PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Tiny Cryptanthe (*Cryptantha minima*) in Canada

Tiny Cryptanthe

July 2006

Environment Canada Environnement Canada

Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http:/www.sararegistry.gc.ca/the_act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the Web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

Recovery Strategy for the Tiny Cryptanthe (*Cryptantha minima*) in Canada [Proposed]

July 2006

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Additional copies:

Additional copies can be downloaded from the SARA Public Registry (http://www.sararegistry.gc.ca/).

Cover illustration: Tiny Cryptanthe by John R. Maywood ©

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« Programme de rétablissement de la cryptanthe minuscule (*Cryptantha minima*) au Canada [Proposition] »

ISBN *To come*
Cat. no. *To come*

DECLARATION

Environment Canada has developed its recovery strategy for tiny cryptanthe, as required by the *Species at Risk Act*. This proposed recovery strategy has been prepared in cooperation with jurisdictions responsible for the species, as described in the Preface.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada or any other jurisdiction alone. In the spirit of the Accord for the Protection of Species at Risk, the Minister of the Environment invites all Canadians to join Environment Canada in supporting and implementing this strategy for the benefit of tiny cryptanthe and Canadian society as a whole. Environment Canada will endeavour to support implementation of this strategy, given available resources and varying species at risk conservation priorities. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible, Canadians directly affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

Environment Canada (Prairie and Northern Region)
Government of Alberta
Government of Saskatchewan

AUTHORS

This strategy was prepared by Candace Elchuk (Canadian Wildlife Service – Prairie and Northern Region) and Dean Nernberg (Canadian Wildlife Service – National Capital Region).

ACKNOWLEDGMENTS

The recovery strategy was prepared by Candace Elchuk and Dean Nernberg on behalf of the Recovery Team for Plants at Risk in the Prairie Provinces. The Recovery Team provided valuable comments on the drafts of this document. Recovery Team members, as of January 2006, included Candace Elchuk (Secretary and Acting Chair; Environment Canada), Jason Greenall (Manitoba Conservation), Robin Gutsell (Alberta Sustainable Resource Development), Lisa Matthias (Alberta Sustainable Resource Development; temporarily acting for Robin Gutsell), Sue McAdam (Saskatchewan Environment), Chris Nykoluk (Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration), and Peggy Strankman (Canadian Cattlemen's Association). Recovery Team participants, as of January 2006, included Cheryl Ann Beckles (Department of National Defence, 17-Wing Detachment Dundurn), Delaney Boyd (Department of National Defence, Canadian Forces Base (CFB) Suffield), Joel Nicholson (Alberta Sustainable Resource Development), and Sherry Lynn Punak (Department of National Defence, CFB Shilo). Dean Nernberg (Environment Canada) was the Recovery Team chair until August 2005. Helpful comments were also provided by Dave Duncan, Renee Franken, Ray Poulin, and staff from Canadian Wildlife Service, Habitat Conservation Section and Canadian Wildlife Service, Recovery Section. We thank Cheryl Bradley, who provided her expertise as well as updated information on the species. The Saskatchewan Conservation Data Centre and the Alberta Natural Heritage Information Centre provided updated element occurrences for this species. We would also like to thank all the landowners, lessees, and land managers who allowed us access to their land to do tiny cryptanthe surveys. The cover illustration was graciously provided by the artist, John Maywood.

STRATEGIC ENVIRONMENTAL ASSESSMENT

In accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*, a strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of tiny cryptanthe. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. Refer to the following sections of the document in particular: 1.3 Needs of Tiny Cryptanthe; 1.5 Threats to the Survival of Tiny Cryptanthe and its Habitat; 2.3 Recovery Objectives; 2.4 Research and Management Activities Recommended to Meet Objectives; 2.6 Critical Habitat; and 2.7 Effects on Non-target Species.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SARA public registry:
http://www.sararegistry.gc.ca/plans/residence_e.cfm.

PREFACE

The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed Extirpated, Endangered, or Threatened species. Tiny cryptanthe was listed as endangered under SARA in June 2003. The Canadian Wildlife Service – Prairie and Northern Region, Environment Canada, led the development of this recovery strategy. All responsible jurisdictions (Saskatchewan and Alberta) reviewed and approved the strategy. The proposed strategy meets SARA requirements in terms of content and process (Sections 39–41). It was developed in cooperation or consultation with:

- provincial jurisdictions in which the species occurs — Saskatchewan and Alberta;
- industry stakeholders — Canadian Cattlemen's Association; and
- federal land managers — Department of National Defence (CFB Suffield, 17-Wing Detachment Dundurn), Agriculture and Agri-Food Canada (Prairie Farm Rehabilitation Administration).

This will be the first recovery strategy for tiny cryptanthe posted on the SARA Public Registry.

EXECUTIVE SUMMARY

- Tiny cryptanthe is a small, bristly-haired annual plant that has minuscule white flowers with yellow centres. It is associated with river valleys and grows on sandy, rolling upland, valley slopes, or terraces in xeric to subxeric environments. In Canada, tiny cryptanthe has been found in 28 areas in Alberta and four in Saskatchewan.
- Currently identified threats to tiny cryptanthe include habitat loss and degradation as a result of cultivation, residential development, oil and gas activities, and sand/gravel extraction. Additional threats are modifications to natural processes through altered hydrological regimes and lack of grazing and/or fire, invasion by exotic species, and climate change.
- The overall recovery goal for tiny cryptanthe is to maintain the persistence of all naturally occurring populations in Canada. The population and distribution objective is to ensure the maintenance or the natural increase of existing populations while maintaining habitat to support their distribution.
- Four objectives have been identified for the recovery of tiny cryptanthe:
    1) Increase knowledge of the species' distribution and population size by 2009 to the point where critical habitat can be identified and natural population fluctuations are understood (*Priority – Urgent*).
    2) Manage habitat on an ongoing basis, using a landscape approach, to support the distribution of the Canadian population and maintain a minimum of 50% of the largest recorded abundance for each population in at least one in 10 years under the natural range of environmental conditions (*Priority – Urgent*).
    3) Increase knowledge of the biology of tiny cryptanthe by 2011 to the point where population demographics, reproductive ecology, and genetic variability are understood (*Priority – Necessary*).
    4) On an ongoing basis, increase landowner, land manager, stakeholder, and industry (e.g., oil and gas) awareness of tiny cryptanthe and its needs so that by 2011, stewardship activities and beneficial management practices are being implemented (*Priority – Beneficial*).
- Research and management activities needed to achieve these objectives include establishing standardized monitoring and surveying guidelines, continuing to monitor and survey for tiny cryptanthe, evaluating effects of threats, developing beneficial management practices to reduce threats and promoting them to land managers, developing and initiating stewardship agreements with land managers to protect habitat, completing population viability analyses, and initiating additional research to increase knowledge of the biology of this species.
- Owing to a lack of knowledge on the species' abundance, distribution, and habitat requirements/associations, critical habitat is not identified in this recovery strategy.

Critical habitat for tiny cryptanthe will be identified in one or more upcoming action plans.

TABLE OF CONTENTS

SPECIES ASSESSMENT INFORMATION FROM COSEWIC

Date of Assessment: May 2000

Common Name: Tiny Cryptanthe

Scientific Name: *Cryptantha minima*

COSEWIC Status: Endangered

Reason for designation: Few highly localized, disjunct populations at risk due to extremely low population sizes and occurrence in disturbed areas.

Canadian Occurrence: Alberta, Saskatchewan

COSEWIC Status History: Designated Endangered in April 1998. Status re-examined and confirmed in May 2000. Last assessment based on an existing status report.

1. BACKGROUND

1.1 Description

Tiny cryptanthe (*Cryptantha minima* Rydb.) is an annual species in the Borage family (Boraginaceae). The bristly-haired stems are branched from near the base and grow up to 10–20 cm high. The leaves, also bristly-haired, are spatula-shaped and can be up to 6 cm long by 0.5 cm wide at the base of the plants, but get smaller as they proceed up the stem (Moss 1994). Tiny cryptanthe flowers from late May to early July (Smith 1998; Kershaw *et al*. 2001; Alberta Sustainable Resource Development 2004). The flowers are tube-shaped, with white petals and yellow centres, and are arranged along the top side of the branches (Figure 1). At the base of each flower is a small leaf, or bract. The flowers are up to 2 mm across and 3 mm long. Bristly, green sepals with thickened, whitish midribs surround the flower petals, forming a calyx (Figure 1).

Figure 1. Photo of tiny cryptanthe plant with flowers.

Within the calyx, four small nutlets (seeds) form, maturing in late July and August; one nutlet is larger and smooth, and three nutlets are smaller and covered by small bumps. The calices turn brown when mature (Figure 2). The plant eventually turns greyish in September before dying.

1.2 Distribution and Abundance

Tiny cryptanthe is native to North America. In Canada, its known locations are 28 populations[1] in Alberta and four populations in Saskatchewan (Alberta Sustainable Resource Development 2004; C. Bradley pers. comm.; C. Elchuk pers. obs.; D. Nernberg pers. obs.) (Figure 3, Table 1). Tiny cryptanthe is associated with river systems, mainly the South Saskatchewan River valley in the eastern half of Alberta and near the western border of Saskatchewan. Tiny cryptanthe has also been found in the vicinity of the lower Bow and upper Oldman rivers in Alberta and the Red Deer River in Saskatchewan. The nearest location in the United States is in Montana, 450 km from the southernmost Alberta location (Alberta Sustainable Resource Development 2004). The number of populations in the United States is not documented; it is not known what percentage of the species' global distribution and abundance is currently found in Canada, although it is undoubtedly small (Figure 4). There are insufficient historical and long-term data collected for this species to allow a rate of population decline to be determined.

Figure 2. Photo of mature tiny cryptanthe, showing the brown calices.

[1] Using the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) definition, populations are geographically or otherwise distinct groups within a species that have little demographic or genetic exchange (typically one successful breeding immigrant individual or gamete per generation or less) (COSEWIC 2005). This is equivalent to the term "subpopulation" employed by the World Conservation Union (IUCN 2001). NatureServe considers sites within 1 km of each other, or within 2 km if there is appropriate habitat between the sites, to be from the same element occurrence (population) (NatureServe 2004). In the case of annuals, a few hundred metres may constitute separate populations, as long-distance dispersal of seed is rare (Cain *et al.* 2000; Alberta Sustainable Resource Development 2004). As knowledge about the basic ecology and boundaries of tiny cryptanthe populations increases, this number may change. The Canadian population, or total population, is the total number of mature individuals in Canada (equivalent to the term "population" employed by the World Conservation Union) (COSEWIC 2005).

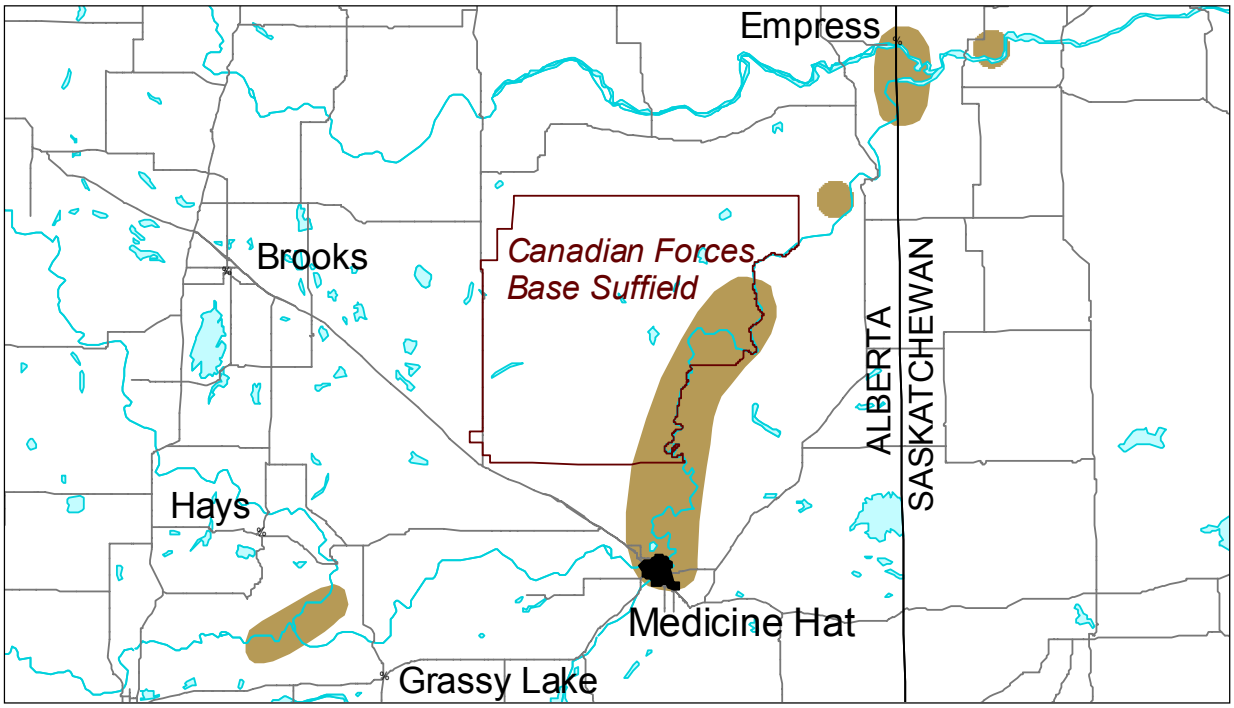

Figure 3. Known range of tiny cryptanthe in Canada.

In Canada, tiny cryptanthe is ranked S1 in both Alberta and Saskatchewan and N1 nationally, meaning that it is considered extremely rare, with five or fewer occurrences or very few remaining individuals (Vujnovic and Gould 2002; NatureServe 2004; Saskatchewan Conservation Data Centre 2004).

In the United States, tiny cryptanthe extends through the central plains (Figure 4), but a rank has not been assigned for its national status. The status of tiny cryptanthe is not ranked or is under review in Colorado, Kansas, Montana, Nebraska, New Mexico, and Oklahoma. However, it is ranked as vulnerable in Wyoming (S3) and apparently secure in South Dakota (S4).

Globally, tiny cryptanthe is ranked as demonstrably secure under present conditions (G5) (NatureServe 2004).

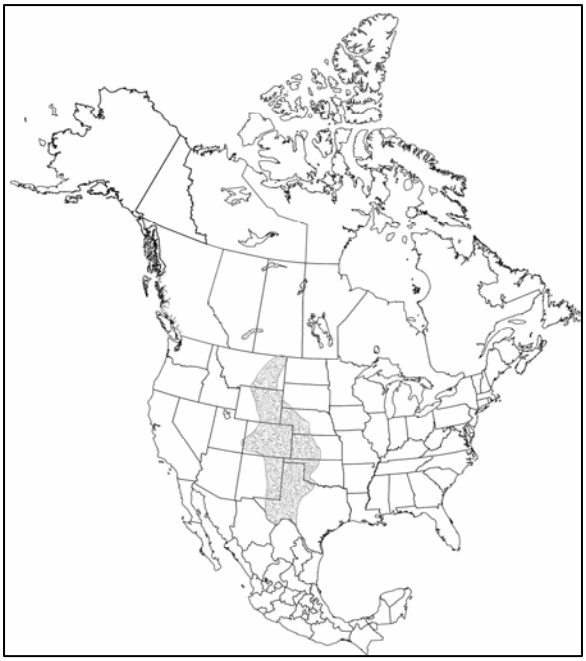

Figure 4. Known range of tiny cryptanthe in North America (adapted from Alberta Sustainable Resource Development 2004).

Table 1. Summary of tiny cryptanthe populations in Canada[a]

Site	Recent population estimate[b]	Land tenure	Threats
ALBERTA			
Oldman River	>500	ditch, private	road maintenance, herbicides, exotics
Bow River			
3–8 km upstream	>568	leased Crown	oil/gas activity, cultivation, invasive exotics
6 km upstream	62[c]		
9 km upstream	5		
11 km upstream	3		
South Saskatchewan River[d]			
Medicine Hat, Seven Persons Creek	9	municipal	oil/gas
Medicine Hat, Gas City Campground	1 100	municipal	habitat degradation
Medicine Hat, Ranchlands	40 000	municipal	urban development
Medicine Hat, Box Springs Road	60	municipal	invasive exotics
km 120–123, east side	450	private	
km 131, west side	>1 000	ditch, private	herbicides, exotics, road maintenance
km 136–141, west side	>2 600	private	oil/gas, cultivation
km 157, east side	11 500[e]	leased Crown	oil/gas, seeding to non-native pasture, cultivation, exotics
km 158, east side	40[f]		
km 160, east side	110		
km 167–169, east side	80[g]		
km 174, east side	0[h]		
km 178, east side	7 500		
km 181, east side	37		
km 190, east side	2		
km 263, west side, valley	20	private	oil/gas
South Empress, east side	900	leased Crown	
South Saskatchewan River, CFB Suffield and CFB Suffield National Wildlife Area			
km 156–175, south Fish Creek[i]	172 174	federal land (Department of National Defence – CFB Suffield)	lack of grazing (some areas), oil/gas (all areas), military activities (some areas)
km 196–198, north Casa Berardi	72 475		
km 200–201, north Nishimoto Flats	16 011		
km 198–200, northwest Koomati	1 390		
km 208, north Mule Deer Springs	1		
km 230, Ypres	399		
SASKATCHEWAN			

Site	Recent population estimate[b]	Land tenure	Threats
South Saskatchewan River			
Estuary	366	leased Crown	
South of Ebenau Island	45	private	cultivation
Red Deer Forks	14 363	leased Crown, private	
Westerham	0	private	

[a] Note that population sizes are difficult to quantify because of yearly fluctuations in population size and the use of different census techniques.
[b] Based on 2004 survey unless otherwise noted.
[c] 2002 survey.
[d] South Saskatchewan River kilometre values based on Alberta Sustainable Resource Development (2004) and maps from Dickinson and Baresco (1996).
[e] 2003 survey.
[f] >725 found in 2003.
[g] 17 500 found in 2003.
[h] 12 found in 2003.
[i] Site names (e.g. Casa Berardi, Ypres) refer to training area subdivisions in use by CFB Suffield (map: CFB Suffield Reduction – Navaids, Series GSGS 5826-N, Sheet 156, Edition 1-GSGS)

1.2.1 Specific Areas in Canada

Alberta

Tiny cryptanthe is found in southeastern Alberta in the vicinity of the upper Oldman River, the lower Bow River, and the South Saskatchewan River from Medicine Hat east to the Saskatchewan border (Table 1).

Oldman River – The Oldman River site is located 11 km upstream of the confluence with the Bow River in the sandy upland of the Purple Springs dunes in a slightly disturbed area beside a road in sandy soil (Bradley and Ernst 2004).

Bow River – The sites associated with the Bow River are on upland sandy terrain, some associated with side coulees running off the valley, between 3 and 11 km upstream from the confluence with the Oldman River. Sites associated with side coulees appear secure, provided grazing and small patch disturbances from mammals continue with no permanent loss of vegetation.

South Saskatchewan River – The first sighting of tiny cryptanthe at Medicine Hat was in 1894, with no relocations until large numbers of tiny cryptanthe were found on valley slopes and sandy uplands within the city limits of Medicine Hat in 2004. Three sites (Seven Persons Creek, Gas City Campground, Box Springs Road) are located along steep coulee slopes and, although near developments (e.g., golf course, campground), are considered secure because the terrain is not suitable for development. In the northern Ranchlands area, plants were on undulating uplands and mid- to upper valley slopes, although over half of the habitat has recently been lost to housing development and road construction (Alberta Sustainable Resource Development 2004; Bradley 2004; Bradley and Ernst 2004).

Additional sites along the South Saskatchewan River, downstream from Medicine Hat, are located on valley benches, upper valley slopes, and adjacent upland areas on both sides of the river in areas used mainly for grazing and some oil/gas activities. These sites are likely secure, particularly the sites on steeper valley slopes, as long as grazing and only small patch disturbances continue and there is no permanent loss of vegetation or major shifts in land use that would negatively affect tiny cryptanthe (Alberta Sustainable Resource Development 2004).

South Saskatchewan River, CFB Suffield and CFB Suffield National Wildlife Area – The CFB Suffield National Wildlife Area is a federally protected wildlife area comprising 458 km^2 on the east side of CFB Suffield adjacent to the South Saskatchewan River. A small portion of the CFB Suffield training area bisects the CFB Suffield National Wildlife Area and straddles the South Saskatchewan River. Until 2004, only small numbers of tiny cryptanthe were found in CFB Suffield National Wildlife Area (Macdonald 1997; Alberta Sustainable Resource Development 2004). Surveys in 2004 located large populations of tiny cryptanthe in both the CFB Suffield National Wildlife Area and the CFB Suffield training area adjacent to the South Saskatchewan River (D. Nernberg pers. obs.). Most of the tiny cryptanthe sites were located on mid-slope terraces and on the slopes of hills and undulations (D. Nernberg pers. obs.). Although the CFB Suffield National Wildlife Area is a protected area and no motorized military training occurs within its boundaries, other activities occur in the national wildlife area, including cattle grazing and oil and gas activities. Sites outside the CFB Suffield National Wildlife Area in the CFB Suffield training area may be subject to active military operations and oil and gas development; cattle grazing is not allowed in the training areas of CFB Suffield (B. Smith pers. comm.).

Saskatchewan

Until 2004, tiny cryptanthe had been reported at two locations in Saskatchewan: one near Westerham and one near the border close to Empress, Alberta. Expanded surveys in 2004 relocated one of the historical locations as well as locating new sites for tiny cryptanthe along the South Saskatchewan River west of Leader to the Alberta border (Table 1). All sites are used for ranching and should be secure as long as there is no major change in land use.

Estuary – The Estuary site is located east of the Estuary ferry on a sandy, undulating, and hummocky valley bottom terrace with stabilized sand dunes.

South of Ebenau Island – The locations that are south of Ebenau Island are on upland habitat near the valley breaks.

Red Deer Forks – This is a large tract of native pasture between the confluence of the Red Deer and South Saskatchewan rivers. Tiny cryptanthe locations are along valley breaks or coulee slopes leading into the river valley.

Westerham – The Westerham site has not been relocated, despite numerous search attempts since it was reported in the 1970s. The site was reported to be an upland area on disturbed, cindery soil adjacent to an old railway bed and elevator. Fendler's cryptanthe (*Cryptantha fendleri*) and Kelsey's cryptanthe (*Cryptantha kelseyana*) currently inhabit the area. The specimen located in

the University of Saskatchewan W.P. Fraser herbarium (Accession number 67852) is a young specimen in the flowering stage, and it is difficult to confirm if it is tiny cryptanthe.

1.3 Needs of Tiny Cryptanthe

1.3.1 Environment

Tiny cryptanthe occurs in the Mixed Grassland Ecoregion of the Prairie Ecozone in Saskatchewan and mainly in the Dry Mixedgrass Natural Subregion, with some locations in the Mixedgrass Natural Subregion, of the Grassland Natural Region in Alberta (Alberta Environmental Protection 1994; Acton *et al*. 1998). Tiny cryptanthe grows in a steppe climate, which is characterized as being dry year-round as a result of low annual precipitation levels, high rates of evaporation, and fast surface runoff (Smith 1998; Fung 1999). In Medicine Hat, Alberta, annual precipitation is about 334 mm, with the highest precipitation occurring in June (Environment Canada 2004). In Saskatchewan, annual precipitation at Leader is 360 mm, with the peak precipitation occurring in June. These areas experience warm summers (mean summer temperatures of 18.5°C at Medicine Hat and 17.8°C at Leader) and cold winters (mean winter temperatures of −8.1°C at Medicine Hat and −11.4°C at Leader) (Environment Canada 2004). Soils in the areas where tiny cryptanthe is growing are Brown and typically formed in sandy fluvial or aeolian materials, described as Orthic Regosols or Rego Chernozems, with coarser soil textures of sandy loam or loamy sand to silty (Kjearsgaard and Pettapiece 1986; Saskatchewan Soil Survey 1990, 1993; Fung 1999; Alberta Sustainable Resource Development 2004; Bradley and Ernst 2004).

1.3.2 Habitat

Tiny cryptanthe appears to occur within a few kilometres of river systems and is typically located in three types of habitat: 1) sandy, level to rolling upland areas, and sand dunes near valley breaks; 2) valley slopes with up to 50% slope; and 3) level or gently sloping terraces in the valley bottom, particularly in meander lobes (Alberta Sustainable Resource Development 2004). On a microhabitat level, tiny cryptanthe tends to occupy xeric to subxeric sites with slopes most commonly under 20 degrees, with varying aspects, but dominated by southerly to easterly directions. Tiny cryptanthe appears to need habitat with low litter levels and a minimum of 10% bare soil for establishment.

Associated vegetation communities are dominated by needle-and-thread (*Stipa comata*) and blue grama (*Bouteloua gracilis*). They commonly include prickly pear cactus (*Opuntia polyacantha*), Pursh's plantain (*Plantago patagonica*), goosefoot (*Chenopodium pratericola*), pasture sage (*Artemisia frigida*), thread-leaved sedge (*Carex filifolia*), low sedge (*Carex stenophylla*), peppergrass (*Lepidium densiflorum*), Indian rice grass (*Oryzopsis hymenoides*), alkali blue grass (*Poa juncifolia*), and two non-native plants, Russian thistle (*Salsola kali*) and bluebur (*Lappula echinata*) (Alberta Sustainable Resource Development 2004; Bradley and Ernst 2004; C. Elchuk pers. obs.; D. Nernberg pers. obs.).

1.3.3 Limiting Factors

Tiny cryptanthe appears to require some element of disturbance. Habitats that contain tiny cryptanthe have occasional natural disturbances in the form of deposition, caused by the action of water (terraces in meander lobes), gravity (valley and upland slopes), wind (sandy, upland plains and dunes), and soil-disturbing animals that open up bare soil patches (Alberta Sustainable Resource Development 2004). Areas that have repeated intense disturbances, such as cultivated fields or active sandbars, and areas with actively eroding slopes and cutbanks do not appear to support tiny cryptanthe populations (Alberta Sustainable Resource Development 2004).

Tiny cryptanthe is an annual plant, with a large portion of its life cycle spent dormant as seed. The continued existence of tiny cryptanthe populations is reliant on the seed bank. Incorporating seed bank counts with the estimation of population size has not been carried out to date in Canada. Counts of plants and their distribution, if done over a number of years, can give an estimate of the distribution of the seedbed, suitable habitat, and disturbance regimes, as well as weather-related population trends or germination requirements. Numbers of plants can vary greatly from year to year (e.g., zero to over 50 000 plants at one site) because of factors such as the amount of rainfall, the timing of rainfall, seed production from past years, and germination conditions. Different surveying techniques can also result in varying counts within or between years (Alberta Sustainable Resource Development 2004). Therefore, although in some years there may not be any plants growing at a site, these populations should not be considered extirpated, as there is likely viable seed in the seed bank. Similarly, areas that appear to have suitable habitat but no tiny cryptanthe plants should be resurveyed in years of favourable growing conditions. It is not known how long tiny cryptanthe seeds remain viable in the seed bank or what proportion of seeds are deposited into the seed bank, but annual plants often depend on seed longevity to buffer against environmental unpredictability (Harper 1977).

Dispersal of tiny cryptanthe seeds may be limited. The majority of tiny cryptanthe seed dispersal is likely passive, with seeds falling close to the parent plant, although there may also be dispersal by animals. Bristles on the calyx, which contains the seeds, may catch on fur, or the animals may drag the plants to their burrows for food (Bradley and Ernst 2004). Some seeds may also be dispersed through wind, rain, or snowmelt. Once seeds are on the ground, however, animals, wind, and water do not appear to move seeds significant distances (Primack and Miao 1992). In general, most seeds usually move only a few metres, with anything beyond a few hundred metres being rare (Harper 1977; Primack and Miao 1992; Cain *et al.* 2000). Therefore, seed dispersal to other populations and establishment of new populations may be unlikely. Specific pollinators are unknown, as is the distance between plants for cross-pollination to occur.

1.4 Protection

In addition to the protection afforded to tiny cryptanthe under the federal *Species at Risk Act*, it is protected by provincial legislation. Tiny cryptanthe was declared endangered in Saskatchewan under Part V of *The Wildlife Act* in 1999, and it is therefore protected on private, provincial, and federal lands. In Alberta, tiny cryptanthe has been proposed for listing as an endangered species by the provincial Endangered Species Conservation Committee; the development of protective

regulations under the provincial *Wildlife Act* is in progress (R. Gutsell, pers. comm.; L. Matthias, pers. comm.).

1.5 Threats to the Survival of Tiny Cryptanthe and its Habitat

The threats to tiny cryptanthe relate ultimately to alteration of habitat, including loss of habitat from changes in land use, such as cultivation or urban development (see Table 1 for site-specific threats). Some proximate causes of habitat alteration include decreased or no grazing, fire control, climate change, and encroachment of invasive vegetation. These are discussed in more detail below.

Adaptive management will be an important component in managing threats to tiny cryptanthe. In addition, obtaining information on species biology and life history traits will be crucial to understanding where the demographic bottlenecks are, what stages of tiny cryptanthe are most vulnerable, and the long-term viability of populations.

1.5.1 Habitat Loss or Degradation

Cultivation

In general, the sandy areas and soil type that support tiny cryptanthe are not considered suitable for agriculture because of low soil moisture, low water-holding capacity, low soil fertility, and susceptibility to wind erosion (Saskatchewan Soil Survey 1993; Geological Survey of Canada 2001). However, some sites may be suitable for cropland, perennial forages, hayfields, or potato crops. In Alberta, some sandy upland areas have been converted to potato crops, and it is possible that areas inhabited by tiny cryptanthe may be affected in the future (Alberta Sustainable Resource Development 2004; Bradley and Ernst 2004). In addition, areas containing tiny cryptanthe are often surrounded by mixed prairie grasslands, which are commonly converted for cultivation, creating islands in a landscape dominated by crops. Only 54% of the Dry Mixedgrass Natural Subregion in Alberta and 31.3% of the Mixed Grassland Ecoregion in Saskatchewan are estimated to remain in native vegetation (Alberta Sustainable Resource Development 2000; Gauthier *et al*. 2002). Cultivation is mostly a threat to those populations occurring on the upland habitat or in the river valley terraces that are often seeded to non-native pasture or cultivated and irrigated. Habitat adjacent to valley breaks or on valley slopes is thought to be secure, as the topography of these areas does not facilitate cultivation. However, irrigation and the use of some chemicals (e.g., herbicides, fertilizer, pesticides) on adjacent converted upland areas have the potential to alter the habitat on nearby slopes (e.g., change species composition, canopy cover, hydrology, soil stability, degrade pollinator populations).

Residential Development

In 2004, over 40 000 tiny cryptanthe plants were found within the municipality of Medicine Hat on valley slopes, upland areas, and benches. Parts of this area have been developed for residential housing and roads since the 2004 survey. Some plants located on steep valley slopes would likely not be disturbed directly by development but could suffer as a result of loss of a large portion of the adjacent population and the seed bank, as well as potentially being affected

by invasive species from development and increased vegetation growth resulting from increased water runoff and fertilizer from residential landscapes.

Oil and Gas Activities

Some tiny cryptanthe habitat has been lost to oil and gas activities, including road building, well sites, pipelines, and other actions related to active exploration and oilfield development. In some areas, these activities occur without any rare plant surveys being conducted. Tiny cryptanthe has not been observed in areas where there are repeated disturbances or heavy compaction, such as on roads. Although some of these disturbances may create temporary habitat for species such as tiny cryptanthe, these areas are not good quality habitat in the long term, as plants often get destroyed. Moreover, in some areas, non-native plant species are still being used to reclaim disturbed areas along access roads and well-sites, although this is no longer allowed on provincial Crown lands (Saskatchewan Agriculture, Food and Rural Revitalization 2000; Government of Alberta 2004). Nevertheless, even when native seed mixes are used in reclamation, invasive species often still colonize these areas. These non-native species have the potential to invade and outcompete native species (Alberta Sustainable Resource Development 2004).

Sand and Gravel Removal

Sand and gravel removal for road building or personal use and the levelling of dunes are potential threats to tiny cryptanthe populations. Gravel extraction is known to have occurred at one site and is present at areas that contain potential tiny cryptanthe habitat (Alberta Sustainable Resource Development 2004). The removal of sand or gravel may destroy portions of the tiny cryptanthe seed bank, which could have substantial implications for the future survival of the populations at these sites.

Military Activities

It is not clear how military activities may affect tiny cryptanthe. Tiny cryptanthe occurs in large numbers within CFB Suffield (Bradley and Ernst 2004; D. Nernberg pers. obs.). The potential exists for road creation, use of heavy machinery, and military operations to damage tiny cryptanthe plants or populations. Some minor disturbance may enhance populations by opening habitat and suppressing competition from other plant species.

1.5.2 Modification of Natural Processes

Altered Hydrological Regimes

Altering the hydrological regime of an area may be detrimental to tiny cryptanthe. Because tiny cryptanthe appears to be limited to xeric–subxeric habitat, changes to the moisture regime could adversely affect its growth and survival. Its association with river systems means that any developments that restrict natural periodic floods, cause unnatural flooding, inhibit channel migration, or divert water could alter the disturbance regime beyond the range of natural variability, potentially negatively impacting the creation and maintenance of tiny cryptanthe habitat (Smith 1998; Alberta Sustainable Resource Development 2004). Dams in general result

in numerous impacts to habitat; native rangeland is often converted to irrigated cropland, and floodplains and valley bottoms become flooded from reservoir inundation, both resulting in habitat loss and fragmentation. Downstream of dams there are reduced flooding events, reduced water flow, and reduced sediment deposition on floodplains, resulting in changes to species richness, species composition, and vegetation structure (Golder Associates 2002). Damming of the South Saskatchewan River near Outlook, Saskatchewan, in 1967 resulted in flooding of a considerable area; it is not known if tiny cryptanthe populations were present in the area (Smith 1998). The Meridian Dam project, proposed to be located along the South Saskatchewan River near the Saskatchewan–Alberta border (Government of Alberta 2002), would have undoubtedly impacted tiny cryptanthe habitat had it been approved. Other anthropogenic alterations, such as roads, urban developments, and irrigation, can also change the hydrology of habitat by modifying drainage patterns and water flow in an area.

Lack of Grazing and/or Fire

The occurrence of tiny cryptanthe in habitats that have periodic depositional processes by wind, water, gravity, or animals suggests a reliance on disturbance. These disturbances shift the soil and can open up the canopy and create spaces for germination and establishment. Fire and grazing assist these disturbance processes by destabilizing sand hills, opening up areas of bare soil, and keeping canopy vegetation and litter levels lower (Hayes and Holl 2003). Grazing can also create trails or small blowouts that may be important for tiny cryptanthe establishment. Studies have shown that grazing can help maintain or increase populations of annual plants in mesic grasslands (Collins 1987; Hayes and Holl 2003). There have been no observations of animals grazing on tiny cryptanthe.

1.5.3 Invasive Exotic Species

Tiny cryptanthe appears to require an element of shifting soil, relatively low vegetation and litter cover, and open patches of soil for successive germinations and growth. Invasive exotic species such as crested wheat-grass (*Agropyron cristatum*), which can stabilize sand hill areas and produce higher levels of canopy cover and litter, would likely outcompete tiny cryptanthe and create unsuitable habitat. Tiny cryptanthe has been found only in native pastures and has not been found in pastures converted to, or heavily invaded by, exotic species. Some areas along the South Saskatchewan River valley, particularly the meander lobe terraces, have been converted to crested wheat-grass, while other areas are adjacent to pastures of crested wheat-grass, which can invade native pasture (Bush 2001; Alberta Sustainable Resource Development 2004). There is the potential for tiny cryptanthe plants to be killed or for the species' habitat to be negatively altered by indiscriminate use of herbicides intended to control invasive species.

1.5.4 Climate and Natural Disasters

Climate Change

Tiny cryptanthe appears to prefer hotter, dry climates in the Canadian prairies, as indicated by its current distribution. If there is a shift towards a warmer climate within its Canadian range as a result of global warming, as predicted by climate change projections (Government of Canada

2004), this may favour tiny cryptanthe and potentially result in an expansion in its range, provided there is suitable habitat remaining. If there is a shift to a cooler climate within its Canadian range, this could be detrimental to tiny cryptanthe, decreasing its range and possibly leading to extirpation (Alberta Sustainable Resource Development 2004). However, the potential effects of climate change on this species are only speculative.

2. RECOVERY

2.1 Recovery Feasibility

Historical population sizes and distribution for this species are unknown. There is the potential for the status of this species to be downlisted from Endangered if there are new populations found in Canada. However, this species may inherently have a small area of occupancy in Canada. Any continuing decline in the area of suitable habitat, combined with large population fluctuations from factors such as weather, may keep this a species at risk. Nevertheless, it should be feasible to maintain this species under the normal range of environmental conditions. Therefore, the maintenance of existing populations and their distribution will constitute the recovery of tiny cryptanthe.

Recovery of tiny cryptanthe is both biologically and technically feasible. There are activities and actions that can reduce the threats to tiny cryptanthe, and these can be feasibly implemented. This species is adapted to disturbances such as grazing and fire, which can be communicated as beneficial actions with careful management on appropriate lands. Measures to reduce the threat of exotic species can also be implemented. A number of locations currently occupied by tiny cryptanthe are areas managed as protected wildlife areas (e.g., CFB Suffield National Wildlife Area). Remaining sites could be secured through stewardship agreements with landowners.

2.2 Recovery Goal

The recovery goal for tiny cryptanthe is to maintain the persistence of all naturally[2] occurring populations in Canada.

2.2.1 Population and Distribution Objective

The population and distribution objective is to ensure the maintenance or the natural increase of existing populations while maintaining habitat to support their distribution by 2021.

[2] Naturally occurring population refers to any population within the native range on naturally occurring habitat. It excludes horticultural populations or those that are dispersed by humans and establish themselves outside the native range or on unnatural habitats.

2.3 Recovery Objectives

Objective 1: Increase knowledge of the species' distribution and population size by 2009 to the point where critical habitat can be identified and natural population fluctuations are understood (*Priority – Urgent*).

Objective 2: Manage habitat on an ongoing basis, using a landscape approach, to support the distribution of the Canadian population and maintain a minimum of 50% of the largest recorded abundance for each population in at least one in 10 years under the natural range of environmental conditions. This includes developing an understanding of management techniques, threats, and habitat associations (*Priority – Urgent*).

This objective was developed using the best available expert knowledge and reflects the need to take into account the widely fluctuating annual population levels and the need to set a reasonable trigger for taking action. It is speculated that conditions conducive for germination and growth of this species may occur in at least one out of every 10 years. A 50% target was chosen to create a threshold at which concern for population persistence and viability would be triggered and more intensive investigation initiated. To set the target too high might trigger unnecessary actions. To set the target too low may risk allowing the population to get too small or disappear.

Objective 3: Increase knowledge of the biology of tiny cryptanthe by 2011 to the point where population demographics, reproductive ecology, and genetic variability are understood (*Priority – Necessary*).

Objective 4: On an ongoing basis, increase landowner, land manager, stakeholder, and industry (e.g., oil and gas) awareness of tiny cryptanthe and its needs so that by 2011, stewardship activities and beneficial management practices are being implemented (*Priority – Beneficial*).

2.4 Research and Management Activities Recommended to Meet Objectives

As described below, one of the main factors that may impede recovery planning activities, in addition to the threats, is a lack of knowledge about this species. Further research will be an essential component of the overall strategy to recover the species.

Distribution and Abundance

There is a lack of knowledge about the entire distribution of tiny cryptanthe, as well as its population abundance. Not knowing the locations of all populations of tiny cryptanthe may result in populations not being protected and being potentially lost. Failing to determine the distribution of the seed bank could result in parts of the population not being protected or managed. As tiny cryptanthe is an annual species, there can be considerable fluctuation in population abundance and distribution from year to year. Long-term information on population dynamics would help to understand species viability.

Population Viability

There is a lack of information on the natural history and life cycle of tiny cryptanthe. This includes information about the seeds (production, germination rates, germination requirements, viability, dormancy, seed bank longevity, dispersal, and dispersal distances), pollination (identification of pollinators and distance of pollen dispersal), genetics (metapopulation dynamics and genetic variability within Canadian populations and within North America), and predators. This information is necessary to understand the population viability of the species.

Table 2 provides a general description of the research and management activities that are recommended to meet the objectives and address the threats. The action plan(s) will contain more detailed information on the actions and the implementation schedule.

2.5 Broad Strategies to Address Threats

2.5.1 Habitat Loss or Degradation

The recovery of tiny cryptanthe will include identifying activities that are detrimental to this species. Habitat protection, while essential to recovery, needs to be used in combination with management to ensure the continued persistence of this species. Effective conservation of this species will require appropriate management practices to be in place. Beneficial management practices will be identified and stewardship or conservation agreements will be developed with landowners and managers to conserve habitat and promote existing supportive management practices for this species. In addition, an education and communication program will be developed for land managers and the general public to minimize habitat deterioration. The effects of military activities on tiny cryptanthe will be assessed and stewardship agreements will be developed with military bases to manage for tiny cryptanthe. Recommended guidelines or restrictions of setback distances for various activities will be developed for use by regulatory agencies.

2.5.2 Modification of Natural Processes

More information is needed on the roles of grazing and fire in sand hill environments in the southern prairies and the subsequent effect on tiny cryptanthe. More information is also needed on the interaction between fire and grazing and its role in shaping vegetation communities in these areas. The recovery of tiny cryptanthe will include an evaluative and adaptive approach to identifying appropriate beneficial management practices.

2.5.3 Invasive Exotic Species

The recovery of tiny cryptanthe will include identifying the impacts of invasive species on tiny cryptanthe establishment and persistence. Beneficial management practices will be identified and stewardship agreements will be developed with land managers to ensure that habitat quality for the tiny cryptanthe is conserved.

2.5.4 Climate and Natural Disasters

Although it is probably not possible to mitigate this threat, monitoring of populations may elucidate trends. However, to identify trends, long-term data sets are required, and the fluctuating nature of annual plants may make it difficult to draw conclusions. If trends demonstrate that changes are occurring, either negatively or positively, assessment of potential beneficial actions would occur at that time.

Table 2. Strategies to Affect Recovery

Priority	Objective No.	Broad strategy	Threat/concern addressed	Recommended research/management activities
Urgent	1	• Inventory and monitoring	• Lack of knowledge • Climate	• Develop simple guidelines for monitoring, including methods for estimating population size, which should be implemented by all organizations/agencies in both provinces. • Compile all data on tiny cryptanthe, and map locations and distribution of populations, if not already available. Determining where data will be stored and managed will be important. • Continue surveying and monitoring known locations with tiny cryptanthe. • Implement a study on habitat suitability and predictability for occurrence within different locations. • Survey similar habitats for potential additional populations. • Identify critical habitat for tiny cryptanthe. • Complete population viability analyses on known populations to determine population viability under current conditions (unlikely to be completed by 2009).
Urgent	2	• Beneficial management practices and stewardship • Education/ communication • Research	• Habitat loss/ degradation • Modification of natural processes • Invasive exotics	• Continue to monitor populations for trends, abundance, and extent. • Continue to evaluate the effect of threats on the various populations. • Identify the positive and/or negative impacts of grazing (domestic and wild herbivory), idling, brush control, fire, floods, and herbicides using incidental evidence, past observations, and research; identify beneficial management practices for the species based on the outcomes. • Conduct research on the effects of exotic species invasion on the presence of tiny cryptanthe. Identify and evaluate methods to control the invasion, including biological control, herbicides, and grazing. • Develop a list of the potential effects of resource extraction. Make recommendations for appropriate regulatory agencies (i.e., develop plant species at risk guidelines for set-back distances). • Convey recommendations and beneficial management practices to landowners and land managers through conservation and stewardship agreements. Communicate existing supportive land management practices where appropriate. • Use adaptive management throughout to improve management practices. • Examine the influence of companion vegetation (e.g. impact of canopy cover, litter, amount of bare soil). • Recognize and ensure appropriate conservation and stewardship of tiny cryptanthe habitat.

Priority	Objective No.	Broad strategy	Threat/concern addressed	Recommended research/management activities
Necessary	3	• Research	• Lack of knowledge	• Examine the life cycle of tiny cryptanthe, including seed bank longevity, size of the seed banks, seed viability, impacts of rainfall, mechanisms of seed dispersal, seed germination rates, specific germination requirements, establishment requirements, rates of seed and seedling loss, seed production, and establishment success. Knowledge of reproductive ecology and population demographics will be important for assessing population viability. • Investigate seed and pollen dispersal distances and the degree of isolation of populations (metapopulation dynamics). • Investigate genetic variability within and between Canadian and U.S. populations. • Establish a seed gene bank. • Investigate systematics of plants within Canada and between Canada and the United States. This includes examining morphological differences between plants and whether there is hybridization with other *Cryptantha* species, such as Kelsey's cryptanthe and Fendler's cryptanthe. • Determine the pollinators of tiny cryptanthe.
Beneficial	4	• Education/ communication	• Habitat loss/ degradation • Modification of natural processes • Invasive exotics	• Develop an overall approach to landowner and public communication. This may include factsheets and interpretation programs for the public, recreational users, and land managers. • Develop a web site on tiny cryptanthe and its threats; encourage people to contribute sightings. • Promote beneficial management practices to landowners and land managers. • Coordinate among government departments and non-government organizations regarding surveying and landowner communication.

2.6 Critical Habitat

2.6.1 Critical Habitat Identification for Tiny Cryptanthe

Critical habitat is defined in the *Species at Risk Act* as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" (Subsection 2(1)).

There is a lack of knowledge on many aspects of tiny cryptanthe (see section 2.9), which is preventing the identification of critical habitat at this time. Identification of critical habitat for an annual plant species, for which the most genetically diverse, abundant, and long-lived phase of the species is in the seed bank, cannot be accomplished by creating arbitrary boundaries around every individual or population found. For example, critical habitat may be related to disturbance factors, such as grazing, fire, and drought, that vary in time and space or to a particular successional stage of vegetation. This greatly complicates using fixed geographic coordinates to designate critical habitat. In addition, the majority of the information available on this species is based on recently collected one-year data and lacks the quantitative detail necessary to create a probabilistic model of tiny cryptanthe habitat associations suitable for identifying current and potential scientifically defensible critical habitat.

Although critical habitat is not being designated in this recovery strategy, there are areas and factors that will be the focus of future studies (see Table 1 and section 2.6.2 Schedule of studies to identify critical habitat). Identification of critical habitat will be based on the best scientific information available and expert opinion concerning the species' present and historical range, habitat, biology, and threats. Information reviewed will include known locations, the reason for listing the species, recent biological surveys and reports, peer-reviewed literature, local people and First Nations knowledge, the recovery strategy, and discussions and recommendations from plant experts. All locations known to be inhabited by tiny cryptanthe will receive consideration for future designation as critical habitat. Specific locations and land descriptions of critical habitat will be determined during preparation of action plan(s) and may be withheld from the Public Registry to protect tiny cryptanthe as well as landowner privacy. Critical habitat will be identified with guidance from this recovery strategy as well as guidance from the Recovery Team and will be completed by 2009 as part of the action plan(s). Some of the locations could be identified as critical habitat sooner if sufficient information is collected.

2.6.2 Schedule of Studies to Identify Critical Habitat

General descriptions of significant habitat features and areas for tiny cryptanthe are provided in section 1.2.1 Specific areas in Canada and in Table 1. The future identification of critical habitat will consider areas in and around these sites, as well as any sites identified by further study.

Table 2 outlines recommended research and management activities to effect recovery and support in the identification of critical habitat. This section outlines specific recommended studies and actions necessary to identify critical habitat:

1) Resurvey existing populations to determine abundance and extent at each site, using standardized methodology suitable for annual species. Since the boundaries of populations and numbers of plants fluctuate yearly, a few years of surveys are required to get a more accurate estimate of the extent of the seed bank. Also, detection probability modelling and seed dispersal studies can be used to estimate the seed bank abundance and distribution, which will aid in identifying habitat that should be designated as critical (to be completed by 2008).

2) Collect information on habitat characteristics from known tiny cryptanthe populations, as well as unoccupied sites, to conduct habitat suitability modelling. This information may be analyzed using multivariate analysis to identify key variables for the occurrence of tiny cryptanthe. Analysis will assist in determining the potential suitability of habitat for focusing survey effort and identifying critical habitat (to be completed by 2007).

3) Survey suitable habitat to look for additional sites. If new populations are found, a few years of inventory will be required to assess the extent and population size. Areas that appear suitable but where tiny cryptanthe has not been found may need to be surveyed again in favourable growing years to rule out the existence of a seed bank (to be completed by 2008).

4) Perform population viability analyses (PVAs) on tiny cryptanthe populations. The PVA will assist in determining which populations are viable and therefore in prioritizing critical habitat designation. However, reliable PVAs typically require long-term data sets. Because of dormancy in plants, short-term studies have been found to inflate mortality estimates when used in PVAs (Menges 2000), and long-term experiments are often needed to quantify seed bank dynamics (Reed *et al*. 2002). Therefore, it is not likely that a reliable PVA can be completed within a few years for a fluctuating annual with limited data by the time critical habitat is designated in the action plan(s) in 2009. If this is the case, the best available biological knowledge collected to that time will be used to designate critical habitat for the action plan; once enough information has been collected for a PVA, the areas initially designated for critical habitat will be reassessed.

2.7 Effects on Non-target Species

A number of plant species at risk rely on sandy environments in the prairies, including small-flowered sand verbena (*Tripterocalyx micranthus*), hairy prairie-clover (*Dalea villosa* var. *villosa*), and smooth goosefoot (*Chenopodium subglabrum*). These species will benefit from research on sand hill environments. In addition, there are a number of provincially rare plant species that are found in the same habitat as tiny cryptanthe. These include stinking goosefoot (*Chenopodium watsonii*), Kelsey's cryptanthe, nodding umbrella-plant (*Eriogonum cernuum*), false buffalo-grass (*Munroa squarrosa*), narrow-leaved umbrella-wort (*Mirabilis linearis*), and clammyweed (*Polainsia dodecandra*).

There are also a number of rare vertebrate species that use sandy habitat, including Ord's kangaroo rat (*Dipodomys ordii*), olive-backed pocket mouse (*Perognathus fasciatus*), northern grasshopper mouse (*Onychomys leucogaster*) (Pattie and Fisher 1999), Western Hognose Snake

(*Heterodon nasicus*) (Russell and Bauer 1993), and Prairie Rattlesnake (*Crotalus viridus*); these species may also benefit from the conservation of tiny cryptanthe habitat. There are also a number of invertebrate species found in close association with sand dune and sand plain habitats (e.g., tiger beetles, moths, burrowing wolf spiders, etc.; J. Acorn pers. comm.) that may benefit from conservation and management of sandy environments and dune ecosystems.

Sand hill and sand plain communities are very diverse, and management actions will need to maintain a variety of stages of dune stabilization (i.e., stabilized to active) to preserve ecological diversity. Recovery activities for tiny cryptanthe should be combined with activities for other species occurring in sand hill and sand plain ecosystems in the southern prairies. Efforts should be coordinated with other recovery teams for the most efficient use of resources and to prevent duplication of research. Creation of a multispecies action plan may be beneficial for the species inhabiting this ecosystem (e.g., Multiple Species at Risk, or MultiSAR, in Alberta; Downey *et al.* 2005).

2.8 Evaluation of Success

A number of measures will be used to evaluate the success of the recovery strategy. These include the continued persistence of existing populations and conservation of habitat, which can be measured through a monitoring program. In addition, increased awareness of tiny cryptanthe can be measured by feedback from landowners, comparing public awareness over time, measurable changes in management practices, and the number of agreements or other forms of protection established over time.

2.9 Additional Information Required

Knowledge gaps for tiny cryptanthe have been identified in section 2.3 Recovery Objectives, section 2.4 Research and Management Activities Recommended to Meet Objectives, and Table 2 and include:

1) standardized guidelines for inventory and monitoring of tiny cryptanthe;

2) full extent of population distribution and abundance;

3) population trends of tiny cryptanthe;

4) habitat preferences and critical habitat of tiny cryptanthe;

5) effect and extent of factors influencing tiny cryptanthe habitat (e.g., timing and intensity of grazing, idling, fire control, invasive species);

6) knowledge of the species' life cycle, including mechanisms of seed dispersal and dispersal distances, seed production per plant, seed germination rates and establishment success, germination requirements, seed viability and overwintering success, seed bank longevity, rates of seed germination loss, rates of seed predation and decomposition, importance of seed bank to long-term population viability, population genetics, and identification of pollinators; and

7) degree and effect of isolation from other populations.

2.10 Action Plan Timeline

The action plan(s) for tiny cryptanthe will be completed by January 2009. Action plans will be completed by jurisdictions with guidance from this recovery strategy and the Recovery Team. There is the potential for a multispecies or an ecosystem-based action plan that could benefit multiple species at risk inhabiting this ecosystem. Steps to achieve recovery as listed in the recovery objectives will be ongoing in the interim.

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