochemical controls so they are delayed in germination until this danger period has passed (Evans and Thames 1981).

The fruit of small-flowered sand-verbena is composed of an achene (seed) which is enclosed by a persistent winged structure. Moisture is required to leach substances from these wings or promote fungal growth and hence mechanical softening. Therefore, germination will also depend not only on the total rainfall but also on the duration. A slow rain brings on more germination through the leaching effect on seeds than does a cloudburst yielding the same precipitation total. Temperatures also interact strongly with precipitation (Evans and Thames 1981). Exact effects of temperature and precipitation on small-flowered sand-verbena requires further study.

Flowering occurs from May to July over the range of the species but at Canadian sites occurs mostly in middle June with fruit set in middle July.

Survival

Adaptation of annuals in arid conditions requires prompt response to irregularly occurring favorable growth periods, rapid completion of the reproductive process, and production of massive numbers of durable seeds that can survive long periods of unfavorable environment (Evans and Thames 1981). Small-flowered sand-verbena is superbly adapted for survival within its sand dune habitat. Most arid plant adaptations are geared around increasing the ability of the plant to obtain and maintain moisture levels so necessary for survival. The low, shrub-like form of the plant's canopy and silhouette is typical of species which have been adapted to trap fine silts and clays as a result of lower wind velocities within the canopy and around the base of the plant (Danin 1996). Silt and clay have a higher water holding capability than find to coarse sand, and this silt/clay can absorb early morning dews more efficiently (Danin 1996).

The stems, leaves, and roots of small-flowered sand-verbena are also adapted in a variety of ways to ensure the survival of the plant in arid conditions. The rigid stems of small-flowered sand-verbena offers protection from dessication. The stems of this plant may be viscid (with sand adhering to the surface) which insulates them from abrasive hazards such as airborne sand. Lower surfaces of leaves may have a similar coating. Leaves also are fairly thick and simple in form offering a reduction in leaf area and decreasing potential water loss (Danin 1996). Also, the smooth upper surface and erect form of the leaf may direct condensation from early morning dews to the root system (Figure 1). As the plant is an annual the root system is a simple taproot (Welsh 1987).

Annual plants of the desert generally resemble mesic rather than xeric plants in morphology and function (Evans and Thames 1981). A perennial desert or xeric plant would have more extensive adaptations to their stem, leaf, and root systems given the necessity of multi-year survival in difficult circumstances.

The formation of a viable seed bank is vital for the future survival of the species within its sandy habitat. Directed wind dispersal of the fruit of desert dune species enable them to remain in their most appropriate sites and avoid being carried off the dunes to unsafe sites. The wind causes the fruit to roll or glide eventually coming to rest on leeward slopes of dunes where wind velocity approaches zero. The fruit is covered by sand during future wind depositions. As the leeward slope slowly moves forward, new fruits are deposited in new leeward slopes. Consequently, the entire dune area becomes a seed bank at all depths. Seeds remain in the system of mobile sand protected from animals. Exposed fruit may move with strong winds to nearby areas where correct moisture and temperature regimes result in germination (Danin 1996).

Physiology

Annuals commonly exhibit rapid germination of seeds, rapid extension of primary root systems, and high vigor in seedlings. High seed germination percentage is the usual response in annuals. The growth of desert plants is directly related to the availability of moisture. The timing of the availability of moisture is extremely important (Evans and Thames 1981).

Annuals have very low structural carbon requirements for maintaining leaves, roots, and other plant parts when compared to perennials. Annual plant structures are normally functional but once, and then they die and disintegrate. It is not necessary that annual plants be heavily protected as perennial plants against drought and excessive temperature because they grow only in relatively favorable seasons (Evans and Thames).

Movements/dispersal

Since small-flowered sand-verbena is an annual species it would not be likely to be found in exactly the same location from year to year. The fruit, an achene, is enveloped by the persistent calyx in the form of three thin wings that facilitate dissemination. The fruit, seeds and seed dispersal system are all fully adapted for survival within arid habitats. The winged fruit may roll on the ground or float well on water. Hairs are absent on fruits as this would impede wind dispersal during rolling or gliding on sandy surfaces (Danin 1996). The wings on these fruits aid dispersal by the gusty winds of sand dune fields (Alberta Native Plant Council 2001). It is probable to expect establishment of the seeds downwind or downstream from the original sites as a result of wind or water dissemination of the seeds. Two past investigators (Hudson 1982, Johnson and Hallworth 1975) located additional populations by following this logic.

Hudson (1982) made several assumptions in searching for the Saskatchewan localities. He assumed small-flowered sand-verbena would be found in generally sandy country, deep down in a hot microclimate, and on the inner or convex side of a bend in the river, and therefore, on the slip-off slope where the substrate would be alluvially deposited sand. Hudson's assumptions were proven to be correct during field examination of the rediscovered site.

Nutrition and interspecific interactions

There was little data found on the specific nutrition and interspecific interactions of small-flowered sand-verbena.

Dense canopies of annuals prevent further germination by some interference pattern. Germination has been shown to occur in soil removed from below the canopy suggesting that germination inhibition under the canopy may be caused by the reduced red-to-far-red radiation ratio (Evans and Thames 1981).

Behaviour/adaptability

Small-flowered sand-verbena is apparently unable to adapt to habitat that does not contain sand deposition, therefore, the species is restricted to habitat containing blowing sand.

POPULATION SIZES AND TRENDS

In 1992, the total Alberta population of small-flowered sand-verbena was estimated to be under 1000 plants (Smith and Bradley 1992). At that time, the population was distributed amongst the southeastern Alberta localities as follows: Lost River - 200 plants, Bow Island - 265 plants, Purple Springs — 30 plants, Bull Pound — less than 100 plants, Wolf Island - 110 plants. Population data were collected by Wallis and Wershler (1988) during the 1987 field season. Johnson (1975) surveyed the Bull Pound area. The Suffield National Wildlife Area site was examined in 1994 (Macdonald 1997). At that time only one plant was found in the area.

There are no population data available for the Saskatchewan site (collected 1981) but fewer than 10 plants were noted at the time of the collection (pers. comm. From V. Harms, University of Saskatchewan to E. Haber, COSEWIC).

In 2001, the author resurveyed all known Canadian small-flowered sand-verbena sites, with the exception of the Suffield Wildlife National Area site (Macdonald 1997). The survey was undertaken during the months of July and August. Sites were surveyed later in the season since the distinctive three-winged, peach-colored fruit is the most recognizable feature of the species. The Bow Island and Bull Pound sites were surveyed on three separate occasions (early July, mid-July, early August) in an attempt to find specimens. All other sites were surveyed once in mid-July and again in early August. In all cases the site was identified on topographic maps, located in the field and suitable habitat examined. In the case of the Lost River site a one kilometre area both up and downstream from the original site was investigated for suitable habitat occurrences. In the case of the Purple Springs site the entire area of the partly-stabilized dune ridges in the small dune field was investigated. There was no suitable habitat found at or near the Wolf Island site. Surveys were intensive and extended beyond the original site to include surrounding areas in an attempt to locate other potential habitat.

During fieldwork conducted in the 2001 field season only one plant was found along a sandy road cut at the Bow Island site in Alberta. This was the only specimen of small-flowered sand-verbena located during 2001.

Field data were noted as follows:

Bow Island — 1 plant along an area of artificially exposed actively blowing sand along a road cut in an operating oil and gas field. Although the surrounding area was extensively surveyed no additional specimens were found. This area represented the most extensive zone of actively blowing sand in the oil field associated with the Bow River. Small scattered areas of sand, no more than a square metre of area at most, were found throughout the northeastern areas of the oil field. No specimens of small-flowered sand-verbena were found in any of these areas.

Lost River — no remaining suitable habitat. In 2001, the area was surveyed one kilometer up and downstream from the original location along the course of the Lost River. Small-flowered sand-verbena was previously located at this site in 1975, 1977 and 1987. There is a possible extirpation of the species at this site.

Purple Springs — small dune field of three separate sand dune ridges with scattered small areas of open sand. No specimens were found. Plants may be located at this site in a non-drought year but there is little available habitat for the species at this site.

Wolf Island — this site is now totally stabilized by prairie vegetation and has likely been lost as a possible location for small-flowered sand-verbena.

Bull Pound — areas of open sand exist which might provide suitable habitat in a non-drought year but no specimens were found during the 2001 survey.

Suffield National Wildlife Area - one plant found in 1994 (Macdonald 1997). No other specimens found during the survey of the wildlife area.

Saskatchewan site on the South Saskatchewan River just east of the Alberta border - no specimens found. There is apparently no suitable habitat but a more extensive search should be conducted down river during a non-drought year.

Small-flowered sand-verbena apparently occurs as individual or very small populations along the course of the South Saskatchewan River from the confluence with the Oldman and Bow Rivers to the Saskatchewan border. Only very small patches of available habitat now remain, which undoubtedly limits population size and any chance of small-flowered sand-verbena expanding its range into new territory.

LIMITING FACTORS AND THREATS

1. Dune stabilization

The main limiting factor affecting small-flowered sand-verbena is its narrow preference for unstabilized sites within dune fields. Indeed, the single greatest threat to the survival of this species in Canada is habitat loss due to the process of dune stabilization resulting from the encroachment of vegetation on active dunes. This process is apparently occurring throughout the prairie provinces. In several sandy sites in Alberta there had been a reduction of between 30% and 90% in active sand. Large areas of once active sand have been stabilized over the last forty years (Wallis 1988). If the current trends continue, rare native plants, such as small-flowered sand-verbena, which now have dangerously low populations, could be eliminated entirely (Wallis and Wershler 1988). This long-term process could be reversed with climatic changes or through human interference with selective dune destabilization.

In 2001, a severe drought year, there was an ever increasing and substantial loss of habitat over the Canadian range of small-flowered sand-verbena. The Wolf Island and Lost River sites have most likely suffered a total stabilization of habitat resulting in the species being extirpated from these two sites. The South Saskatchewan River site in Saskatchewan has also lost most of its sandy habitat. Also, there has been substantial habitat loss as a result of dune stabilization in the remaining sites at Bow Island, Purple Springs and Bull Pound. There has apparently been an overall dramatic loss of sandy habitat over the Canadian range of small-flowered sand-verbena.

It would take several years of drought and active dune destabilization to restore necessary habitat for the survival of small-flowered sand-verbena. Habitat has simply been lost, dune surfaces stabilized by various other species in what appears to be a natural extension of the process resulting from the absence of fire and browsing by buffalo over the Canadian prairie. In the author's opinion it would not be overstating the situation to suggest that small-flowered sand-verbena will disappear over its Canadian range in probably a relatively short time period if the process of dune stabilization is not somehow reversed.

A variety of researchers have noted the ongoing process of dune stabilization over the past fifty years in both Alberta and Saskatchewan (Epp and Townley-Smith1980, 1982, Pylypec 1989, Wallis 1988, Wallis and Wershler 1988). Most dune areas in Alberta and Saskatchewan have experienced severe loss of open sandy habitat as a result of dune stabilization. Documented loss of habitat has been established in the Middle Sand Hills in Alberta as well as the Dundurn, Harris and Great Sand Hills in Saskatchewan (Smith and Bradley 1992).

Ironically, stabilization of the active dunes was seen as good conservation practice. Land managers went to great lengths to stabilize active blowouts, extinquishing fires, modifying their grazing patterns, and even placing old tires in the blowouts. (Wallis and Wershler 1988)

2. Changes in land use

Historically, suitable habitat has been lost as a direct result of farming practices. Several major sand plains have been almost completely cultivated and a major threat exists to the remaining habitats (Wallis 1988). The process of cultivation of areas surrounding the known small-flowered sand-verbena sites disallows the spread of the species to surrounding areas.

The Bow Island site, previously containing the largest Canadian population of small-flowered sand-verbena, is fully engaged as an oil field with extensive road, transmission lines, well sites and active exploration and oilfield activities. In effect, this activity has destabilized the sand in several dune areas allowing for creation of suitable habitat for the species. This potentially positive effect must be countered with the physical loss of habitat, within the dune field, now used for facilities and roads.

3. Invasion of weedy species

There is also the potential for invasion of non-native species as a result of vegetation reclamation along oil and gas access roads and well-sites. The Lower Bow dune at one site is being stabilized by Russian thistle (*Salsola kali*), bee plant (*Cleome serrulata*) and foxtail barley (*Hordeum jubatum) (Wallis 1987).*

SPECIAL SIGNIFICANCE OF THE SPECIES

Small-flowered sand-verbena has no known commercial uses. Many species of the genus *Tripterocalyx* have horticultural use in borders, rockeries and baskets. Small-flowered sand-verbena, given its preference for actively drifting sand as habitat, has little known horticultural value.

EVALUATION AND PROPOSED STATUS

Existing protection or other status

Small-flowered sand-verbena was assigned a status of 'Threatened' by COSEWIC in 1992 based on the information in the original status report written for the species. No specific legal status is accorded small-flowered sand-verbena in any part of Canada. Nature Conservancy Rank is Global G?, Canada N1, Alberta S1, Saskatchewan S1. United States ranks: Arizona (SR), California (S1.3; 5 or fewer sites and no known threats), Colorado (SR), Kansas (S1), Montana (SR), Nebraska (S1), Nevada (SR), New Mexico (SR), North Dakota (SR), South Dakota (SH), Utah (SR) and Wyoming (S3).

Assessment of status and author's recommendation

Small-flowered sand-verbena is historically known from Alberta (6 sites), total population 1000 plants as of the late 1980's and Saskatchewan (1 site), total population approximately 10 plants in 1981. Total population has drastically declined in 2001. Most known Alberta sites have suffered great, if not total loss, of potential habitat as active sandy areas have stabilized and been taken over by native prairie species as well as introduced weedy species. Only one plant, at Bow Island on a road cut which artificially exposed an area of blowing sand, has been found in Alberta. The sites at Lost River and Wolf Island contain no actively blowing sandy habitat. The remaining sites contain extremely limited areas of active sand. The Purple Springs site was extensively searched and no specimens were found. Although there is a fair amount of open sand in areas near the Bull Pound site no plants were found. In addition, no suitable habitat was located in the sole Saskatchewan site on the South Saskatchewan River site just east of the Alberta border.

There has been a dramatic population loss over the range of the species' habitat in Canada. This may be partially due to the severe drought the area has experienced in 2001, nonetheless, little habitat now remains for this species in Canada. Current population and habitat information suggest that an upgrade in rank from threatened to endangered is warranted. This designation is recommended given the severe habitat loss and crash in population numbers. Small-flowered sand-verbena should be resurveyed in a non-drought year to determine if numbers of plants increase to any extent.

TECHNICAL SUMMARY

Tripterocalyx micranthus (Torr.) Hook.
Small-flowered sand-verbena Abronie à petites fleurs
Canada: Alberta, Saskatchewan

Extent and Area information	
• *extent of occurrence (EO)(km²)*	9.7 km^2
• *specify trend (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	presence of occurrences likely vary with climatic conditions
• *area of occupancy (AO) (km²)*	< 1 sq. km
• *specify trend (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	Major decline.
• *number of extant locations*	2?
• *specify trend in # locations (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	?
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Extreme decline in available habitat.
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	One year (annual).
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	1 - Bow Island (2001) 1 - Suffield (1994)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	declining
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	1000 plant, 1980's to 2 plants, 2001; 99.8% decline
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	Requires further study.
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	yes
• *list each population and the number of mature individuals in each*	Bow Island- 1 Suffield - 1
• *specify trend in number of populations (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	yes
Threats (actual or imminent threats to populations or habitats) [add rows as needed]	
- habitat loss due to dune stabilization, fire control, grazing, cultivation, industrial activity	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Western U.S.
• *status of the outside population(s)?*	Kansas (S1), Nebraska (S1), California (S1.3), Wyoming (S3), South Dakota (SH)
• *is immigration known or possible?*	no
• *would immigrants be adapted to survive here?*	unknown
• *is there sufficient habitat for immigrants here?*	no
Quantitative Analysis	

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THE AUTHOR

The author received her B.Sc. (Botany) from Mount Allison University, Sackville, N.B. in 1977. She has been employed at the University of Calgary, Department of Biological Sciences Herbarium as Technician from 1981 to 1992. Since 1992, she has been greenhouse/herbarium technician at the University of Calgary. Ms. Smith has authored or co-authored twelve COSEWIC status reports on rare plants and is employed as a botanical consultant and rare plant specialist on an on-going basis.

COLLECTIONS EXAMINED

University of Calgary Herbarium, Calgary, Alberta
Alberta Natural Heritage Information Centre, Edmonton, Alberta
Saskatchewan Rare Plants Data Base, Saskatoon, Saskatchewan

ADDENDUM

Status of the Small-flowered Sand-verbena (*Tripterocalyx micranthus*) based on field data from 2002. This addendum was prepared by E. Haber based on information provided by Bonnie Smith that was available for designation purposes. This addendum contains only the basic population data, a revised technical summary and a revised figure 4.

Summary

Small-flowered sand-verbena (*Tripterocalyx micranthus* (Torr.) Hook.) is primarily distributed in southeastern Alberta (seven sites) in Canada. As well, the species occurs at one site just east of the Alberta border in southern Saskatchewan.

Small-flowered sand-verbena sites is documented at Lower Bow (789 plants), Purple Springs (269 plants), Grassy Lake (1797 plants) and North of Medicine Hat (100 plants estimated), North of Medicine Hat Suffield (100 plants), Lost River (100 plants estimated), Suffield National Wildlife Area (1 plant). The total population of four sites surveyed during the 2002 field season by the author was 2955 plants. The total population (counts and estimates) for all Alberta sites is 3156 plants. The Grassy Lake and North of Medicine Hat Suffield sites are new locations for the species not reported in the earlier report (Smith and Bradley 1992). In the process of conducting surveys, other areas of potential suitable habitat were also examined in and around the known sites. No plants were found at the Saskatchewan site during the 2002 field season.

Small-flowered sand-verbena sites are typically small in size usually not exceeding 100 sq. m. Population numbers can change dramatically from year to year based on climatic conditions, in particular, moisture levels. In 2001 the Lower Bow site contained 1 plant while in 2002 the same site contained 789 plants. Small-flowered sand-verbena is an ephemeral annual species which in good years produces masses of seeds that remain viable in the sandy seed bank until a future growing season with suitable climatic conditions.

Small-flowered sand-verbena is found in dry habitats, particularly in loose sands of dune and sandhill areas. Some element of active sand is usually required. The largest populations are on hard packed finer sand on level terrain but it also occurs on south, west, and east-facing slopes and along dune ridge tops. Most sites are on the uplands but the species may also occur in the valleys of the Lost and South Saskatchewan Rivers where sand dunes extend down into the valleys. It is restricted to the Dry Mixedgrass Subregion of the Grassland Natural Region - an area that has undergone extensive modification from its natural state by human activity.

Limiting factors of concern include the following: dune stabilization, changes in land use and invasion of weedy species. The Grassy Lake site, containing more than half of the plant's Alberta population, is currently under threat as a result of sand removal and levelling of the main dune area. Considerable work on management

strategies and population assessment should be undertaken as soon as possible as a means of maintaining the presence of this species in Alberta.

Population Size and Trends

Alberta

Summary

During the 2002 field season small-flowered sand-verbena sites were located at Lower Bow (789 plants), Purple Springs (269 plants), and Grassy Lake (1797 plants). The total population of Alberta plants counted by the author during the summer 2002 field season was 2855 plants. In addition, Trottier counted 100 plants at the North of Medicine Hat Suffield site. Macdonald (1994) reported 1 plant at the Suffield National Wildlife Area site. The Lost River site is reported as containing a small population, probably not exceeding 100 plants for the year 2000 (Wallis, pers. comm.). The North of Medicine Hat site originally located by Johnson is likely small in size and is estimated to contain a small population of approximately 100 plants. In total, the Alberta population is estimated to contain 3156 plants. Localities are indicated in the revised figure 4.

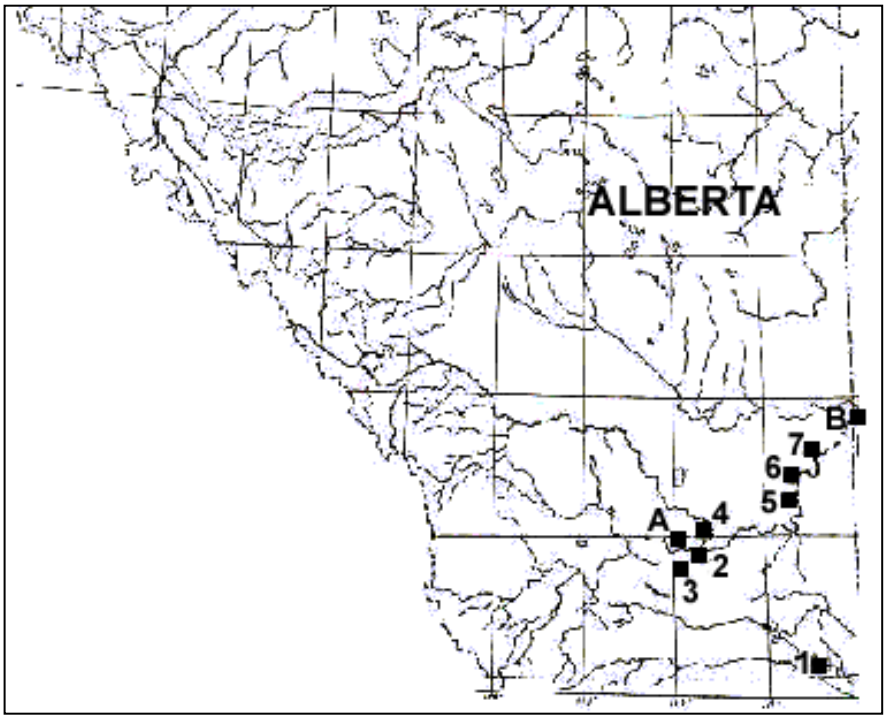

Figure 4 (revised). Canadian distribution of small-flowered sand-verbena.
1) Lost River, 2) Grassy Lake, 3) Purple Springs, 4) Lower Bow, 5) North of Medicine Hat, 6) North of Medicine Hat Suffield, 7) Suffield National Wildlife Area. A – Wolf Island (extirpated), B – Saskatchewan location (no plants recently).

The population numbers for the 2002 field season are considerably higher most likely as a result of a greatly increased amount of precipitation. In 2001, a drought year, only one plant was counted (Lower Bow). The Grassy Lake site is a new location for the species. In the process of conducting surveys on known sites other areas of potential suitable habitat were also examined in and around the known sites. The Suffield National Wildlife Area site was not included in the 2002 survey as a result of access difficulties due to restrictive military protocols required to enter Canadian Forces Base Suffield.

In the original COSEWIC status report (Smith and Bradley 1992), small-flowered sand-verbena was known from five sites in Alberta. The sites were as follows: 1) Lost River, 2) Lower Bow, 3) Purple Springs, 4) South Saskatchewan River, north of Medicine Hat, and 5) Wolf Island. The total Alberta population of small-flowered sand-verbena was estimated to be under 1000 plants (Smith and Bradley 1992). At that time, the population was distributed amongst the southeastern Alberta localities as follows: Lost River - 200 plants, Bow Island - 265 plants, Purple Springs - 30 plants, North of Medicine Hat - less than 100 plants, Wolf Island - 110 plants.

As well, historically, small-flowered sand-verbena had been collected by Macoun from the crossing of Manyberries Creek, north of Milk River in 1895. This site has not been relocated.

The Lower Bow, Purple Springs, Wolf Island and Lost River sites were surveyed by Wallis and Wershler in 1987 (Wallis and Wershler 1988). Johnson surveyed the site north of Medicine Hat on the South Saskatchewan River in 1972 and 1973 (Johnson and Hallworth 1975). Macdonald surveyed the Suffield National Wildlife Area site in 1994 (Macdonald 1997). As well, Sharp and STG (collector) visited the Lost River site in 1972 and 1979, respectively (ANHIC 2001). Smith resurveyed all existing sites, except the Suffield Wildlife Area site, in 2001 (Smith 2002 pending).

Alberta Site Population Data - 2002

Grassy Lake (figure 4 site 2)

This site contains well over 50% of the known Alberta population of small-flowered sand-verbena - 1797 of the 3024 plants counted during the 2002 field season. This site is of vital importance for ensuring the survival of the species in Alberta. Plants are found on a dune that rises 6 m from the surrounding plain. As well, plants are found on the surrounding sandy plain. Of the 1797 plants, 570 are found on the sand dune (60 of these on the open northeast dune face, the remainder on the dune crest and upper southwest facing dune slopes). A total of 1227 plants are found on the surrounding sandy plain (1070 of these south of the access road to the dune, the remainder north of the access road and south of the gas battery). Small-flowered sand-verbena disappears as the prairie becomes more stabilized with grasses and other herbs. The site is small in size, approximately 100 m (north to south) x 40 m (east to west). Small-

flowered sand-verbena occurs with considerable density especially around and under the edges of *Artemisia cana* shrubs (Figure 5) on the open sandy plains east of the sand dune at this site. Plants on open sand can become 3-4 ft. in width (Figure 6), very large in comparison to other sites investigated during the 2002 field season.

Purple Springs (figure 4 site 3)

Small-flowered sand-verbena occurs at three areas along the dune. Area 1: western adjacent dune, 30% open sand - 60 plants along the upper dune areas and on open sand. Area 2: southern dune area of main dune. 30 m area of blowouts and open sand associated with bank swallow nest site. Population 197 plants. Area 3: northern dune area of main dune. 10 m area of exposed sand, bank swallow nest sites, ATV use and tracks up the dune face. Population 12 plants. Total population: 269 plants.

Typical small-flowered sand-verbena plants at area 3 are 4-6 inches in height. Plants at area 2 can be 2 ft. x 3 ft. in diameter at the largest.

Lower Bow (figure 4 site 4)

The population is distributed at three locations within a small dune field composed of about a dozen dunes. Two dunes within this field contain areas of open sand, blow-outs and bank swallow nests. Small-flowered sand-verbena is found on these two dunes, one of which is intersected by the gravel road which provides access to the site. The total population found on the western dune along the gravel road is 293 plants (area 1). An additional 2 plants were located on the portion of this dune separated from the remainder of the dune by the gravel road (area 2). The eastern dune nearer the brook contained 494 plants. In total, the Lower Bow site contained 789 plants (area 3).

Plants are not evenly distributed around the dunes. At area 1, 266 plants of the 293 found on this dune are concentrated along a 10 m x 20 m strip near the road on the southern dune area. Of these 266 plants, 247 plants were found on the southern and northern dune slopes, 19 along the dune crest. The remaining 27 plants are scattered along the northern dune crest area. No plants were found along the eastern lower dune slopes or crests. At area 3, two plants were found at the southern dune crest. At area 2, 407 of the 494 plants were located within a southwestern blow-out area and along dune crests. The remaining 87 plants were distributed along the dune slopes above the inner dune circle. Typically, small-flowered sand-verbena is found on higher slopes of partly stabilized dune areas. Usually, there is significant open sand at these sites.

North of Medicine Hat (figure 4 site 5)

This site was included in the original report (Smith and Bradley 1992) and had been found by Johnson (1975). This is estimated to have about 100 plants.

North of Medicine Hat Suffield (figure 4 site 6)

In 2002, another investigator, Garry Trottier, discovered a new site on Canadian Forces Base Suffield north of Medicine Hat. (Garry Trottier, pers. com., September 2002). Trottier discovered three nearby locations with a total population count of 100 plants. The population counts for these sites were as follows: Location 1 (Fish Creek): 80 plants in groupings of 48, 29, 1 and 2 plants; Location 2 (Down-river from Location 1): 19 plants in groupings of 17 and 2 plants; and Location 3 (Koomati): 1 plant. (Trottier 2002).

Suffield National Wildlife Area (figure 4 site 7)

Macdonald (1994) reported 1 plant at the Suffield National Wildlife Area site.

Saskatchewan

Only one other Canadian small-flowered sand-verbena site exists outside Alberta. This site lies just east of the Alberta/Saskatchewan along the South Saskatchewan River in Saskatchewan. John H. Hudson located ten plants at this site in 1981 and describes it as a steep sloping cutbank on loose sand (figure 4 site B).

The Saskatchewan site was surveyed by Sheila Lamont and Wayne Harris from Saskatchewan in August 2002. The dune site lying west of the South Saskatchewan River but east of the Alberta/Saskatchewan border was surveyed but no small-flowered sand-verbena plants were found. An abundance of other annuals was noted during the survey of the dune area. (Candace Elchuk, personal communication, Sept. 16, 2002)

OTHER ALBERTA AREAS SURVEYED

Lost River (figure 4 site 1)

The proper Lost River site was not located although several areas were surveyed by the author (August 31, 2002). In later communication with Clifford Wallis, who discovered the original site, the author realized she missed the site by approximately 1 km or less, turning south towards the Lost River instead of continuing west towards the Lost River site. Mr. Wallis assured the author that small-flowered sand-verbena had been observed at this site last year or the year before, but very recently, nonetheless. The site is very small in size and consists of a few old, partially stabilized sand blowouts (Clifford Wallis, personal communication, Sept. 14, 2002).

Wolf Island (figure 4 site A)

First observed by Wallis in 1987 (Wallis and Wershler 1988). The area north of the site was typified by *Rumex venosus, Artemisia cana (*4 ft.), *Rosa woodsii*. The area is badly infested with downy chess (*Bromus tectorum*) and badly trampled by cattle. The area south of the site was typified by badland near the Oldman River. *Rumex venosus* was scattered on river banks. No potential sites were noted on either the north or south approach. All surrounding areas were agricultural. This site was not relocated and may be lost as a result of the process of dune stabilization. The Wolf Island site is apparently fully stabilized and contains no functioning habitat.

Purple Springs Sandhills

One of the Purple Springs Sandhills sites surveyed during 2002 was an area containing three northeast-running (N48°E) dunes adjacent to the Oldman River. These sandhills were typified by the following species: *Rumex venosus, Artemisia cana* (2-3 ft.), *Oryzopsis hymenoides, Erysimum cheiranthoides, Psoralea lanceolata, Cryptantha fendleri, Cleome serrulata, Stipa viridula, Agropyron trachycaulum, Chenopodium pratericola, Lygodesmia juncea, Rosa woodsii, Euphorbia glyptosperma*. Dominant association: *Artemisia cana, Rosa woodsii, Cryptantha fendleri, Stipa viridula*. Taller shrubs on dune tops and backs, grassy in dune hollows (*Glycyrrhiza lepidota, Agropyron trachycaulum, Artemisia frigida, Artemisia cana*). Although this area contained habitat which was apparently suitable for small-flowered sand-verbena no plants were found during the authors 2001 or 2002 surveys. *Rumex venosus* is common on sandy soils to the apparent exclusion of small-flowered sand-verbena.

Several additional sites were investigated within the Purple Springs dune field which extends southwest from the above site towards the town of Purple Springs. All were covered with *Rumex venosus*, often heavily trampled by cattle. Only two good sandy sites with small-flowered sand-verbena were discovered within the dune field (described as the Grassy Lake and Purple Springs small-flowered sand-verbena sites in this report), although several other sites were surveyed. There are yet other potential sites within the dune field which should be surveyed. Time limitations and distance to these dune sites did not allow them to be surveyed in the 2002 field season.

REVISED TECHNICAL SUMMARY

Tripterocalyx micranthus (Torr.) Hook.
Small-flowered sand-verbena Abronie à petites fleurs
Canada: Alberta, Saskatchewan

Extent and Area information	
• *extent of occurrence (EO)(km²)*	9.7 km^2
• *specify trend (decline, stable, increasing, unknown)*	Decline (one extirpated population)
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	no
• *area of occupancy (AO) (km²)*	< 1 sq. km
• *specify trend (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No but visible presence of plants is dependent on degree of precipitation each year
• *number of extant locations*	8
• *specify trend in # locations (decline, stable, increasing, unknown)*	decline
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	no
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	decline in available habitat.
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	one year (annual).
• *number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)*	<4000 (3156 counts and estimated)
• *total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals*	Uncertain (fluctuating numbers)
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)*	
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	yes
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤ 1 successful migrant / year)?*	yes
• *list each population and the number of mature individuals in each*	Alberta Lower Bow, 789 Purple Springs, 269 Grassy Lake, 1797 N of Medicine Hat, 100 est. N of Medicine Hat (Suffield), 100 Lost River, 100 est. Suffield Nat. Wild. Area, 1 Wolf Island, extirpated? Saskatchewan 1site, none recently
• *specify trend in number of populations (decline, stable, increasing, unknown)*	decline

• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	fluctuation primarily due to dormancy under drought conditions
Threats	
- habitat loss due to dune stabilization, fire control, grazing, cultivation, industrial activity	
Rescue Effect (immigration from an outside source)	
• *does species exist elsewhere (in Canada or outside)?*	Western U.S.
• *status of the outside population(s)?*	Kansas (S1), Nebraska (S1), California (S1.3), Wyoming (S3), South Dakota (SH)
• *is immigration known or possible?*	not likely due to disjunction
• *would immigrants be adapted to survive here?*	unknown
• *is there sufficient habitat for immigrants here?*	possibly
Quantitative Analysis	none