Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

Ottawa, Ont. K1A 0H3
(819) 997-4991

STATUS REPORT ON THE SMOOTH GOOSEFOOT

CHENOPODIUM SUBGLABRUM (S. WATS.) A. NELS.

BY

BONNIE SMITH

AND

CHERYL BRADLEY

STATUS ASSIGNED IN 1992

VULNERABLE

REASON: LIMITED, BUT WIDELY SCATTERED SITES IN THREE PROVINCES, WITH TWO SITES LOST TO FLOODING, AND THE SAND DUNE HABITATS AFFECTED BY CATTLE GRAZING.

OCCURRENCE: ALBERTA, SASKATCHEWAN AND MANITOBA.

COSEWIC — A committee of representatives from federal, provincial and private agencies which assigns national status to species at risk in Canada.

CSEMDC — Un comité de représentants d'organismes fédéraux, provinciaux et privés qui attribue un statut national aux espèces menacées disparition au Canada.

STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA

Smooth Goosefoot

COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA

COSEWIC

Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

JUNE 1990

OH3 (819)
Ottawa, Ont. K1A [illegible] (819) 997-4991

NOTES

1. This report is a working document used by COSEWIC in assigning status according to criteria listed below. It is released in its original form in the interest of making scientific information available to the public.

2. Reports are the property of COSEWIC and the author. They may not be presented as the work of any other person or agency. Anyone wishing to quote or cite information contained in status reports may do so provided that both the author and COSEWIC are credited. Reports may be cited as in the following example:

   Bredin, E. J. 1989. Status report on the Northern Prairie Skink, Eumeces septentrionalis, in Canada. Committee on the Status of Endangered Wildlife in Canada. 48 pp.

3. Additional copies of this report may be obtained at nominal cost from Canadian Nature Federation, 453 Sussex Drive, Ottawa, Ontario, K1N 6Z4.

DEFINITIONS

SPECIES: "Species" means any species, subspecies, or geographically separate population.

VULNERABLE SPECIES: Any indigenous species of fauna or flora that is particularly at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not a threatened species.

THREATENED SPECIES: Any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability do not become reversed.

ENDANGERED SPECIES: Any indigenous species of fauna or flora that is threatened with imminent extinction or extirpation throughout all or a significant portion of its Canadian range.

EXTIRPATED SPECIES: Any indigenous species of fauna or flora no longer known to exist in the wild in Canada but occurring elsewhere.

EXTINCT SPECIES: Any species of fauna or flora formerly indigenous to Canada but no longer known to exist anywhere.

STATUS REPORT ON THE SMOOTH GOOSEFOOT

CHENOPODIUM SUBGLABRUM (S. WATS.) A. NELS.

IN CANADA

BY

BONNIE SMITH

AND

CHERYL BRADLEY

459 - 30TH AVENUE N.W.
CALGARY, ALBERTA
T2M 2N5

1990

STATUS ASSIGNED IN 1992

VULNERABLE

TABLE OF CONTENTS

Abstract

Smooth goosefoot is an annual herbaceous plant of sand dune habitats. It is known from seven sites in Alberta, ten extant sites in Saskatchewan (with two lost due to flooding) and one site in Manitoba. In Alberta there is an estimated total of fewer than 1000 plants. No population data is available for the two other provinces.

A status of threatened is recommended for this species because there are relatively few sites in total for the species, populations (where numbers are known) are relatively small except for one site in Alberta and the habitat is threatened through grazing and fire control.

[Note: This species was designated as vulnerable by COSEWIC because the sites are widely scattered in three provinces (thereby minimizing the risk of catastrophic loss), one sizeable population exists in Alberta, no clear evidence of population decline was documented, but the species is still at risk from various land use practices of sand dune sites where the species occurs. Erich Haber, Chairman, Plants Subcommittee (COSEWIC)]

I. Species Information

1. Classification and Nomenclature

The scientific name for smooth goosefoot is Chenopodium subglabrum (S. Wats.) A. Nels. It is a member of the family Chenopodiaceae in the order Caryophyllales, subclass Carophyllidae in one of a group of families referred to as the Centrospermae. Alternatively, the Chenopodiaceae is placed in the order Chenopodiales (Porter 1967, Jones and Luchsinger 1986). The name Chenopodium comes from the Greek chen, goose, and podos, foot, because of the shape of the leaves of some species (Hitchcock et al. 1964).

The Chenopodiaceae is a cosmopolitan family whose centers of distribution include the prairies and plains of North America, Australia, the pampas of South America, the Mediterranean coasts, the Karoo of South Africa, the shores of the Red Sea, the southwest Caspian coast, and central and eastern Asia (Caspian to Himalayas, deserts and salt steppes of east Asia). Members of the family are characteristically found on xeric, halophytic or salty soils. There are approximately 102 genera containing 1400 species in the family Chenopodiaceae. Fourteen genera are native to the United States, occurring mostly in the west (Payne-Smith, Jr. 1977, Radford 1986, Lawrence 1951).

No world-wide taxonomic treatment of Chenopodium has been published since those of Moquin-Tandon (1840, 1849). Brenan (1964) prepared a taxonomic treatment of Chenopodium for Flora Europaea. Watson (1874), Standley (1916), Aellen (1929, 1960), Aellen and Just (1943), and Wahl (1954) revised existing treatments of introduced and native North American taxa. Divergent estimates of the number of Chenopodium taxa in Canada are found in the North American taxonomic literature. Species of Chenopodium are not easily defined because of a lack of distinctive macroscopic morphological characters in the genus (Bassett and Crompton 1982).

The genus Chenopodium has nearly 100 species (Hitchcock et al. 1964) which are rather cosmopolitan in distribution but mostly Eurasian in origin. Most of the species found in the northwestern United States and southwestern Canada are weeds of wide distribution (Hitchcock et al. 1964). Jones and Luchsinger (1986) recognize 100-150 species of Chenopodium while Payne-Smith, Jr. (1977) recognizes 200+ species.

There are no recognized varieties of Chenopodium subglabrum although the species was originally listed as a variety of Chenopodium leptophyllum; namely, C. leptophyllum var. subglabrum (S. Wats. in Proc. Am. Acad. Arts & Sci. 9:95. 1874) from the lectotype specimen from the sandhills of the Platte. Sereno Watson was an American botanist trained as a physician who assisted Asa Gray at the Gray Herbarium (1874-1888) and later served as curator (1888-1892) (Stafleu and Cowan 1981). The species was first described under the name Chenopodium subglabrum by Nelson in 1902 in the Botanical Gazette 34:362. Aven Nelson (1859-1952) was an American botanist and professor of biology from 1887 at the University of Wyoming (Stafleu and Cowan 1981). Another synonym listed for the species

was Botrys subglabra (S. Wats.) Lunnell.

Bassett and Crompton (1982), in a survey of various North American floras, including those concerned with all parts of Canada, e.g., Scoggan (1978), Taylor and McBryde (1977), Moss (1959), Boivin (1968), Looman and Best (1978), Marie-Victorin and Rouleau (1964), Roland and Smith (1969), Fernald (1950), Gleason and Cronquist (1963), Hitchcock et al. (1964), and Wahl's (1954) preliminary treatment, shows that there are several questionable names applied to the different taxa. Only a few cytotaxonomical studies of Chenopodium in Canada have been carried out (Bassett and Crompton 1978, Bouchard et al. 1978, Gervais 1979, Bassett and Crompton 1982).

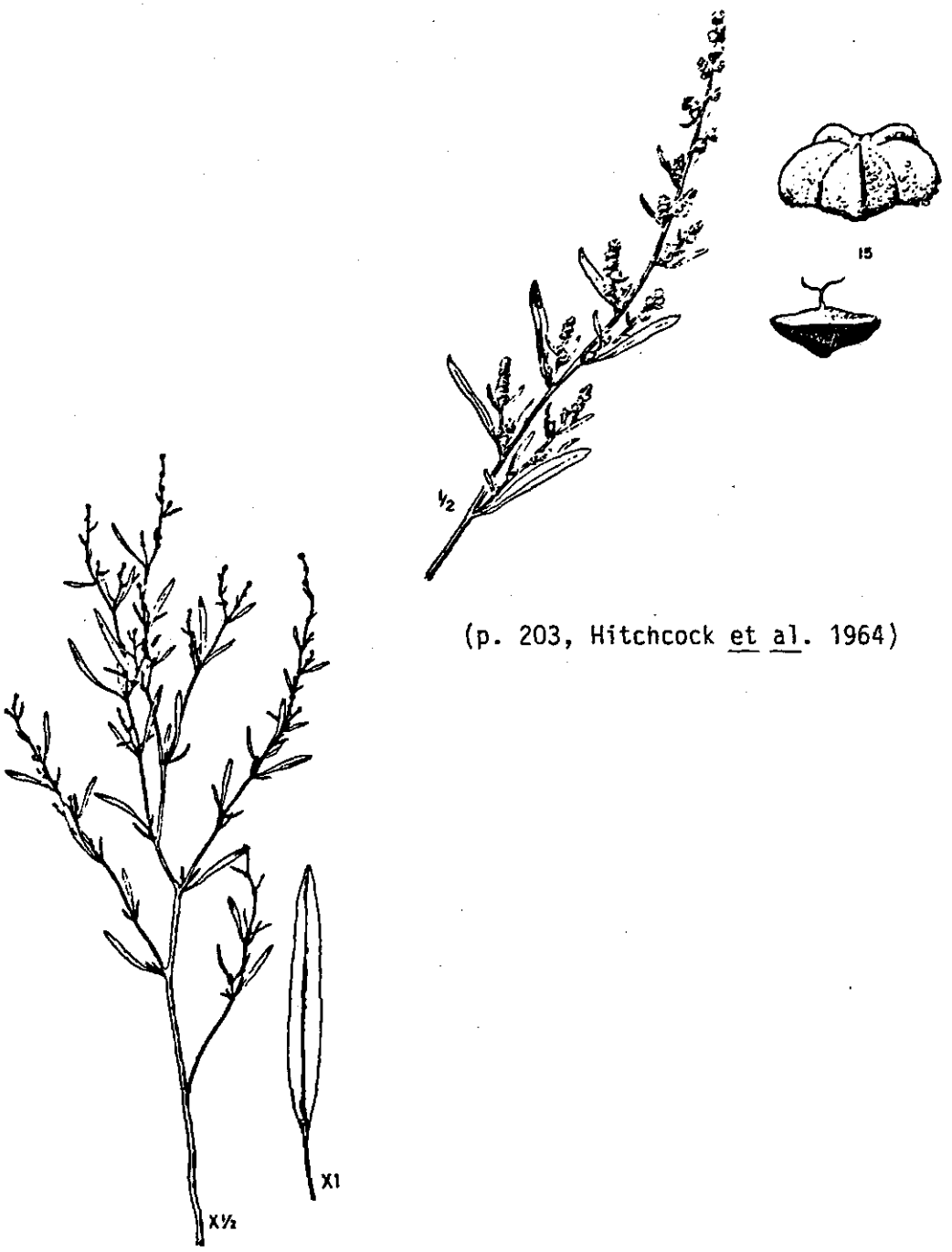
Bassett and Crompton (1982) recognize 31 species of Chenopodium as occurring in Canada. Scoggan (1978) in the Flora of Canada recognizes 17 species of Chenopodium as occurring in Canada, 9 of which are introduced species. Three species are of questionable taxonomy leaving five clearly defined native Canadian species of Chenopodium; namely, C. capitatum (L.) Aschers, C. fremontii Wats., C. hybridum L., C. leptophyllum (Moq.) Wats. (including var. subglabrum Wats.), and C. rubrum L. Bassett and Crompton (1982) recognize the following native Canadian species as well: C. macrospermum, C. salinum, C. pratericola, C. subglabrum, C. desiccatum, C. atrovirens, C. standleyanum, C. ficifolium, C. gigantospermum, C. watsonii, C. incanum, C. berlandieri, C. bushianum, C. macrocalycium, and C. opulifolium.

2. Description

Chenopodium subglabrum is an erect or semi-erect annual 20-80 cm high, with many ascending branches, with alternate, linear, acute, entire, 1-veined, fleshy, light-green leaves. Leaves are glabrous, or nearly so, and green above, 1-5 cm long, 1-4 mm wide, gradually narrowed into a petiole which is up to 6 mm long. Stem leaves are mealy. The inflorescence is open and leafy. Flowers are conspicuous, small, greenish or reddish, perfect and produced in small, widely spaced glomerules. Glomerules form terminal and subterminal, simple or branched spikes. Calyx lobes cover the fruit. The perianth (calyx) lobes are cleft to about the middle or below, the lobes strongly keeled. The pericarp is non-adherent. Stamens are 2-5, opposite the calyx lobes, the filaments sometimes shortly connate at the base. Styles and stigmas are 2-5 in number and short. The fruit is thin-walled containing one lens-shaped seed. Seeds are nearly black, shining, 1.3-1.6 mm long, 1.2-1.4 mm wide. $2n=18$ (Budd 1979, Moss 1983, Hitchcock et al. 1964, Gleason 1952, Rydberg 1931). See Figure 1.

Plants from Washington that have been referred to this species are distinct in having smaller, rougher seeds and more congested, farinose inflorescences than are found in typical C. subglabrum. Morphological and chemical data suggests that C. cycloides, C. pallescens and C. subglabrum represent closely related yet distinct species (Crawford 1975).

Flowering occurs from June to July (Wallis and Wershler 1988).



(p. 203, Hitchcock et al. 1964)

(p. 90, Gleason 1963)

Figure 1. General habit of Chenopodium subglabrum.

The order Chenopodiales includes the following six families: Phytolaccaceae, Cynocrambaceae, Chenopodiaceae, Batidaceae, Amaranthaceae, and Basellaceae. The Chenopodiaceae are distinguished from related families by various technical considerations regarding vegetative and reproductive features (Porter 1967, Lawrence 1951). For example, the Chenopodiaceae differs from the Amaranthaceae, the only other Canadian family in the Chenopodiales, in lacking dry, papery, sharp pointed bracts and connate filaments (Payne-Smith, Jr. 1977).

The family Chenopodiaceae was divided by Ulbrich in 1934 into the Cyclobeae (embryo annular or conduplicate) and Spirolobeae (embryo coiled spirally), and then into eight subfamilies and 14 tribes. Chenopodium is included in the more primitive Cyclobeae (Lawrence 1951). Of the genera of Chenopodiaceae, only 15 extend to Canada. Of these genera only 11 were originally native to Canada, the others (Axyris, Bassia, Kochia, Polynemum) having been introduced from Eurasia or having escaped from cultivation. Atriplex, Chenopodium, Corispermum, Cycloloma, Eurotia, Monolepis, Salicornia, Salsola, Sarcobatus, Suaeda, and Suckleya are native to Canada (Scoggan 1978).

Chenopodium is distinquished from other genera in the Chenopodiaceae by the following characteristics: annular embryo, stems and branches not jointed, leaves not scale-like, flowers perfect, all with perianth, not enclosed in a pair of bracts, fruit enclosed in the calyx, calyx in fruit not transversely winged, sepals 3-5, stamens usually 2-5, fruiting calyx herbaceous (Rydberg 1931).

The taxonomy of the Chenopodiaceae and the genus Chenopodium is rather complicated. Wahl (1952-1953) presented several reasons for difficulties in understanding the genus, primarily stemming from ecological variability and absence of both primary leaves and mature fruits in many individuals. A special problem exists in the narrow-leaved native taxa and in the frequently introduced species. Crawford (1975) presented a key to ten native diploid species of Chenopodium occurring primarily in the western United States and designated these as the narrow-leaved complex. Chenopodium subglabrum belongs to this narrow-leaved group. Six of the taxa have more in common than the other four. The six similar taxa differ on morphological, geographic distribution, and ecological considerations (Crawford 1975).

Chenopodium subglabrum has been viewed either as a distinct species or as a variety of C. leptophyllum. Crawford (1975) found, in numerical studies based on only one population of C. subglabrum, that the species is distinct from C. leptophyllum. Morphologically, C. subglabrum is recognizable on the basis of the following features: 1) entire plant glabrous to sparingly farinose, 2) leaves linear, with one main nerve (vein) from the base, 3) inflorescence open, with the glomerules widely spaced, 4) seeds 1.2-1.6 mm broad, usually horizontally flattened, and the surface extremely smooth, black, and shiny, and 5) pericarp light brown, often tinged yellow, and very readily separable from the seed. Chenopodium subglabrum is easily distinguished from C. leptophyllum because the latter is much more densely farinose, its seeds are mostly 1 mm or less in diameter, and the pericarp is firmly

attached to the seed. The two taxa do share the features of linear, one-nerved leaves (Crawford 1975, Nelson 1902). The flavonoid chemistry of C. subglabrum clearly separates it from C. leptophyllum (Crawford 1974, Crawford 1975).

Crawford and Reynolds (1974), in a numerical study, also found that C. subglabrum was not very similar to C. leptophyllum and should probably be treated as a separate species rather than as a variety of the latter. Bassett and Crompton (1982) agreed with this result. The seed protein profile of C. subglabrum is readily separable from that of C. leptophyllum. Studies on seed proteins reinforce other data in lending support to the interpretation of C. subglabrum as taxonomically quite distinct from C. leptophyllum (Crawford and Julian 1976). No intergradation was noted between C. subglabrum and other closely related species in the field or when plants were studied under greenhouse conditions (Bassett and Crompton 1982).

3. Biological and Economic Significance

The Chenopodiaceae contains several cultivated genera including the following: Atriplex, Beta (beets), Champhorosma, Chenopodium, Enchylaena, Eurotia, Kochia, Rhagodia, Sarcobatus, Spinacia (spinach), and Suaeda. Other genera also have varied economic uses. Economically the family is of minor importance with the garden beet, a commercial source of sugar (sucrose) and a root vegetable, followed in importance by the potherbs spinach and Swiss chard, Beta vulgaris var. cicla (Bailey 1951, Everett 1981, Lawrence 1951).

Few of the 100 or more species of Chenopodium are cultivated. Many are weeds of gardens and waste places, in some cases occurring world-wide. The genus includes a few ornamentals as well as the little known vegetable Good King Henry (C. bonus-henricus), quinoa (C. quinoa), and the weed lamb's quarters (C. album). The seeds of quinoa are boiled like rice and are an important food plant in South America. Quinoa provided a staple food for the Inca Empire. The weed lamb's quarters, which has plagued farmers in many agricultural regions, is sometimes gathered, boiled and eaten as greens. Seeds had been made into flour for cakes and gruel by the Indians. In Europe Good King Henry or mercury and strawberry blite (C. capitatum) are planted occasionally as pot herbs or novelty vegetables (Bailey 1951, Everett 1981, Jones and Luchsinger 1986).

The seeds of C. leptophyllum, closely allied to C. subglabrum, can be mixed with corn meal and salt as a food source. As well, raw or cooked plants were consumed by the Indians of Utah, Nevada, and New Mexico. Chenopodium fremontii, a western North American species, was used by the Klamat Indians in Oregon as food. The roasted seeds were ground and eaten (Uphof 1968).

Various other species of Chenopodium are also used economically. Chenopodium botrys (feather geranium, Jerusaleum Oak) is used in baskets as an ornamental. Some species contain strong essential oils and have medicinal uses. Chenopodium ambrosioides (wormwood), introduced in North America, is used as an anthelmintic for round worms,

hook worms, intestinal amoeba, and as a source of Mexican tea. Oil of wormwood, a vermifuge, is obtained from seeds of C. anthelminticum. The roots of C. californicum (California soap plant) have saponaceous properties and are used for washing (Uphof 1968, Jones and Luchsinger 1986, Bailey 1930).

Species of Chenopodium have a wide range of uses world-wide. They are used by natives in East Africa and Chile to eradicate ants and other vermin, in religious activities in Mexico, as food in South America, Chile and Australia, to combat migraines in Africa, as cosmetics in Europe, as a source of yellow dye in Europe and the Mediterranean area, and as feed for cattle in Australia (Uphof 1968).

4. Distribution

The genus Chenopodium is cosmopolitan in distribution (Rendle 1967). Chenopodium subglabrum is found from Alberta to southern Manitoba in Canada and south to eastern Washington, Oregon, Montana and South Dakota (White and Johnson 1980, Packer and Bradley 1984). Specifically, C. subglabrum occurs in the following states: Washington, Oregon, Nevada, Idaho, Montana, Wyoming, Utah, Colorado, South Dakota, North Dakota, Nebraska, and Kansas. Chenopodium subglabrum is centered in Nebraska and South Dakota (Crawford 1975). In Canada, C. subglabrum is restricted to southeastern Alberta, southern Saskatchewan, and southwestern Manitoba (maps 1-4). Chenopodium subglabrum was first reported from Manitoba by Boivin in 1966 and from Swift Current and Saskatoon, Saskatchewan in 1952 by Wahl (see Scoggan 1978).

Precise locality data and land ownership, if known, is on file with COSEWIC and the appropriate provincial/territorial jurisdictions. This information is generally available unless the localities are considered to be publicity-sensitive.

4.1 Alberta

Chenopodium subglabrum, in Alberta, is represented by widely scattered populations in the southern mixed grassland. Specifically, C. subglabrum occurs at the following seven sites: Barnwell, Hilda, Lonesome Lake, Lost River, Pakowki Lake North, Purple Springs, and Turin (Maps 1, 2). The Turin site is the only site at which C. subglabrum occurs with any frequency (Wallis and Wershler 1988).

4.2 Saskatchewan

Chenopodium subglabrum is found from Cramersburg to Beaver Creek (Saskatoon) and Mortlach in southwestern Saskatchewan (Maher et al. 1979). As is indicated on Map 3, C. subglabrum occurred historically at 12 sites. A site at Broderick along the S. Saskatchewan R. and one at Dunblane are no longer extant (V. Harms, Plants Subcommittee (COSEWIC), pers. comm.).

4.3 Manitoba

Chenopodium subglabrum is known from only one location (Maps 1, 4) in southwestern Manitoba, namely, the Oak Lake area near Routledge (White and Johnson 1980).

5. General Environment and Habitat Characteristics

Chenopodium subglabrum populations occur in the mixed grassland (prairie) natural region in Alberta, Saskatchewan, and Manitoba, particularly in active sand dunes, sandhills, and river banks (Packer and Bradley 1984, Maher et al. 1979, White and Johnson 1980). Chenopodium subglabrum is generally found on south or west-facing actively eroding slopes at the edge of stabilizing sand and sometimes is found in dune slacks. Populations are highest in areas of finer and more compacted sand. Rarely, this species grows in very active sand away from the stabilization zone but also may grow in stabilized sand. Populations in these habitats are always very low (Wallis and Wershler 1988). In some cases, C. subglabrum was collected from areas grazed by cattle in sand dune blowouts or along trails in sandy heathland (actual specimen data).

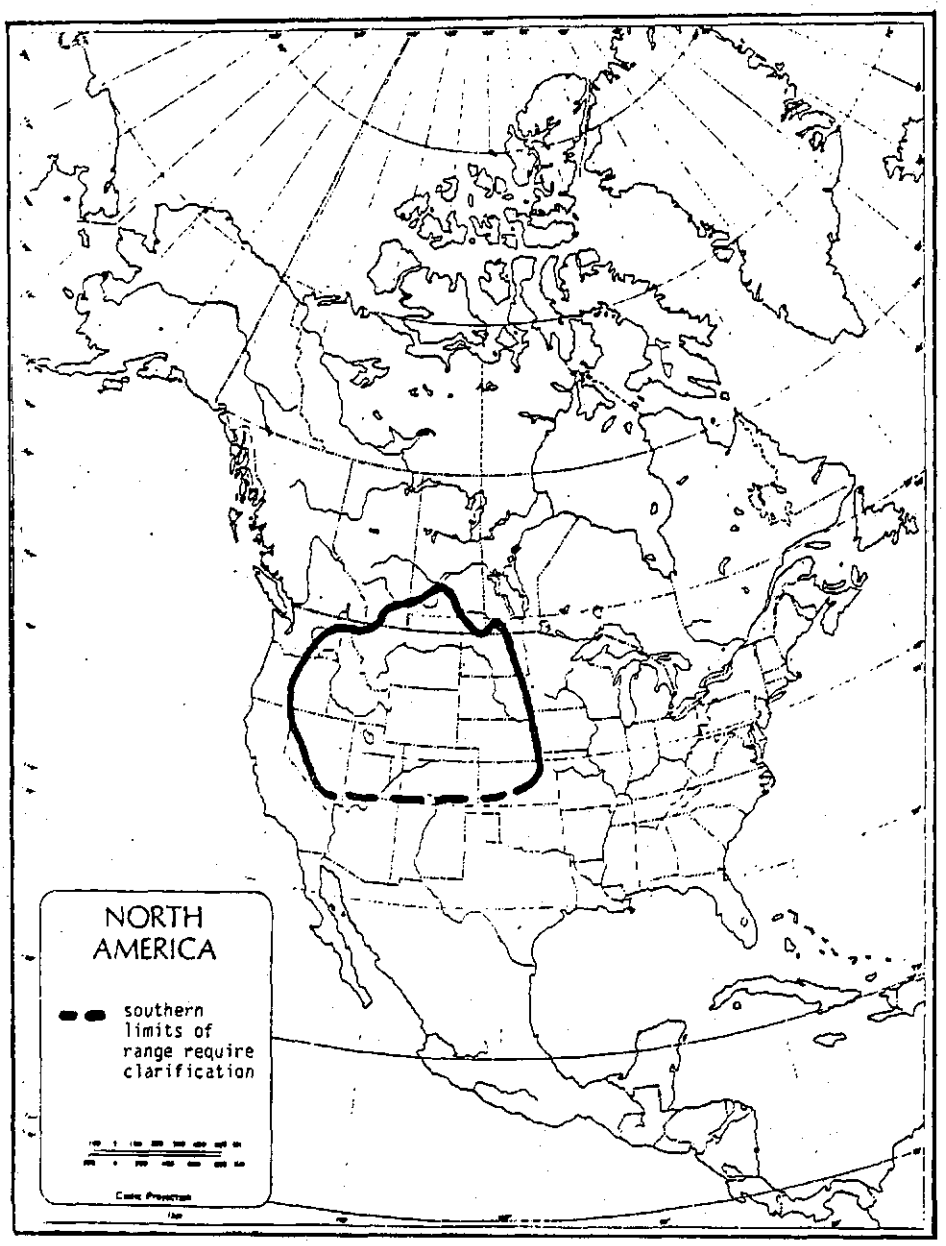
Chenopodium subglabrum, as most members of the Chenopodiaceae, is tolerant of alkali-impregnated areas. Most other plants are unable to occupy such areas as they are so inhospitable. Differences in soil from one such area to another is a matter of degree rather than of quality. There is little other competition on such soils as well (Nelson 1902).

Salt-loving plants are referred to as halophytes. Plants which prefer dry habitats are referred to as xerophytes. Therefore, C. subglabrum is both a halophyte and a xerophyte. Xerophytes and halophytes are very similar. Halophytes take up as little as possible of the solutions presented to them in the soil in order that nutrition may not be prejudiced by an excess of salt in the tissue. Xerophytes must use wisely whatever moisture they can attain given the dryness of their habitats. Hence, the necessity of checking transpiration for which similar means have been adopted in halophytic and xerophytic plants (Rendle 1967).

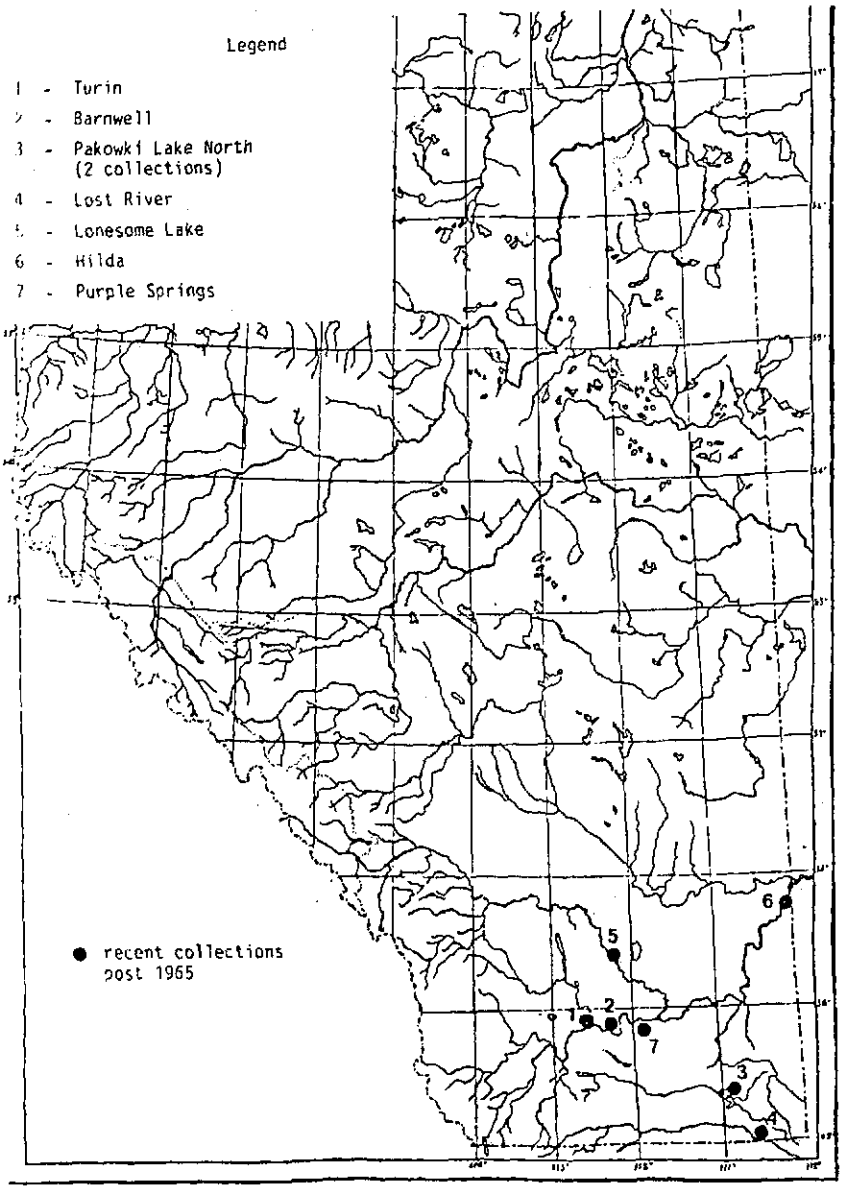
5.1 Climate

The Prairies Climatic Region, encompassing both the Alberta, Saskatchewan, and Manitoba populations, are characterized by low winter precipitation. Soil moisture is not always restored to capacity in an average year and water surplus averages only 7 mm. Southeastern Alberta, southern Saskatchewan, and the southern interior of British Columbia have a very high average annual water deficiency, the highest in Canada. The southeastern Alberta area has a greater annual water deficiency than the southwestern Manitoba area (Sanderson 1988).

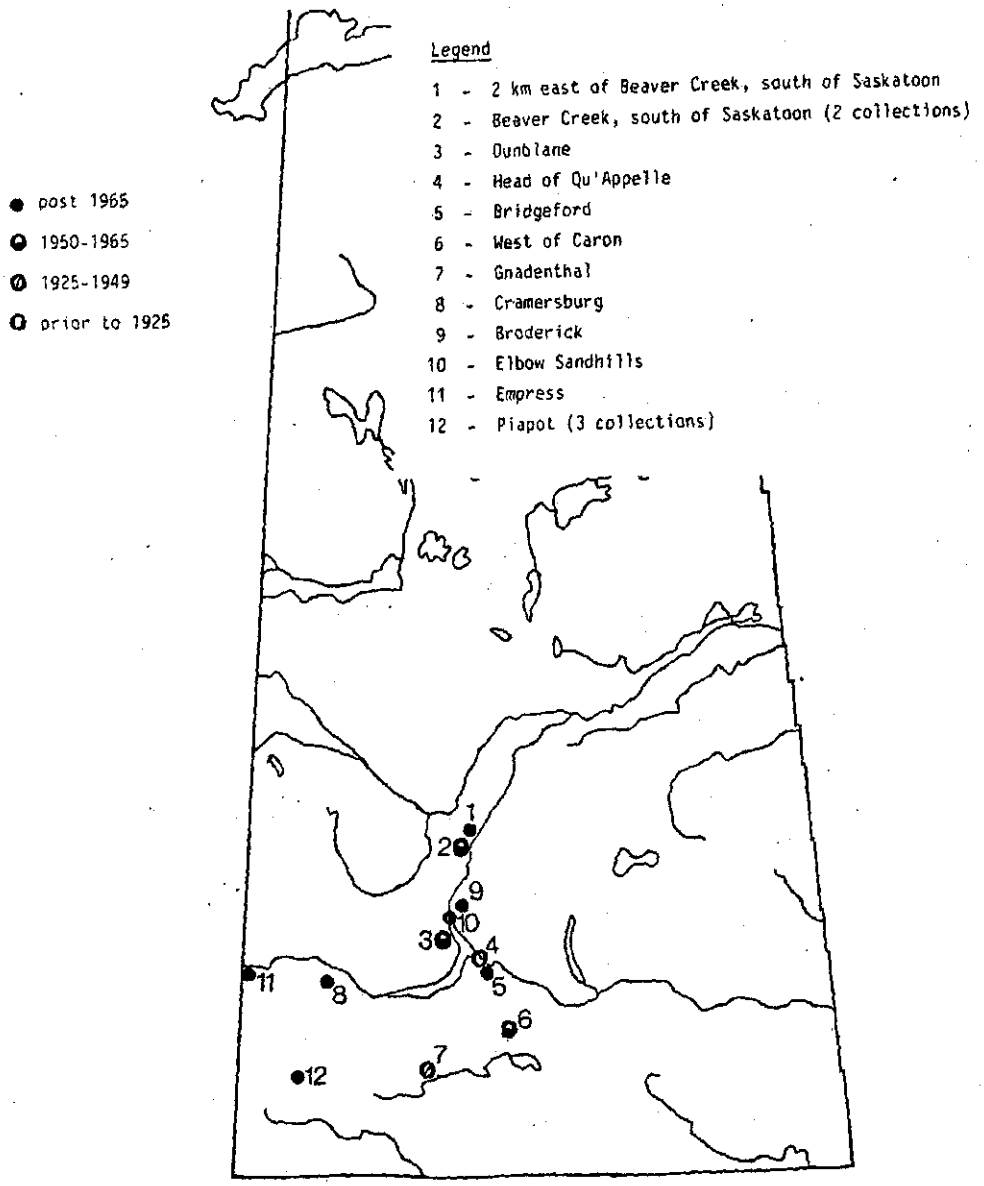
The climate of the mixed grassland natural region is continental, characterized by extremes in temperatures with warm summers and cold winters. The mean annual temperature ranges from 6°C in the hotter parts to 0°C in the cooler areas. The growing season is relatively short, with an average of 105 to 130 frost-free days. There is comparatively low annual



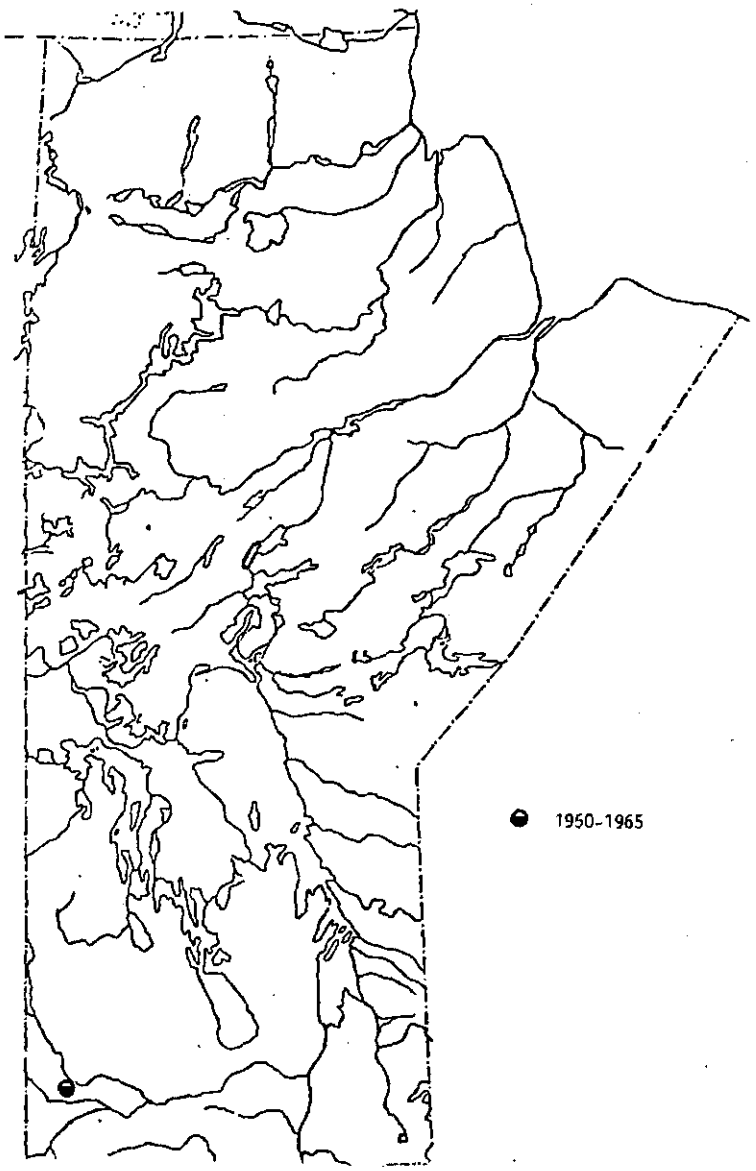
Map 1. Distribution of Chenopodium subglabrum in North America.



Map. 2. Distribution of Chenopodium subglabrum in Alberta.



Map 3. Distribution of Chenopodium subglabrum in Saskatchewan.



Map 4. Distribution of Chenopodium subglabrum in Manitoba.

precipitation, ranging from about thirty centimetres in extreme south-eastern Alberta and south-western Saskatchewan to forty centimetres along the western and northern fringes. Dry summers and winters are typical. Spring is the wettest season with about two-thirds of the annual precipitation falling as rain, the peak occurring in June. Because of the warm temperatures and high average wind speed, the rate of evaporation is high through the summer months (Wallis 1982).

The Alberta and Saskatchewan sites lie in the northern cool-temperate zone characterized by low annual precipitation, high evaporation rates and fast runoff. These factors lead to chronic water deficits with severe shortages in the short-grass prairie area. In southern Alberta the mean temperature is -8°C in January and 20°C in July (Stamp 1988).

Nearly two thirds of the precipitation falling on the Manitoba sites occurs during the six summer months, the remainder appearing mostly as snow. The southwestern area of Manitoba has an average 100-day frost-free period (Weir 1988).

5.2 Physiography, Hydrology, and Edaphic Factors

The Alberta, Saskatchewan, and Manitoba populations occur in sand dune areas of the Interior Plains physiographic region (Brookes 1988). The sand dune areas occurring in southern Saskatchewan are aeolian deposits derived from glacial alluvial and lacustrine sediments. Glacial ice retreated from the region 10,000 to 13,000 B.P. Since the general inclination of the land surface was to the north and east and the ice obstructed water flow to the northeast, the melt water moved southeastward along the ice front until it was impounded in one of several glacial lakes. When it flowed into a lake the load capacity of the water decreased. The larger particles (sand) were deposited first in deltas, the finer materials being carried farther to be deposited lakeward. Subsequent exposure of the sand in extensive deltas has permitted modification of the surface by wind to form parabolic dunes. These are characteristic of semiarid climates where a partial cover of vegetation is present during dune formation. Since the effective wind direction in southwestern Saskatchewan is from the northwest, most of the present dunes tend to be oriented in a northwest to southeast direction. Rates of movement of partially denuded dunes reported in other areas vary from 2 to 22 ft. (0.6 to 6.6 m) per year (Hulett et al. 1966).

5.3 Dependence on Dynamic Factors

Chenopodium subglabrum is restricted to sand dune areas. It appears to require some element of active (drifting) sand. Annual water deficiency and wind erosion cause considerable soil drifting in sand dunes. Populations of Chenopodium subglabrum are dependent, as are numerous rare, threatened, and endangered species of plants and animals, on major active sandy areas which now have been almost completely cultivated. However, Wallis and Wershler in their study of sand dune areas in southern Alberta note sand dunes are stabilizing and attribute it to lack of fire. Large areas of once active sand have become stabilized over the last forty years (Wallis 1988).

5.4 Biological Characteristics

Alberta, Saskatchewan, and Manitoba sites are located in the Western Grassland vegetation region in Canada, specifically, the mixed grassland natural region. Plants are perennials on prairies being composed mostly of grasses associated with sedges, forbs, and a few dwarf shrubs. Before European settlement, this vegetation occupied valleys of southern interior British Columbia and much of southern Manitoba, Saskatchewan and Alberta. The nature of grassland vegetation depends on climate and soil (Bird 1988).

Sand dunes exhibit a range of habitats from active dunes to stabilized sites with spear grass (Stipa comata) and sand grass (Calamovilfa longifolia); a variety of low shrubs, primarily buckbrush (Symphoricarpos occidentalis) and rose (Rosa acicularis); tall shrubs, mainly chokecherry (Prunus virginiana), silverberry (Elaeagnus commutata), and water birch (Betula occidentalis) and trees, including clones of aspen (Populus tremuloides) and scattered cottonwoods (Populus deltoides). These dune areas support some of the largest upland bird and ungulate populations in the mixed grasslands, as well as some rare small mammals and birds, for example, Ord's Kangaroo Rat (Dipodomys ordii) and Grasshopper Sparrow (Ammodramus savannarum) (Wallis 1982).

The southeastern Alberta populations and the southern Saskatchewan populations occur in the mixed grassland natural region populated by relatively drought resistant grasses such as blue grama and spear grass (Bird 1988). Populations in Alberta appear to be associated with Oryzopsis hymenoides (Wallis and Wershler 1988). The data for Chenopodium subglabrum from Saskatchewan sites follows. On one site northeast of Beaver Creek, C. subglabrum was found growing with Elaeagnus, Prunus and Elymus. At a second location, on top of an erosion island in the middle of a large blowout, C. subglabrum was found growing with Juniperus horizontalis and Linum rigidum. On another site at Bridgeford, C. subglabrum was found growing in a sandy heathland of Arctostaphylos-Juniperus, occasionally with Chenopodium pratericola, Glycyrrhiza lepidota, and Agropyron subsecundum. At Broderick, C. subglabrum was found growing along the South Saskatchewan River in sand dunes on rather bare sand with Populus sargentii, Oryzopsis hymenoides, Corispermum, and Helianthus petiolaris. At Cramersburg, C. subglabrum was found growing in vegetated clefts between two active sand blowouts with Calamovilfa longifolia, Psoralea lancelota, and Elymus canadensis. At the Elbow sandhills C. subglabrum grew in semi-stabilized sandhills dominated by Calamovilfa with Helianthus petiolaris, Lygodesmia rostrata, Lygodesmia juncea, and Chrysopis. At Empress, C. subglabrum was found growing on a dry hot south slope of a sand ridge on the north side ravine trending toward the river with C. leptophyllum, Cryptantha fendleri, and Psoralea lanceolata. The prairies of southern Manitoba are true prairies with bluestems and porcupine grass forming the dominant species (Bird 1988). Southern Manitoba's natural vegetation is open grassland and aspen. In the south, high evaporation rates discourage the growth of trees which are replaced by prairie. Both tall-grass and mixed-grass species were extensive before settlement. Elm, ash, and Manitoba Maple grow along stream courses, and oak grows on dry sites (Weir 1988).

The sandy hills of the Manitoba sites immediately south of Routledge are of low relief and covered with Populus tremuloides and Acer negundo around the wet areas. Level areas have been cultivated and cropped. The Oak Lake area itself is a broad lake plain with bur oak woodland at its northeast end. This area is adjacent to a provincial park and cottage developments. The sand hills of higher relief (3-5 m) three miles south of the lake are probably beach ridges. The sandy areas are mostly well forested and stable. The only bare sand seen was in areas disturbed by road and pipeline construction operations (pers. comm., Johnson, June 28, 1989).

6. Population Biology and Ecology

A. Alberta

The total Alberta population is estimated to be under 100 individuals. The population is widely scattered amongst southeastern Alberta localities as follows: Barnwell - 8, Hilda - 3, Lonesome Lake - 1, Lost River - less than 5, Pakowki Lake North - 4 (in three sites of 2, 1 and 1 individual), Purple Springs - 30, Turin - mid-hundreds (in two sites both with numbers of individuals in the low hundreds). The Alberta population may be declining slowly in the Turin area and more rapidly in other sites due to dune encroachment and heavy summer use by cattle (Wallis and Wershler 1988).

B. Saskatchewan and Manitoba

There is no population data available for the Saskatchewan and Manitoba sites.

7. Land Ownership and Management Responsibility

The two major Alberta populations at the Purple Springs and Turin dunes are both located on crown land leased for grazing (Wallis and Wershler 1988). No information is available for other Alberta locations or for the Saskatchewan and Manitoba locations.

8. Management Practices and Experience

Mixed prairie is so named because it includes both mid and short grasses. This the most extensive grassland region found in North America. The area of uncultivated mixed prairie is declining rapidly. Some 23% of the rangeland still existing in 1956 had been plowed by 1981. Much of the remaining rangeland exists in areas unsuitable for cultivation. At the same time, greatly increased grazing pressure on the remaining rangeland has changed the plant composition in all types of habitats. About 24% of the original mixed prairie remains in its native state. One national park, Grasslands National Park in southwestern Saskatchewan, several provincial parks and natural areas exist within the mixed prairie zone, but further protection is necessary (World Wildlife Fund 1988).

Native grasslands continue to be broken and seeded to tame pasture and crops. The majority

of short-grass and mixed-grass prairie has been lost or converted in Alberta. Within the grasslands natural area several major sand dunes have also been mostly lost through cultivation. A southern Alberta study of rare wildlife and plants in sandhill and sand plain habitats indicates that these areas contain a concentration of significant features, including numerous rare, threatened, and endangered species of plants and animals (Wallis and Wershler 1988). Loss of primary habitat as well as destruction of specific habitats via stabilization of active sand has contributed to a weaker position for the rare entities within these areas.

8.1 Habitat Management

The grasslands natural region in Alberta is considered to be among the most threatened of Alberta's natural regions. They are being lost or converted at an extremely rapid rate (Wallis 1987). Several major sand plains have been almost completely cultivated and a major threat to the remaining habitats exists. Alberta is not alone in the problem of loss of active sand habitats. Nebraska sandhill plants have been placed on the United States endangered species' list. Ironically, stabilization of the active sand was seen as good conservation practice. Land managers went to great lengths to stabilize active blowouts, extinguishing fires, modifying their grazing patterns and even placing old tires in the blowouts (Wallis 1988). This needs to be studied.

8.2 Cultivation

Few of the 100 or more species of the genus Chenopodium are cultivated. Many are weeds of gardens and waste places. Seeds of most species of Chenopodium germinate readily (Everett 1981). Germination is often enhanced by nitrate enrichments (Young and Young 1986). Their cultivation presents no difficulties. All prefer fertile, well-drained soils and sunny locations and are easily raised from seeds (Everett 1981). No specific cultivation data is available for Chenopodium subglabrum.

8.3 Current Management Policies

The two main sites in Alberta, at Turin and Purple Springs, are on crown land and are presently under a grazing lease (Wallis and Wershler 1988). No further information is available on current management policies for Alberta, Saskatchewan or Manitoba.

9. Evidence of Threats to Survival

The Grasslands Natural Region is one of the most threatened natural regions in Alberta. Over two-thirds of the Mixed Grassland has been lost to cultivation or other development (Wallis 1987). Many major sand plains (critical habitat for Chenopodium subglabrum) have been lost and many others are threatened (Wallis 1988). Critical habitat is defined by Wallis (1987) as "most crucial to the survival of population, species, races or form. When these critical habitats are disturbed there will be major effects on the plants and animals that

depend upon them." Over half of the birds and mammals now listed by COSEWIC and found in the three prairie provinces have a conservation status as a result of habitat loss in Western Canada (Hummell 1987). The government of Alberta has priorized the threatened grassland region for representation and protection in the form of ecological reserves but overall representation of ecological reserves in this region of Alberta is very poor to date.

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. Principal threats to these habitats relate to cattle grazing and invasion of non-native species as a result of vegetation reclamation along oil and gas access roads and well-sites (Wallis 1987).

The main limiting factors affecting Chenopodium subglabrum are its natural narrow preference for unstabilized sites within dune fields and loss of natural habitat through management intervention as a result of grazing and fire control. It would appear unstabilized sites within sand hills depend on a continued regimen of grazing and fire working cooperatively. A management dilemma presents itself as the increasing pressure of grazing by livestock is causing a deterioration in the Mixed Prairie Grassland surrounding azonal areas such as sand hills.

9.1 Conversion to Tame Pasture and Cropland

More than two-thirds of the Mixed Prairie Grassland region in Canada has been destroyed by cultivation. Some clearing continues but it is not as pervasive a problem as in the Parkland Region (Wallis 1987).

The proportion of farmland occupied by rangeland declined from 53% to 41% between 1956 and 1981 in Alberta (Mixed Prairie Census Districts). About one-third of the disappearing rangeland has been converted to seeded pasture in the Mixed Prairie Region of Alberta. The area of uncultivated grassland in Saskatchewan and Alberta is declining at a rapid rate. The surviving untilled area contains a smaller proportion of typical grassland and a large proportion of azonal types (saline flats, sloughs, sandhills, badland) as time goes by, because the typical upland situations are being converted to cropland (Coupland 1987). Based on the experience in the United States with sand hill areas, the potential for cultivation exists but has not been developed to a significant degree in Alberta (Wallis 1987).

9.2. Dune Stabilization

Rare, threatened and endangered plants were studied to map distribution and assess the degree to which dune stabilization was occurring and how this was affecting native plants. While the exact mechanisms are unclear, it appears that large areas of once active sand have become stabilized over the last forty years. If the current trends continue, rare native plants which now have dangerously low populations could be eliminated entirely. The active sand surface of some dunes in the Pakowki Lake area has been reduced by 50 to 75% (Wallis

1988). Continued stabilization of the dunes at Pakowki Lake would likely be detrimental to the long-term survival of Chenopodium subglabrum (Wallis and Wershler 1988).

From 1950 to 1987, there has been a 30 to 40% reduction in active sand at Dune Point with invasion by Russian thistle into the gravelly sands. A series of active dunes stretched virtually unbroken for 2 km along the South Saskatchewan River in 1950 - today all these dunes are stabilized and there are only minor active blowouts. All 16 sand blowouts at Remount Community Pasture, which were active in 1950, are now stabilized. Of 51 blowouts active in 1950 in the Middle Sand Hills, only 20 are still active and, of these, 10 are partly stabilized and 7 are mostly stabilized, 90% of the sand which was active in 1950 is now stabilized (Wallis 1988).

The Dundurn Sand Hills near Saskatoon, Saskatchewan have mostly been stabilized by vegetation. Small areas still exist where wind erosion and deposition are altering landforms, particularly under disturbed conditions such as those incurred under heavy grazing in times of drought. Earlier aerial photographs (1944) reveal areas of active dune complexes more extensive in the past (Pylypec 1989).

The Harris Sand Hills, 80 km southwest of Saskatoon, are surrounded by cultivated land mostly in cereal grains. There are only three small active areas remaining in the southwest part of the dune surrounded by a larger aspen forest. The vast majority of the dunes are stabilized. The Harris Sand Hills area was once an oasis for native flora and fauna which inhabit both the grasslands and parklands of central Saskatchewan (Epp 1982).

The Great Sand Hills of Saskatchewan are located west of Regina near the Manitoba border and northeast of Cypress Hills. High stabilized dunes cover the largest area - 50% of the dune field - and are the most sensitive to disturbance. Active complexes are the least extensive (0.4%). The Great Sand Hills form a varied natural ecosystem that is sensitive to disturbance and is a genetic reservoir for rare and common species (Epp 1980).

Encroachment of vegetation on active blowouts could eliminate major and minor populations of Chenopodium subglabrum. Dune encroachment as well as grazing acting together could lead to population declines. This appears to be the case for the Turin (Alberta) site where the population may be slowly declining. Populations may decline more rapidly in other areas (Wallis and Wershler 1988).

Post-glacial History of Dune Stabilization in Southern Manitoba

David (1971) dated periods of dune activity in southern Manitoba by radiocarbon dating buried soil profiles. He found six periods of major dune activity which were associated with major droughts. The earliest recorded active phase ended prior to 4000 B.P. with vegetation stabilizing the dune surface after the end of the Atlantic dry period. Another active phase occurred between 3700-2500 B.P. It ended when the regional climate became more humid. Four active periods followed, ca. 2100, 1500, 900 and 400 B.P. The earliest occurred

during a period of generally sub-humid regional climate and likely was the result of a local drought. The rest occurred during major changes of regional climate (David 1971; Bryson et. al.; from Epp 1980).

There have been periods of dune stabilization in southern Manitoba prior to 4000 years ago but none of the soil profiles which would have been formed have been found. Either such stabilizations have not occurred or subsequent sand movement has destroyed the evidence of them (David 1971 from Epp 1980).

In addition to dune activity, dune size also is an important factor in the response to climatic change. Dunes less than 6 metres high become active only during major periods of drought while larger ones are affected by droughts of both minor and major intensities (David 1971 for Epp 1980). Extensive dune activity occurs only during major droughts except in areas which contain very large dunes (Epp 1980).

9.3 Grazing and Fire Control

The large tracts of uncultivated grassland east of the mountains, mostly community pasture or crown land leased by ranchers, are grazed by livestock (Bird 1988). While the dynamics of dune destabilization are poorly understood, a consensus is emerging that it is a combination of fire and grazing during appropriate seasons that keeps blowouts active. Dunes have been stabilizing in the Middle Sand Hills where there have been repeated fires but little grazing; and in other areas where there has been grazing but few fires (Wallis 1988). The Pakowki Lake, Purple Springs, and Turin (containing the largest Alberta population of Chenopodium subglabrum) sites are leased for grazing (Wallis and Wershler 1988). On the other hand, the condition of surviving Mixed Grassland in Alberta is deteriorating because of increased grazing (Coupland 1987). This presents a management dilemma.The positive or negative impacts of grazing at various seasons are unknown (Wallis and Wershler 1988). A current theory is that late summer or fall fires formerly created lush green areas the following spring. These green patches attracted large herds of grazing animals like bison and resulted in reactivation of the sand dunes. The sandhills were also apparently used as sheltering areas by bison during the winter and this could have been significant in keeping dunes active. Fire control and changes in grazing patterns have completely changed the factors which shape sand dune environments (Wallis 1988).

The effect of cattle grazing is unknown but the only plant remaining at the Lonesome Lake, Alberta site was severely browsed. A dugout placed next to the active dune attracted numerous cattle to the dune. Populations may be slowly declining at the Turin, Alberta site and more rapidly in other sites due to dune encroachment and heavy summer use by cattle (Wallis and Wershler 1988).

9.4 Invasive Weeds

The dune slack at the Barnwell, Alberta site is being invaded by Agropyron cristatum and

Melilotus spp. (Wallis and Wershler 1988). Loss of habitat, given the sparsely scattered populations, will probably lead to the loss of certain sites over time.

10. Present Legal or Other Formal Status

No specific legal status is accorded Chenopodium subglabrum in any part of Canada. Alberta has no legislation which covers plants or endangered species.

In Canada, Chenopodium subglabrum naturally occurs in southeastern Alberta, southern Saskatchewan, and southwestern Manitoba (restricted to only one site at Oak Lake) so it is considered rare from a national perspective. Packer and Bradley (1984) identified Chenopodium subglabrum as rare in Alberta while Maher et al. (1979) identified the species as rare in Saskatchewan. White and Johnson (1980) identified C. subglabrum as rare in Manitoba. Wallis and Wershler (1988) identified C. subglabrum as a potentially threatened species in Alberta. While it is potentially widespread in the United States (given difficulties in taxonomy and possible inclusion of C. subglabrum within C. leptophyllum in many floras), it is only represented by several scattered populations (probably low in number) in Alberta, Saskatchewan, and Manitoba. There has only been one population, collected in 1959, collected from Manitoba (Wallis and Wershler 1988).

The Nature Conservancy rank is Global G?, Canada N1, Alberta P1, Saskatchewan P1, and Manitoba P1. The United States rank is North Dakota SH and Wyoming S1. Ayensu and DeFilipps (1978) did not list it as endangered or threatened on any of their state listings.

All the lists of rare species for the prairie provinces are relatively long. The most recent Alberta list (Packer and Bradley 1984) contains 360 species, representing 24% of the native flora. The Manitoba (White and Johnson 1980) list contains 300 taxa (Kershaw 1987).

Kershaw (1987) acknowledges three major groups of distribution patterns of rare species in prairie provinces. Over 80% of the "rare" species in the prairie provinces appear to belong to a group composed of species extending into the provinces from nearby (non-disjunct) widespread populations. Such populations add considerably to the species diversity of the provinces, probably accounting for more than 20% of the total floras. The Canadian populations of Chenopodium subglabrum probably fall into this category. A second group is composed of species extending into the province as small disjunct populations and is composed of less than 10% of the number of total rare species in the prairie provinces. A third group, composed of endemic species, is limited to a local area and is restricted geographically (Kershaw 1987).

II. Assessment of Status

11. General Assessment

The following criteria have been used to assess the status of Chenopodium subglabrum in Canada:

Taxonomy - Chenopodium is well represented in Canada, Alberta, Saskatchewan, and Manitoba by species other than C. subglabrum

Abundance - Alberta population is estimated at less than 1000 individuals. Populations in Alberta, with the exception of one site, are very low in number. There is no population data available for Saskatchewan or Manitoba.

Distribution - Restricted in Canada to southeastern Alberta , southern Saskatchewan, and southwestern Manitoba. Only one site has been discovered in Manitoba.

Habitat distribution - Restricted in Canada, Alberta, Saskatchewan, and Manitoba.

Habitat stability - Unstable, ongoing loss of sites and habitat through grazing and fire control.

Population trend - Too early to recognize trends. The only extensive survey was conducted for Alberta sites in 1987. It was noted at that time that the population may be declining slowly at the major Alberta site at Turin and more rapidly in other sites.

Reproductive potential - Moderate, given habitat restructuring.

International standing - Unique in North America, not internationally.

Protective status - Low, no formal designation, uncertainty about future landowners and management of grazing leases.

All preceding criteria are items of concern in assessing the status of this species. In Canada, Chenopodium subglabrum has experienced declines in populations and ongoing habitat destruction and changes in land use and grazing patterns in the the remaining known and potential habitat placing the future survival of the species in question. The lack of formal protection for most sites with a viable management plan is a critical problem for the species' survival in Canada. Many sites in this habitat type have been lost through catastrophic destruction by cultivation as well as gradual attrition due to changes in grazing and fire regimes.

12. Status Recommendation

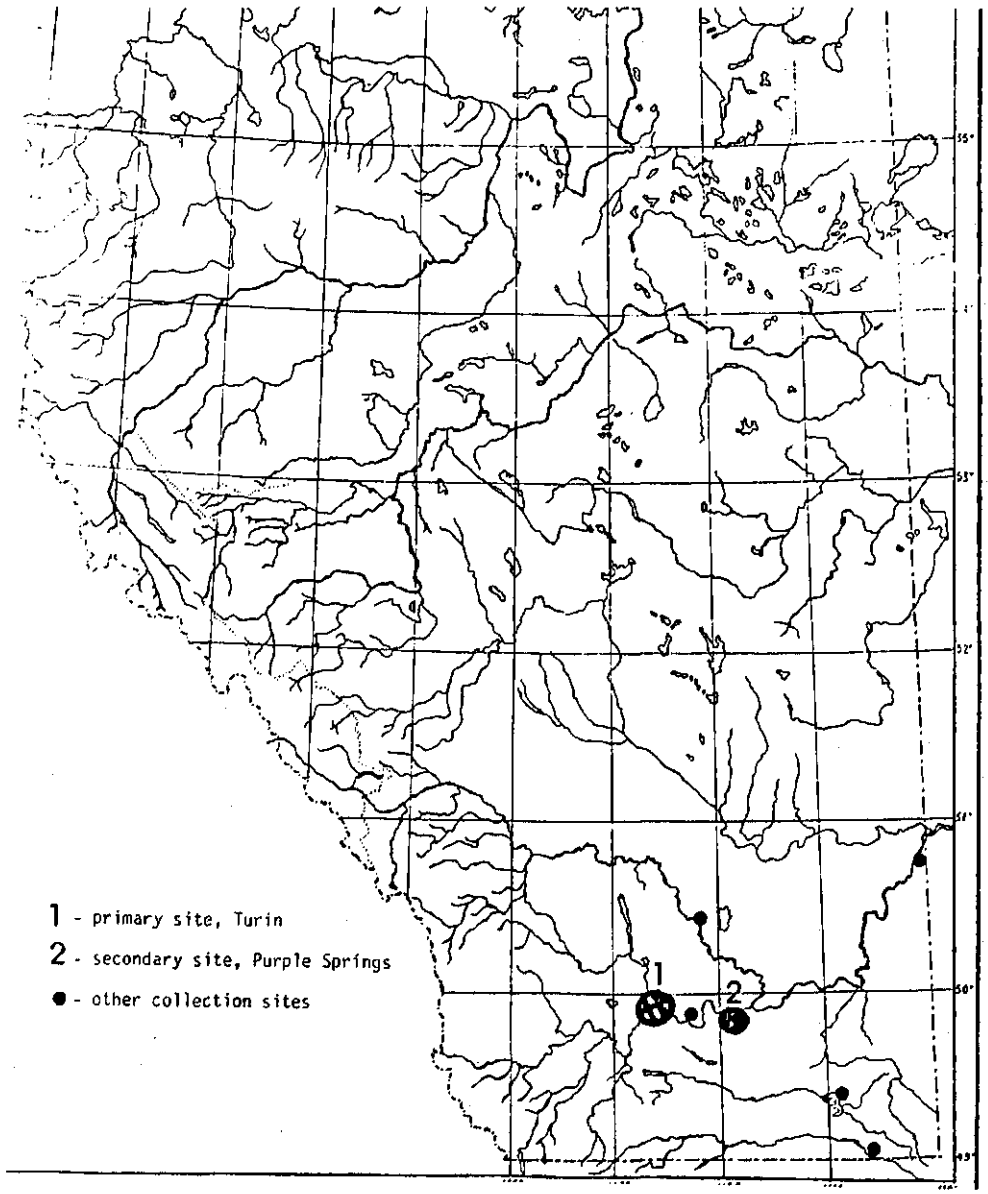
The smooth goosefoot, Chenopodium subglabrum is proposed for listing as a threatened species in Canada.

13. Recommended Critical Habitat

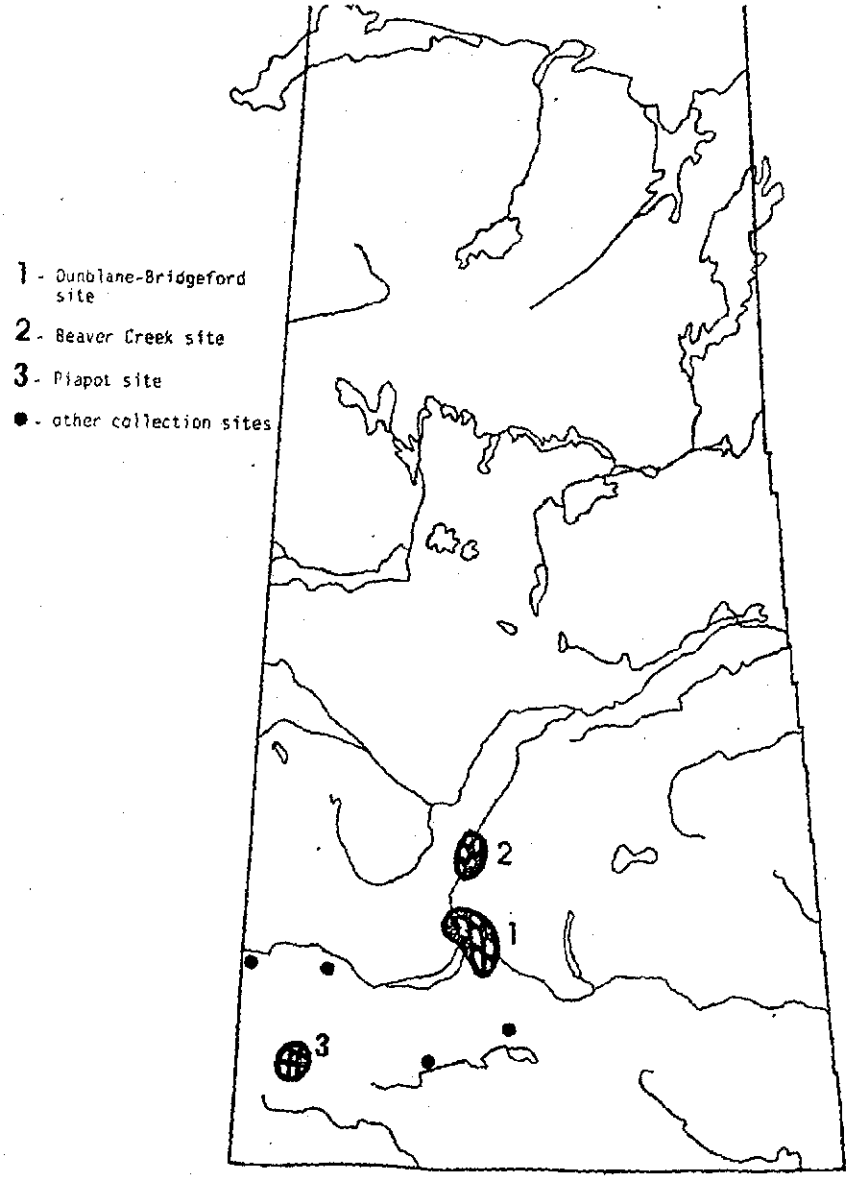
Several major sand plains have been almost completely cultivated (Wallis and Wershler 1988). Designation and appropriate management of the Turin Dunes in Alberta would protect the largest known population of this species in Canada (Map 5). Retention of natural habitat at Purple Springs would protect another significant population. A major threat to remaining sand plain habitats exists in Alberta (Wallis and Wershler 1988).

There are three areas of potential critical habitat in Saskatchewan. The area surrounding the Gordon McKenzie and Thomson Arms of eastern Lake Diefenbaker in southcentral Saskatchewan (Map 6) should be designated as critical habitat. Five collections have been made in this area, three since 1965. The Beaver Creek area (Map 6), south of Saskatoon, should be considered a secondary site for protection as critical habitat. Three collections have been made in this area, one since 1965. The Piapot area (Map 6) should be considered as a third site for protection of critical habitat. Three collections have been made in this area, all since 1965. Other areas deserving consideration as critical habitat in Saskatchewan include the sites at Empress and Cramersburg. (Map 6) Chenopodium subglabrum was collected at Cramersburg in 1977 and at Empress in 1981. The recentness of both collections increases their potential significance as protected areas.

Since Chenopodium subglabrum has only been collected once in Manitoba, in 1959, and has not been confirmed at this location since that time no critical habitat can be designated for Manitoba.



Map 5. Critical habitatof Chenopodium subglabrum in Alberta.



Map. 6. Critical habitat of Chenopodium subglabrum in Saskatchewan.

III. Information Sources

14. References Cited in Report

Ayensu, Edward S. and Robert A. DeFilipps. 1978. Endangered and threatened plants of the United States. Smithsonian Institution and the World Wildlife Fund, Washington.

Bailey, L. H. 1930. The Standard cyclopedia of horticulture. Vol. III. the MacMillan Company, New York.Bailey, L. H. 1951. Manual of cultivated plants. The MacMillan Company, New York.

Bassett, I.J. and C.W. Crompton. 1982. The Genus Chenopodium in Canada. Can. J. Bot. 60:586-610.

Bird, C. J. 1988. "Vegetation regions" in The Canadian Encyclopedia. Vol. 4. 2d ed. Hurtig Publishers, Edmonton.

Budd, A.C. 1979. Budd's flora of the Canadian prairie provinces. Revised and enlarged by J. Looman and K.F. Best. Publication 1662. Agriculture Canada, Ministry of Supply and Services Canada, Ottawa.

Coupland, Robert T. 1987. "Endangered prairie habitats: the mixed prairie", pp. 35-41 in "Proceedings of the workshop on endangered species in the prairie provinces" ed. by Geoffrey L. Holroyd et al. Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Crawford, Daniel J. 1974. Flavonoid chemistry and systematic relationships in some species of Chenopodium occurring in the western United States. Abstracts of Papers (Phytochemical Section) May-June, p. 33.

Crawford, Daniel J. 1975. Systematic relationships in the narrow-leaved species of Chenopodium of the western United States. Brittonia 27:279-288.

Crawford, Daniel J. and Edward A. Julian. 1976. Seed protein profiles in the narrow-leaved species of Chenopodium of the western United States: taxonomic value and comparison with distribution of flavonoid compounds. Amer. J. Bot. 63(3):302-308.

Crawford, Daniel J. and James F. Reynolds. 1974. A Numerical study of the common narrow-leaved taxa of Chenopodium occurring in the western United States. Brittonia 26:398-410.

Epp, H. T., C. I. G. Adam and L. Townley-Smith. 1982. The Harris Sand Hills: A Saskatchewan natural area. Saskatchewan Natural Areas Report No. 6. Saskatchewan Environment, Regina.

Epp, H. T. and L. Townley-Smith, eds. 1980. The Great Sand Hills of Saskatchewan. Policy, Planning and Research Branch, Saskatchewan Department of the Environment, Regina.

Everett, Thomas H. 1981. "Chenopodiaceae", "Chenopodium" in The New York Botanical Garden illustrated encyclopedia of horticulture. Vol. 3. Garland Publishing Inc., New York.

Gleason, H.A. 1963. The New Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. Vol. 2. New York Botanical Garden. Hafner Publ. Co., Inc., New York.

Hitchcock, C.L., A. Cronquist, M. Ownbey and J.W. Thompson. 1964. Flora of the Pacific Northwest. Vol. 2. Salicaceae to Saxifragaceae. University of Washington Publ. Biol. 17. University of Washington Press, Seattle, Washington.

Hummel, Monte. 1987. Prairie conservation, pp. 21-26 in "Proceedings of the workshop on endangered species in the prairie provinces" by Geoffrey L. Holroyd et al. Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Hulett, G., R.T. Coupland and R.L. Dix. 1966. The Vegetation of dune sand areas within the grassland region of Saskatchewan. Can. J. Bot. 44:1307-1331.

Jones, Jr., Samuel B. and Arlene E. Luchsinger. 1979. Plant Systematics. 2d ed. McGraw-Hill Inc., New York.

Kershaw, Linda. 1987. Rare plants in the prairie provinces: a discussion of terms and distribution characteristics, pp. 103-107, in "Proceedings of the workshop on endangered species in the prairie provinces" by Geoffrey L. Holroyd et al. Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Lawrence, George H. M. 1951. Taxonomy of Vascular Plants. MacMillan Publishing Company, New York.Maher, R.V., G.W. Argus, V.L. Harms and J.H. Hudson. 1979. The Rare vascular plants of Saskatchewan. National Museum of Natural Sciences Syllogeus 20. National Museums of Canada, Ottawa.

Moss, E. 1983. A Flora of Alberta. 2d ed. (revised by J.G. Packer) University of Toronto Press, Toronto.

Nelson, Aven. 1902. Contributions from the Rocky Mountain Herbarium IV. Botanical Gazette 34:355-371.

Packer, J.G. and C.E. Bradley. 1984. A Checklist of the rare vascular plants in Alberta. Prov. Mus. Alta. Nat. Hist. Occ. Paper 5. Alberta Culture, Edmonton.

Payne-Smith, Jr., James. 1977. Vascular plant families. Mad River Press, Inc., Eureka, California.

Porter, C.L. 1967. Taxonomy of flowering plants. W.H. Freeman and Company, San Francisco, California.

-----. 1988. Prairie conservation action plan 1989-1994. World Wildlife Fund Canada.

Pylydec, Bohdan. 1989. A Floristic inventory of a sand hills area near Saskatoon, Saskatchewan. Blue Jay 47(2):74-83.

Radford, Albert E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.

Rendle, Alfred Barton. 1967. The Classification of Flowering Plants. Vol. 1: Gymnosperms and Monocotyledons. 2d ed. Cambridge University Press, Cambridge.

Rydberg, Per Axel. 1931. Flora of the prairies and plains of central North America. Vol. 1. Dover Publications, Inc., New York.

Sanderson, Marie. 1988. "Climatic Regions" in The Canadian Encyclopedia. Vol. 1. 2d ed. Hurtig Publishers, Edmonton, Alberta.

Scoggan, H. J. 1978. Flora of Canada. Part 2. Publications in Botany, No. 7. National Museum of Natural Sciences. National Museums of Canada, Ottawa.

Stafleu, Frans A. and Richard S. Cowan. 1981. Taxonomic literature. 2d ed. Bohn, Scheltema & Holkema, Utrecht.

Stamp, Robert M. 1988. "Alberta" in The Canadian Encyclopedia. Vol. 1. 2d ed. Hurtig Publishers, Edmonton, Alberta.

Uphof, J.C.Th. 1968. Dictionary of economic plants. Verlag Von J. Cramer, New York.

Wallis, Clifford A. 1982. An Overview of the mixed grasslands of North America. Proceedings of Grassland Ecology and Classification Symposium, Kamloops, B.C. Publication No. R28-82060. Information Services Branch, B.C. Ministry of Forests, Victoria.

Wallis, Clifford A. 1987. Critical, threatened and endangered habitats in Alberta, pp. 49-63, in "Proceedings of the workshop on endangered species in the prairie provinces" by

Geoffrey L. Holroyd et al. Provincial Museum of Alberta Natural History Occasional Paper No. 9, Edmonton, Alberta.

Wallis, Clifford A. 1988. The Unsung benefits of wind erosion - stabilizing sand dunes spell trouble for rare plants. Iris Newsletter 3:1-2.

Wallis, Clifford A. and Cleve Wershler. 1988. Rare wildlife and plant conservation habitats of southern Alberta. Alberta Forestry, Lands and Wildlife; Alberta Recreation and Parks; World Wildlife Fund Canada, Edmonton, Alberta.

Weir, T. R. 1988. "Manitoba" in The Canadian Encyclopedia. Vol . 2. 2d ed. Hurtig Publishers, Edmonton, Alberta.

White, David and Karen Johnson. 1980. The Rare vascular plants of Manitoba. National Museum of Natural Sciences Syllogeus 27. National Museums of Canada, Ottawa.

Young, James A. and Cheryl G. Young. 1986. Seeds of wildland plants: collecting, processing and germinating. Timber Press, Portland, Oregon.

15. Collections Consulted

The following botanical collections have been consulted:

University of Regina, Regina, SK
University of Saskatchewan, Saskatoon, SK
National Museum of Canada, Ottawa, ON
Department of Agriculture, Ottawa, ON

16. Fieldwork

Clifford A. Wallis and Cleve Wershler (1988) undertook an extensive survey of sand dune areas in southern Alberta during the summer of 1987. During this investigation they identified most of the known Chenopodium subglabrum sites in Alberta including the following populations: Barnwell, Hilda, Lonesome Lake, Lost River, Pakowki Lake North, Purple Springs, and Turin.

17. Knowledgeable Individuals

1. Cheryl Bradley, 158 Westover Dr., Calgary, AB T3C 2S6. Phone: (403) 246-9127

- has prepared background material on Chenopodium subglabrum. Co-author of COSEWIC report on Chenopodium subglabrum.

2. Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5. Phone: (403) 276-9197.

- principal author of COSEWIC report on Chenopodium subglabrum.

3. Cliff Wallis, Cottonwood Consultants Ltd., 615 Deer Croft Way SE, Calgary, AB T2J 5V4. Phone: (403) 271-1408.

- has conducted detailed initial population surveys of sand dune areas of southeastern Alberta. Also, prepared management status recommendation reports on Chenopodium subglabrum. Located additional sites in southeastern Alberta with Cleve Wershler, 1987.

IV. Authorship

18. Initial Authorship of Status Report

The initial authors of this report were:

Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5. Phone: (403) 276-9197.

Cheryl Bradley, 158 Westover Dr., Calgary, AB T3C 2S6. Phone: (403) 246-9127.

19. Maintenance of Status Report

Bonnie Smith, 459-30th Avenue N.W., Calgary, AB T2M 2N5, phone (403) 276-9197, will be responsible for receiving new information and making revisions and corrections to this status report and passing information on to COSEWIC.