PROPOSED

Species at Risk Act
Recovery Strategy Series
Adopted under Section 44 of SARA

Amended Recovery Strategy for the Soapweed (*Yucca glauca*) and Yucca Moth (*Tegeticula yuccasella*) and Recovery Strategy for the Non-pollinating Yucca Moth (*Tegeticula corruptrix*) and Five-spotted Bogus Yucca Moth (*Prodoxus quinquepunctellus*) in Canada

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For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Soapweed -© Gord Court; Yucca Moth -© Olaf Pellmyr; Non-pollinating Yucca Moth – © Donna Hurlburt; Five-spotted Bogus Yucca Moth - © Gord Court

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[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

AMENDED RECOVERY STRATEGY FOR THE SOAPWEED (*YUCCA GLAUCA*) AND YUCCA MOTH (*TEGETICULA YUCCASELLA*) AND RECOVERY STRATEGY FOR THE NON-POLLINATING YUCCA MOTH (*TEGETICULA CORRUPTRIX*) AND FIVE-SPOTTED BOGUS YUCCA MOTH (*PRODOXUS QUINQUEPUNCTELLUS*) IN CANADA

2017

Under the Accord for the Protection of Species at Risk (1996), the federal, provincial, and territorial governments agreed to work together on legislation, programs, and policies to protect wildlife species at risk throughout Canada.

In the spirit of cooperation of the Accord, the Government of Alberta has given permission to the Government of Canada to adopt the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022* (Part 2) under Section 44 of the *Species at Risk Act* (SARA). Environment and Climate Change Canada has included a federal addition (Part 1) which completes the SARA requirements for this recovery strategy.

The federal recovery strategy for the Soapweed, Yucca Moth, the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth in Canada consists of two parts:

Part 1 – Federal Addition to the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022,* prepared by Environment and Climate Change Canada.

Part 2 – *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022*, prepared by the Alberta Environment and Sustainable Resource Development.

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Part 2 – *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022*, prepared by Alberta Environment and Sustainable Resource Development.

Part 1 – Federal Addition to the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022*, prepared by Environment and Climate Change Canada

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Soapweed, Yucca Moth, Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth and has prepared the federal component of this recovery strategy (Part 1), as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Province of Alberta and Agri and Agri-Food Canada, as per section 39(1) of SARA. SARA section 44 allows the Minister to adopt all or part of an existing plan for the species if it meets the requirements under SARA for content (sub-sections 41(1) or (2)). The Province of Alberta led the development of the attached recovery strategy for Soapweed and Yucca Moth species (Part 2) in cooperation with Environment and Climate Change Canada.

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 and Climate Change Canada, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of Soapweed, the Yucca Moth, the Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

[2] http://registrelep-sararegistry.gc.ca/default.asp?lang=en&n=6B319869-1#2

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

Acknowledgments

The federal component of this recovery strategy (Part 1) was written by Medea Curteanu (Environment and Climate Change Canada [ECCC]). An earlier draft was prepared by Julie Pearce (Pearce and Associates Ecological Research). Candace Neufeld (ECCC) provided extensive species information and guidance throughout the development of the document. Donna Hurlburt (Consultant), Dan Johnson (University of Lethbridge) and Cathy Linowski (Medicine Hat College) are acknowledged for providing species data and information. The Alberta Environment and Parks and Alberta Conservation Information Management System (ACIMS) provided updated element occurrences. The cover page photos were generously provided by Gord Court, Olaf Pellmyr, and Donna Hurlburt. Sandi Robertson and David Johns (Alberta Environment and Parks), Bill Houston (Agri and Agri-Food Canada), Greg Wilson, Mark Wayland, Victoria Snable, Kim Borg, Marie-Andree Carriere, and Paul Johanson (ECCC) have reviewed the document and provided valuable comments. Lynne Burns has provided extensive GIS assistance and created the critical habitat map.

Additions and Modifications to the Adopted Document

This recovery strategy replaces Environment Canada's (2011) *Recovery Strategy for the Soapweed (Yucca glauca) and Yucca Moth (*Tegeticula yuccasella*) in Canada* which was posted as final on the Species at Risk Public Registry on August 11, 2011.

It also includes information on two additional yucca moth species, the Non-pollinating Yucca Moth (*Tegeticula corruptrix*) and the Five-spotted Bogus Yucca Moth (*Prodoxus quinquepunctellus*), species that are currently not listed in the Province of Alberta but are federally listed as Endangered.

Under SARA, there are specific requirements and processes set out regarding the protection of critical habitat. Therefore, statements in the provincial recovery plan referring to protection of critical habitat may not directly correspond to federal requirements. Recovery measures dealing with the protection of habitat are adopted; however, whether these measures will result in protection of critical habitat under SARA will be assessed following publication of the final federal recovery strategy.

The following sections have been included to address specific requirements of the federal *Species at Risk Act* (SARA) that are not addressed in the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022* (Part 2 of this document, referred to henceforth as "the provincial recovery plan"), to provide updated or additional information, and to include information on two additional yucca moth species, the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth.

Certain sections of the provincial recovery plan are not adopted and these are:

- 4.5 – Effective Protection of Critical Habitat;
- 8.0 – Action Plan;
- 9.0 – Timetable for Implementation and Schedule of Costs; and
- 10.0 – Socio-economic Considerations.

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, recovery of Soapweed, Yucca Moth, Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth has been deemed technically and biologically feasible.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. Currently, there are two naturally occurring[4] Soapweed populations in Canada and the Yucca Moth, the Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth have been recorded reproducing at both sites. All three yucca moth species depend on the successful sexual reproduction (ie. fruit and seed production) of Soapweed and this is achieved only by the pollination of the Yucca Moth. Sexual reproduction in Soapweed has been confirmed at each naturally occurring Soapweed population, although it is not yet clear if the Yucca Moth population at the Pinhorn Grazing Reserve is viable given the low level of fruiting in 2011 (Hurlburt 2011), which would impact the viability of the other three species. Preliminary results from several management interventions indicate that the potential to increase Yucca Moth reproductive rates exists (Hurlburt 2011), which in turn could increase the recruitment of Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth. There are knowledge gaps concerning population size, structure, and dispersal abilities at each site.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Suitable Soapweed habitat is presently available at the Pinhorn Grazing Reserve and Onefour Research Ranch (previously known as Onefour Research Substation) in Alberta. Since Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth only occur at Soapweed locations, the distribution of Soapweed limits these species' distribution.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Yes. The most significant threats to Soapweed, and thus to Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth recovery include wild ungulate herbivory, particularly at the Pinhorn location, lack of disturbance, cattle grazing, and oil and gas development (COSEWIC 2013a). Limiting factors such as the obligate

[4] 'Naturally occurring' refers to any population within the native range on naturally occurring habitat. It excludes horticultural populations or those that are dispersed by humans and established outside the native range or on unnatural habitats such as gardens.

mutualistic relationship between Soapweed and Yucca Moth, insect herbivory and extreme weather events also play significant role in the recovery of these species (COSEWIC 2013a). Some of these threats can be mitigated through beneficial management practices, protection of species and their habitat, and cooperation with stakeholders. Population monitoring and research into the biology and ecology of Soapweed and all three species of yucca moths can inform management actions.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Yes. The main recovery techniques will be the reduction of ungulate herbivory on Soapweed through erecting exclosures and Yucca Moth translocations at the Pinhorn site, and the conservation of suitable habitat at both locations. These techniques are thought to be effective for Soapweed and yucca moths, allowing for the achievement of the population and distribution objectives.

1. COSEWIC* Species Assessment Information

For clarity, “Yucca Moth” (capitalized) refers to the pollinating *Tegeticula yuccasella* species, while “yucca moth” (lower case) refers to the three species or the family complex as a whole.

Date of Assessment: May 2013

Common Name (population): Soapweed

Scientific Name: *Yucca glauca*

COSEWIC Status: Threatened

Reason for Designation: This long-lived perennial is known from only three sites in southeastern Alberta and southwestern Saskatchewan, where it occurs mainly on south-facing coulee slopes. Plants are pollinated exclusively by Yucca Moth, which lays eggs in the flowers. In Canada, the species reproduces almost exclusively by vegetative spread. Seed production is limited by low numbers of Yucca Moth pollinators, while seedling establishment is negatively impacted by lack of natural disturbance, including fire suppression. Herbivory of flowering stalks by native ungulates also limits seed set. Despite improved management to limit the impact of threats, this perennial is designated Threatened. It is the only host for Yucca Moth, Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth, all of which were assessed as Endangered.

Canadian Occurrence: Alberta, Saskatchewan

COSEWIC Status History: Designated Special Concern in May 2002. Status re-examined and designated Threatened in May 2000 and May 2013.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

Date of Assessment: May 2013

Common Name (population): Yucca Moth

Scientific Name: *Tegeticula yuccasella*

COSEWIC Status: Endangered

Reason for Designation: Only two populations of the Yucca Moth are known from an extremely small and restricted area. This moth species has an obligate mutualistic relationship with Soapweed; Yucca Moth is the sole pollinator of Soapweed and its larvae depend on Soapweed seeds as a food source. One population may not be sustainable as it persists with human intervention that prevents severe herbivory of the flowers, fruits and stalks by wild ungulates. The Non-pollinating Yucca Moth larvae consume Soapweed seeds and compete with Yucca Moth for food. The loss of flowers or seeds as a result of ungulate herbivory is an ongoing threat, while in the long term Soapweed populations may be limited by the lack of fire and other disturbances that provide sites for the establishment of seedlings.

Canadian Occurrence: Alberta

COSEWIC Status History: Designated Endangered in April 2006. Status re-examined and confirmed in May 2013.

Date of Assessment: May 2013

Common Name (population): Non-pollinating Yucca Moth

Scientific Name: *Tegeticula corruptrix*

COSEWIC Status: Endangered

Reason for Designation: Only two populations of the Non-pollinating Yucca Moth are known from an extremely small and restricted area. One site has a small and fluctuating moth population, while only a single adult was observed from 1998-2011 at the other site. This moth species is an obligate seed parasite, the larvae feeding on Soapweed seeds. It relies on the mutualistic relationship between the Soapweed and its pollinator Yucca Moth, as fruit production is needed by larvae of the Non-pollinating Yucca Moth. The loss of flowers or seeds as a result of ungulate herbivory is an ongoing threat, while in the long term Soapweed populations may be limited by the lack of fire and other disturbances that provide sites for the establishment of seedlings.

Canadian Occurrence: Alberta

COSEWIC Status History: Designated Endangered in April 2006. Status re-examined and confirmed in May 2013.

Date of Assessment: May 2013

Common Name (population): Five-spotted Bogus Yucca Moth

Scientific Name: *Prodoxus quinquepunctellus*

COSEWIC Status: Endangered

Reason for Designation: The Five-spotted Bogus Yucca Moth is known from only two sites in Canada, one of which was discovered in 2011. This moth species is an obligate stem borer on the stalks of Soapweed. Larval survival is dependent on the mutualistic relationship between the Soapweed and its pollinator Yucca Moth. The flowers on non-pollinated Soapweed stalks whither faster than pollinated stalks, resulting in almost complete mortality of immature life stages of Five-spotted Bogus Yucca Moth. The loss of flowers or seeds as a result of ungulate herbivory is an ongoing threat, while in the long term Soapweed populations may be limited by the lack of fire and other disturbances that provide sites for the establishment of seedlings.

Canadian Occurrence: Alberta

COSEWIC Status History: Designated Endangered in April 2006. Status re-examined and confirmed in May 2013.

2. Species Status Information

Soapweed

Soapweed (*Yucca glauca*) has been listed as Threatened on Schedule 1 of Canada's *Species at Risk Act* (SARA) since June 2003. The species is listed as Endangered under Alberta's *Wildlife Act* but it has not been listed in Saskatchewan. The Saskatchewan Conservation Data Center (CDC) has recently ranked the single Saskatchewan Soapweed population as S1 (high extirpation risk; Saskatchewan Conservation Data Center 2015). This rank is based on the recent COSEWIC (2013b) assessment, which identified the population as self-sustaining (ie. it is reproducing), occupies similar habitat as the Alberta populations, and the location is within the conceivable natural range of this species (S. Vinge-Mazer pers. comm. 2016, see section 3.2 for further discussion).

The percentage of the global range in Canada for Soapweed is less than 1% (COSEWIC 2013b).

Soapweed is believed to be common throughout most of its North American range and is ranked as globally Secure (G5; NatureServe 2015). In the United States (US), the species is ranked as Secure (N5?; NatureServe 2015), but has not been assessed in most states (Table 1). In Canada and Alberta, Soapweed is ranked Critically Imperiled (N1 and S1 respectively; NatureServe 2015). All Soapweed plants in Saskatchewan are considered exotic thus a conservation status is not applicable at this time (SNA NatureServe 2015).

Yucca Moth Species

The Yucca Moth (*Tegeticula yuccasella*) has been listed as Endangered under SARA since 2005 while the Non-pollinating Yucca Moth (*Tegeticula corruptrix*) and the Five-spotted Bogus Yucca Moth (*Prodoxus quinquepunctellus*) have been listed as Endangered since 2007. The percentage of the global range in Canada for the three yucca moths is likely much less than 1%. All three yucca moth species are known to utilize several different species of the genus *Yucca* and as such have a much wider North American distribution than Soapweed (COSEWIC 2002, COSEWIC 2006 a,b).

In 2003, the Minister of Alberta's Environment and Sustainable Resource Development (AESRD) approved the listing of Soapweed and Yucca Moth as Endangered under Alberta's *Wildlife Act* based on recommendations from the Alberta Endangered Species Conservation Committee. Soapweed was listed as Endangered in November 2007; the Yucca Moth has not yet been listed. The Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth have not been assessed by the Alberta Endangered Species Conservation Committee and are not listed under Alberta's *Wildlife Act*.

Throughout their global range the three yucca moths are common in *Yucca* spp. populations and are Apparently Secure/Secure globally (G4G5; Table 1; NatureServe 2015). In US, the conservation status of Yucca Moth is unranked (NNR) while Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth do not have a national or state conservation status rank (NatureServe 2015). In Canada and Alberta, the Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Yucca Moth are ranked Critically Imperiled (N1,S1; NatureServe 2015).

Table 1. NatureServe[1] ranking for the Soapweed and three yucca moths species in North America (NatureServe 2015).

	Global (G) Rank	National (N) Rank	Subnational (S) Rank
Soapweed	G5	Canada (N1)	Alberta (S1), Saskatchewan (SNA)
		United States (N5?)	Arkansas (SNR), Colorado (SNR), Iowa (S3), Kansas (SNR), Missouri (S2), Montana (S4S5), Nebraska (SNR), New Mexico (SNR), North Dakota (SNR), Oklahoma (SNR), South Dakota (SNR), Texas (SNR), Wyoming (S4)
Yucca Moth	G4G5	Canada (N1)	Alberta (S1)
		United States (NNR)	
Non-pollinating Yucca Moth	G4G5	Canada (N1)	Alberta (S1)
Five-spotted Bogus Yucca Moth	G4G5	Canada (N1)	Alberta (S1)

[1] *The NatureServe conservation status ranks of a species is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). The numbers have the following meaning: 1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, and 5 = secure. Also, NR = unranked, NA = not applicable and ? = inexact/uncertain.*

3. Species Information

3.1 Species Description

Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth are small, nondescript, white or silvery, night-flying moths in the superfamily Incurvarioidea and family Prodoxidae, commonly known as the yucca moth family. Pellmyr (1999) examined the *Tegeticula* genus using morphological and molecular data and identified 12 species within the genus. In literature published prior to 2000 the term "*T. yuccasella"* is used to refer to all 12 species (*see* COSEWIC 2013a). Yucca Moth and Non-pollinating Yucca Moth are the only species of the *Tegeticula* genus found in Canada (COSEWIC 2013a). The Five-spotted Bogus Yucca Moth belongs to the genus *Prodoxus.* There are 10 species within the genus *Prodoxus* and the Five-spotted Bogus Yucca Moth is the only species of this genus found in Canada (COSEWIC 2013a). Members of the family Prodoxidae have only been found to be associated with plants of the genus *Yucca* and *Agave* (Davis 1967). In Canada, Soapweed is the single host plant species for all three yucca moths while Yucca Moth is the sole pollinator for Soapweed.

The obligate mutualistic[5] relationship between Soapweed and its pollinator the Yucca Moth is highly complex and thus cannot be described here in great detail (*see* Powell 1992, Dodd and Linhart 1994 for more information on these species' ecology). A general description for Soapweed and the Yucca Moth is presented in the provincial recovery plan (Part 2: Species Biology). Very little is known about the biology and ecology of Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth in Canada. Most of what is known about the biology and ecology of the Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth comes from studies undertaken in the US.

Non-pollinating Yucca Moth

Non-pollinating Yucca Moth adults have a wingspan of 22.5 to 35 mm with slender white upper wings and brown undersides (COSEWIC 2006a). The species may be distinguished from the other yucca moth species by its relatively larger size and absence of small black dots on its wings (Pellmyr 1999). Females can be further distinguished by the complete absence of maxillary tentacles[6], which are a prominent feature in female Yucca Moths (COSEWIC 2006a).

In Alberta, the species is univoltine (only one generation per year) and adults emerge from the soil in early July through September, generally after pollination of Soapweed has occurred (COSEWIC 2006a). Adults gather at night, mate in Soapweed flowers, stalks or leaves, and die after only a couple of days (Kerley et al. 1993; Marr et al. 2000). Females insert their eggs (oviposition) in the early-stage Soapweed flowers and do not engage in pollination as Yucca Moths do (Csotonyi and Hurlburt 2000, Hurlburt 2007). The eggs of the genus *Tegeticula* are club-shaped, translucent and 2 mm in length (COSEWIC 2002) and hatch within 7-10 days (COSEWIC 2006a). The larva is less than 1 mm at hatching and reaches 14 mm at maturity (COSEWIC 2013a). Non-pollinating Yucca Moth larvae feed on a proportion of the developing Soapweed seeds and thus compete with Yucca Moth larvae for food. Developing larvae may consume up to 40% of seeds (COSEWIC 2013a). However, the reproductive success of the species is highly dependent on successful pollination by the Yucca Moth and the ability of Soapweed to produce fruit. Five to six weeks after hatching, larvae chew their way out of the fruit leaving a distinct hole in the pod and lower themselves to the ground via a silken thread. Larvae burrow 5-20 cm into the soil, spin a cocoon of silk and sand particles and enter prepupal diapause (Fuller 1990). The diapause period is at least one year but may be extended, with anecdotal evidence indicating up to three years (COSEWIC 2013a); mortality rates may be high during extended diapause (Fuller 1990).

[5] Obligate mutualism refers to the interaction between two species where both species benefit from the association but in which at least one of the partners could perish in the absence of the other.
[6] Maxillary tentacles are specialized mouthparts present in female pollinating yucca moths. Their primary function is to purposely aid in the collection and transport of Soapweed pollen (Davis 1967).

Five-spotted Bogus Yucca Moth

Five-spotted Bogus Yucca Moth adults are the smallest of the three yucca moth species found in Canada with a wingspan of 11 to 21mm (Althoff et al. 2001, COSEWIC 2006b). The species can be differentiated from the other two yucca moths by its smaller size, lack of maxillary tentacles on females, and the presence of small black dots on the upper surface of the forewings (COSEWIC 2006b). The upper surface of the hindwings is light to medium gray (Althoff et al. 2001), always darker than the forewing and without the dark spots. The underside is medium brown with yellow where the wings overlap (Althoff et al. 2001). Both the forewings and hindwings have white wing fringes (Althoff et al. 2001). Males and females are identical in appearance, except females tend to be slightly larger than males (COSEWIC 2006b).

In Alberta the species is univoltine and adults fly for only a couple of days from early June to mid- July (COSEWIC 2006b). Adult Five-spotted Bogus Yucca Moths are often the earliest yucca moths to emerge but the flight period is similar to that of the Yucca Moth. Adults emerge from the Soapweed stalk about a week before Soapweed begins to flower and early in the season congregate on the leaves and then reside within Soapweed flowers as the season progresses. Adults mate within Soapweed flowers that open at night and females oviposit on the flowering stalk (Addicott et al. 1990, Pellmyr et al. 1996, James 1998). Females oviposit a single egg at a time 1-2 mm under the stalk surface (Davis 1967) and do not engage in pollination. A noticeable scar develops at each oviposition site which can be used to record species' presence at a location. The eggs are variable in shape, but are usually soft, white and elongated with rounded ends (COSEWIC 2006b). Eggs hatch within about nine days and larvae burrow deeper into the flowering stalk and begin to feed on stem tissue. The larvae lack legs and early instars are whitish but turn pale green as they mature (COSEWIC 2006b). It is important to note that larvae only survive in flowering stalks that support viable fruit, thus the reproductive success of the species is highly dependent on the successful pollination of the Yucca Moth and the ability of Soapweed to produce fruit. Approximately 30 days after hatching, larvae spin a cocoon and enter a state of prepupal diapause within the stalk. In the spring, pupation occurs over approximately one week, and adults emerge through holes in the stalk created during the pupal stage (Davis 1967). Most adults emerge within a year; however extended diapause may occur (Powell 2001).

3.2 Species Population and Distribution

Global Population and Distribution

The global distribution of Soapweed extends from southeastern Alberta south to northern Texas and from the Rocky Mountains east to the Mississippi River (Figure 1: COSEWIC 2013b). One hypothesis suggests that the extreme northern and southern limits of the range may represent naturalized populations that have escaped from cultivated stock (Davis 1967).

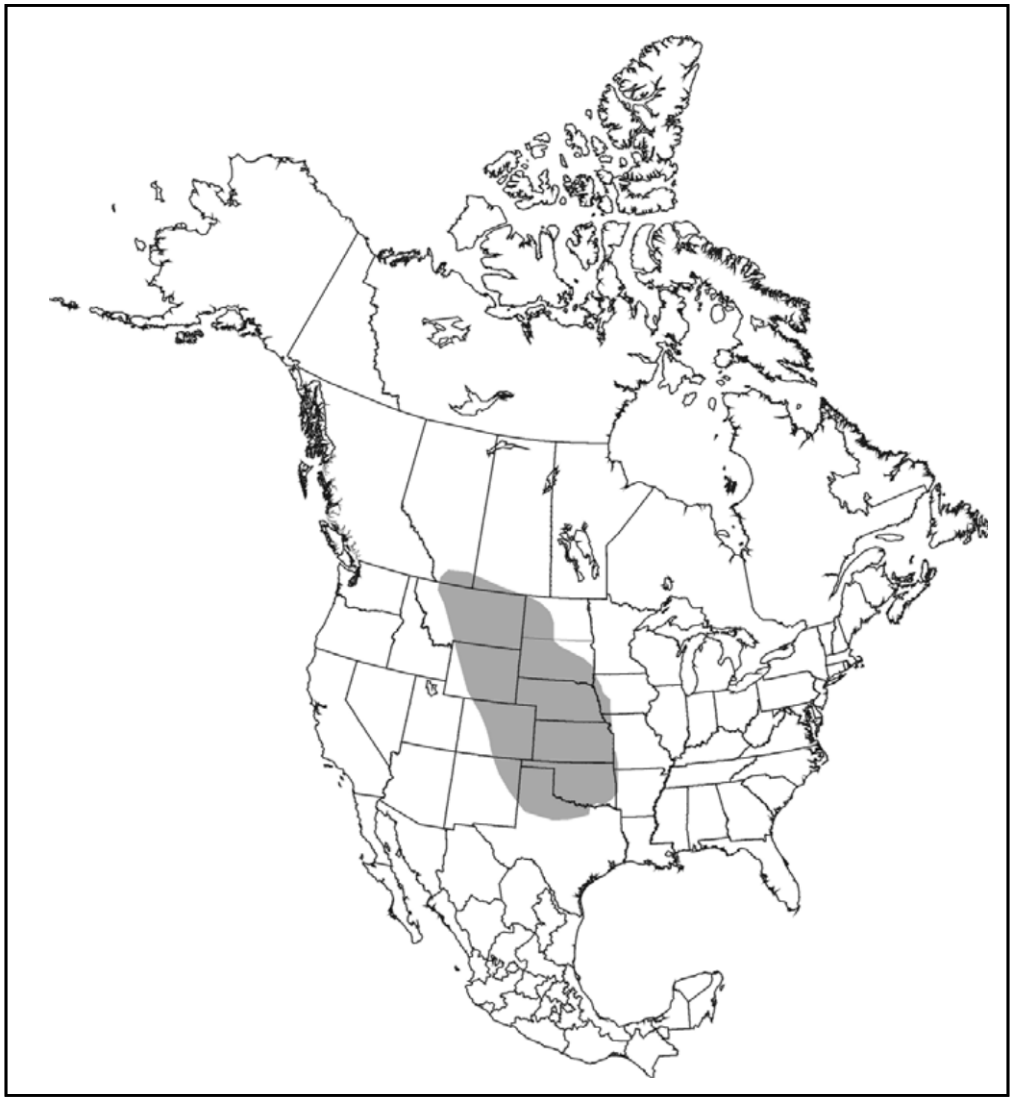

Figure 1. Distribution of naturally occurring Soapweed, *Yucca glauca*, in North America (Hurlburt 2001).

The global distribution of Yucca Moth extends from southeastern Alberta south to the southern tip of Texas and from the Great Plains east to Michigan and Connecticut (COSEWIC 2002). Because Yucca Moth utilizes several *Yucca* species as a host plant, its distribution is much greater than that of Soapweed (Figure 2; COSEWIC 2002).

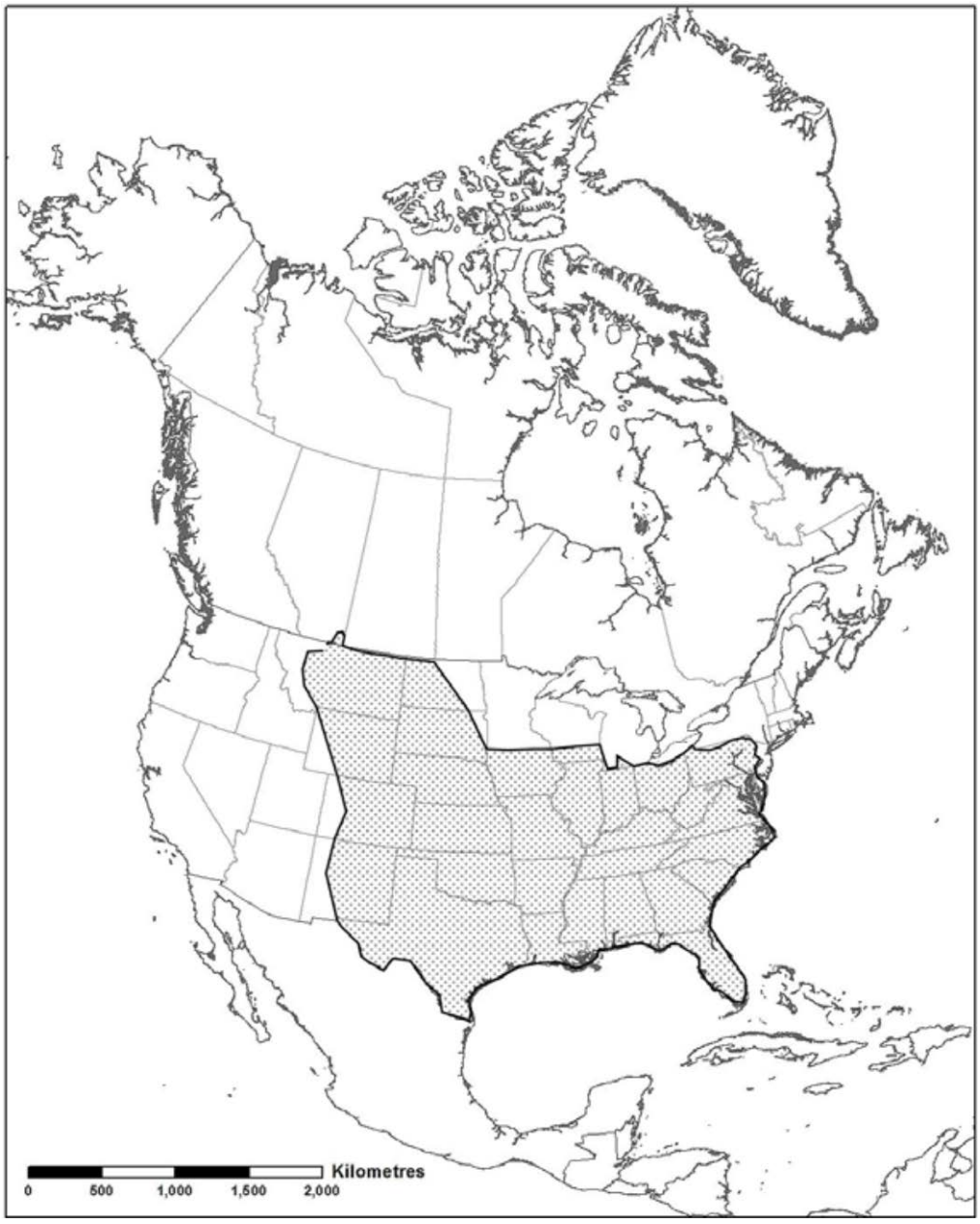

Figure 2. Distribution of the Yucca Moth, *Tegeticula yuccasella*, in North America (COSEWIC 2013a).

The global distribution of Non-pollinating Yucca Moth extends from southeastern Alberta to northern Mexico and from California east to Nebraska (Figure 3; COSEWIC 2006a). Since the species has only been known since 1999 (Pellmyr 1999), the exact distribution in US is not considered complete (COSEWIC 2013a).

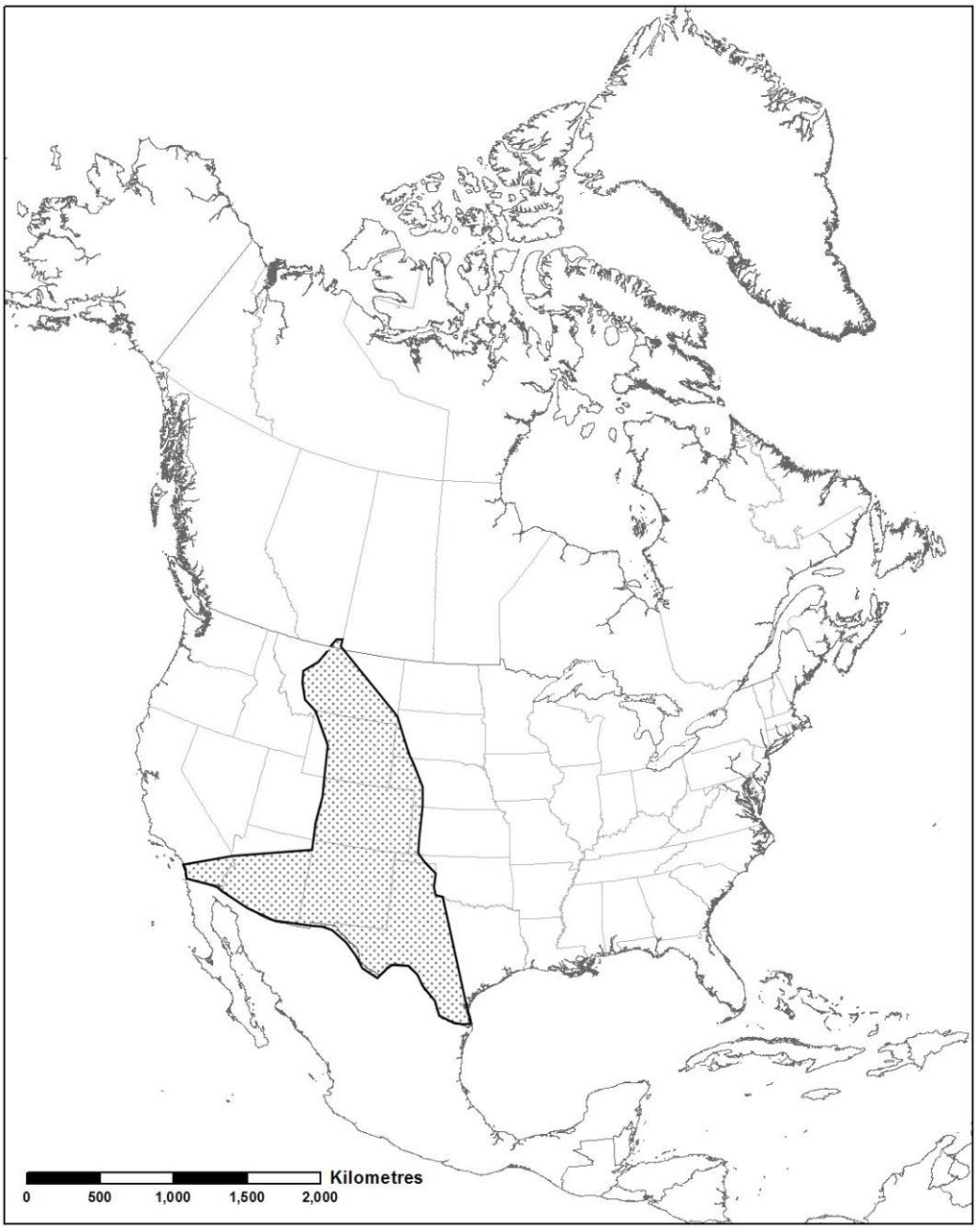

Figure 3. Distribution of the Non-pollinating Yucca Moth, *Tegeticula corruptrix,* in North America (COSEWIC 2013a).

Five-spotted Bogus Yucca Moth is widespread in North America. Its range extends from southeastern Alberta to northwestern Mexico and southern Texas, and from the Great Plains of US east to the Atlantic coast (Figure 4; COSEWIC 2006b). The species is the most geographically widespread species of the yucca moths, being associated with 15 *Yucca* species.

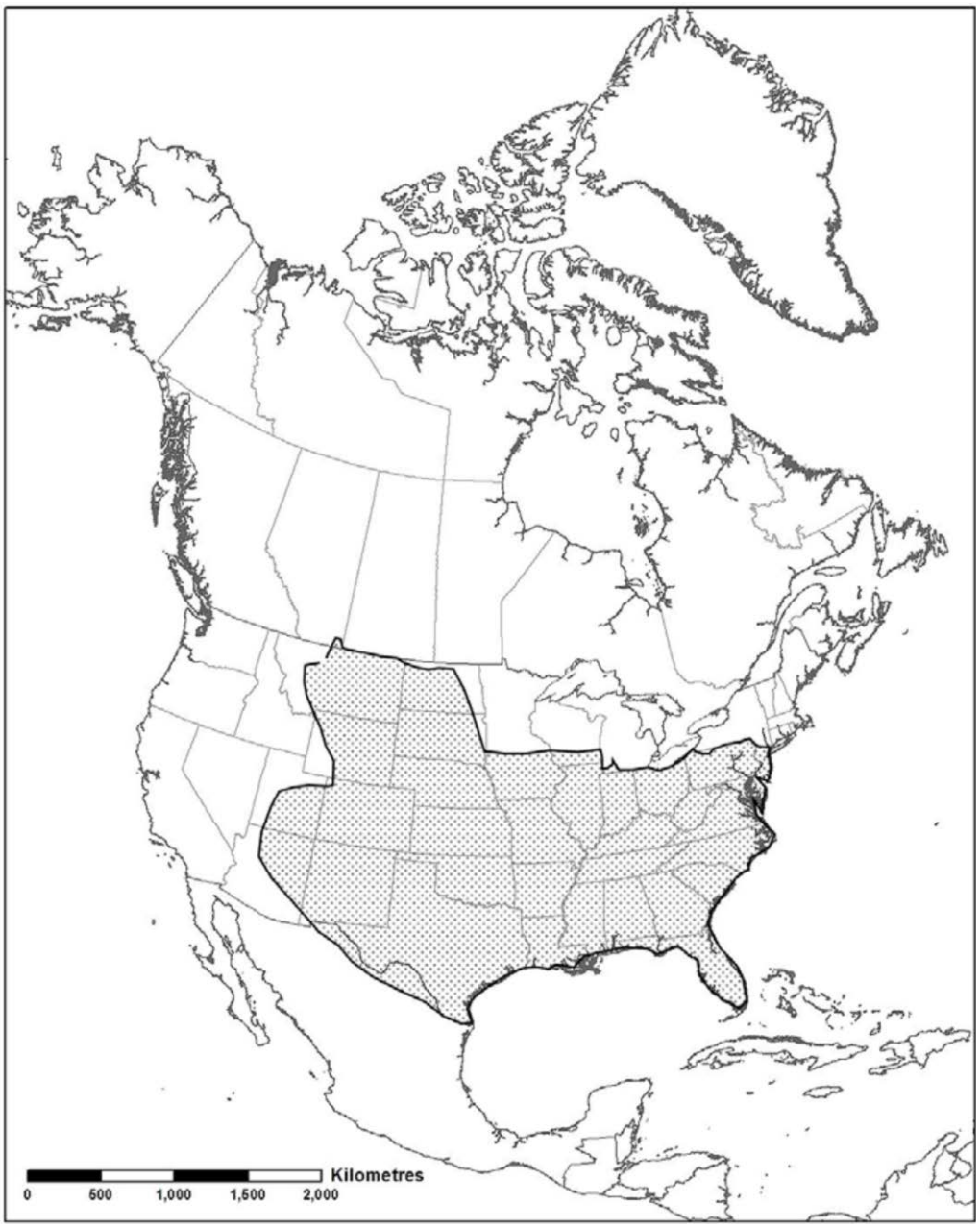

Figure 4. Distribution of the Five-spotted Bogus Yucca Moth, *Prodoxus quinquepunctellus,* in North America (COSEWIC 2013a).

Canadian Distribution

There are two naturally occurring Soapweed populations in Canada, and the Yucca Moth, the Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth have been reported from each location (COSEWIC 2013a, Hurlburt 2011). One Soapweed population is found at Onefour Research Ranch along the Lost River, Alberta, and the second population is found at Pinhorn Grazing Reserve near Manyberries, Alberta (Part 2: Figure1; Hurlburt 2001, Foreman et al. 2006). These populations are separated by approximately 15 km (AESRD 2013). The Soapweed and Yucca Moth populations at Onefour and Pinhorn sites are described in the provincial recovery plan (Part 2: Species Biology).

The closest native US Soapweed, and likely also the yucca moth population, is located approximately 100 km south of the Onefour location; natural immigration of Soapweed plants from Montana is unlikely to occur (COSEWIC 2013b).

Throughout southern Saskatchewan and Alberta, numerous Soapweed plants also occur in horticultural settings, presumably originating as transplants from garden centres or from native populations. Evidence of fruit and seed production at several locations (e.g., Lethbridge valley, Medicine Hat, Magrath, Etzikom Museum) suggests that Yucca Moths are also present (Alberta Soapweed and Yucca Moth [ASYM] Recovery Team 2006, D. Johnson pers. comm. 2016), as the Yucca Moth is the sole pollinator of Soapweed (Marr et al. 2000). It is possible that some moths were transported as larvae or pupa within the soil when the Soapweed was transplanted to the new area (Hurlburt 2004); this would account for some short-term persistence of Yucca Moths at these locations as well as some limited reproduction and dispersal (D. Henderson pers. comm. 2008). In laboratory settings, a closely related yucca moth species, *Prodoxus y-inversus,* has been reported to remain in extended diapause in the soil for up to 30 years (Powell 2001).

Another explanation for the newly observed Soapweed fruit production is that the moths are dispersing from other occupied locations and expanding their range. No studies have examined yucca moth dispersal distance potential. In general, *Prodoxidae* moths live as adults for only a few days, are poor flyers, and thus have been assumed to be unable to travel great distances (Kerley et al. 1993, Marr et al. 2000, Hurlburt 2001). However, Dan Johnson at University of Lethbridge has examined Soapweed fruit production in horticultural settings for five years and concluded that Yucca Moth is capable of dispersal over miles, especially on wind fronts (D. Johnson pers. comm. 2016). Further research into Yucca Moth dispersal potential, persistence in horticultural settings, and the uncoupling of interactions among Soapweed and all three yucca moth species is required. Regardless of the fact that Soapweed plants in horticultural settings are sexually reproducing and the mode by which Yucca Moths are found in horticultural setting, this recovery strategy plan will not address Soapweed and yucca moth populations that occur in horticultural settings.

The recent Soapweed COSEWIC status report includes an introduced Soapweed population found at Rockglen, Saskatchewan, as part of the total Canadian population, which was considered in the overall species status assessment (COSEWIC 2013b). The addition of this third population is based on COSEWIC's guidelines on manipulated populations (COSEWIC 2010), which indicate that individuals of a wildlife species can be included as part of the status assessment if they were accidently or intentionally introduced, they are self-sustaining, and occur in a natural setting within the natural range of the species. The Rockglen population was found in 2000 (D. Henderson pers. comm. 2008); visits and consultations with local landowners have indicated that this population was introduced from Montana 15-20 years ago by a relative of the family that once owned the land where the plants currently exist (T. Sample pers. comm. 2009). Although an anecdotal observation of enlarged pedicels[7] was made in 2003 that might suggest that Yucca Moths are present at the location (ASYM Recovery Team 2006), the Rockglen population consist of only 6 Soapweed clones[8] and does not contain a self-sustaining Yucca Moth population (COSEWIC 2013b). Sexual reproduction, which introduces variation within a population, is crucial for the long term survival of plants, especially in a changing environment. Lack of sexual reproduction within Soapweed populations may impact the long-term survival of the species and as such factors that impact sexual reproduction should be considered (COSEWIC 2013a). Thus, in the absence of a self-sustaining Yucca Moth population that would allow for sexual reproduction, the Soapweed population at the Rockglen location is only reproducing vegetatively and thus it is not considered self-sustaining at this time. Furthermore, based on the COSEWIC guidelines, status assessments must clearly identify if the introduced population is part of the wildlife species (ie. Designable Unit) being considered for assessment. Thus, until genetic studies indicate that the Soapweed population at the Rockglen location is genetically similar to the native populations found in Alberta, this population is considered by Environment and Climate Change Canada (ECCC) as being introduced, not self-sustaining, and thus not part of the total Canadian population.

Several Five-spotted Bogus Yucca Moths have been collected in southern Ontario in the 1930s and 1950s and these are believed to have originated from cultivated Soapweed plants (COSEWIC 2013a). Currently, there are no positive records of Non-pollinating Yucca Moth or the Five-spotted Bogus Yucca Moth using Soapweed in horticultural settings in Alberta although several yucca moth larvae have observed at a few locations (COSEWIC 2013a, D. Johnson pers. comm. 2016). The presence of these yucca moths in horticultural settings cannot be ruled out since only live adults or DNA analysis from larval tissues would prove that these two species do occur in horticultural settings (D. Johnson pers. comm. 2016).

[7] Enlarged pedicels indicate that an individual flower was pollinated by a moth and had initiated a degree of fruit development prior to abscission (Hurlburt 2011).
[8] A clone refers to a group of plants originating by vegetative propagation from a single parent.

As more information becomes available, the status of Soapweed and its three associated yucca moths in horticultural settings and at the Rockglen location will be reassessed by ECCC as needed.

Soapweed Canadian Population

Population data on Soapweed (Table 2) has been collected since 1976 using various sampling methods, indices, search efforts, and timing periods (see COSEWIC 2013a for descriptions); as such, the results of these studies cannot be effectively compared to estimate an accurate Canadian population size at this time.

Table 2. Summary of Soapweed population surveys conducted at Pinhorn Grazing Reserve and Onefour Research Ranch, Alberta[1].

	Pinhorn			**Onefour**			**Reference**
Year	**Clones**[2]	**Rosettes**[3]	**% Fruit in rosettes**	**Clones**	**Rosettes**	**% Fruit in rosettes**	
1976	450	-		>55,000	-		Milner 1977
1998	423[4]	1,383	0	8,499	28,174	0.001	Csotonyi and Hurlburt 2000
2004	1,366	3,510	0.001				Foreman et al. 2006
2006[5]				45,560-71,540	153,980-246,690	21	Bradley et al. 2006
2011			10.08			0.004	Hurlburt 2011

[1] This is the best information available to Environment and Climate Change Canada (up to August 2016)
[2] A clone refers to a group of plants, or rosettes, originating by vegetative propagation from a single parent.
[3] A rosette (also referred to as a ramet) indicates the circular arrangement of leaves that make up a single plant that produces a single inflorescence.
[4]This number represents an addition of 19 clones which were found during the 2004 surveys and represents the actual population estimate for that location (COSEWIC 2013a).
[5] Increased number of the 2006 survey from the 1998 survey is attributed to the different survey method used (ie. methods used to identify clones) and the time of year of the study rather than an increase in population size. Estimates from the 1976 and 2006 are roughly comparable

Yucca Moths Canadian Population

Population surveys for Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moths are limited and these have been carried out at various times of the year and using various techniques and indices that cannot be currently compared to estimate population size or trends (COSEWIC 2013a). For example, oviposition scars in the carpel walls of the Soapweed fruit has been used as an index to determine Non-pollinating Yucca Moth seasonal activity (see COSEWIC 2006 for vital rate), however this is not a direct estimate of abundance. Recruitment of new moths (ie. larvae per fruit) has been also used as an additional index, but this requires fruit dissection which is destructive to the Soapweed plant, as well as Yucca Moth and Non-pollinating Yucca Moth larvae that might be present in the fruit (COSEWIC 2006).

At the Pinhorn location students from Medicine Hat College Environmental Reclamation program, in partnership with volunteers from the Alberta Native Plant Council, have surveyed portions of the Soapweed population from 2009 to 2015, but these visits occur in fall when yucca moth adults are no longer present in the area (C. Linowski pers. comm. 2016). Although data on the number of moth emergence holes per fruit has been collected at this site, this index cannot be used to clearly separate the density of Yucca Moths vs. Non-pollinating Yucca Moth since the larvae of both species develop in the fruit and the exit holes cannot be differentiated.

Onefour Research Ranch

Non-pollinating Yucca Moth at the Onefour site has been surveyed between 1998 and 2007 by examining Soapweed fruit. The number of oviposition scars per fruit has varied substantially annually, ranging from a low of 0.071 in 2007 to a high of 13.939 ± 0.875 (mean ± SE) in 2002 (Hurlburt 2007). Larvae per fruit ranged from 3.636 ± 0.254 in 2002 to 0.033 ± 0.033 in 2003. These values are comparable to those found in the closest Montana population (*see* COSEWIC 2013a for vital rates).

The number of Five-spotted Bogus Yucca Moths adults present in flowers at the Onefour site was counted in 2002, 2007 and 2011 (COSEWIC 2013a). Density per flower was 0.310 ± 0.023 in 2002, 1.086 in 2007 and 0.500 in 2011 (only 6 flowers examined in 2011). In 2003, the number of ovipositions per inflorescence (flowering stalk) and the number of larvae per inflorescence was determined for 16 clones. There were 652.9 ± 130.4 ovipositions per stalk and 27.4 ± 8.2 larvae per stalk. These values were comparable to those observed in Montana (COSEWIC 2013a).

Pinhorn

At the Pinhorn site, Soapweed fruit production had not been observed since 1997, thus the Yucca Moth population was considered extremely low or possibly extirpated (COSEWIC 2002). In the absence of Soapweed sexual reproduction, viable populations of all three yucca moths could not persist. In 2004, a comprehensive inventory of the Soapweed population was conducted and evidence of Yucca Moth reproduction was observed (Foreman et al. 2006). In 2007, effective habitat management interventions, by means of fencing off three sections of the Soapweed population to reduce wild ungulate (ie. Pronghorn [*Antilocapra Americana*] and Mule Deer [*Odocoileus hemionus*]) herbivory, resulted in approximately 10 Soapweed plants producing fruit the following year (J. Nicholson pers. comm. 2009) indicating that the Yucca Moths were still present and reproducing at the site. In 2008, a single Soapweed stalk containing 14 unripe fruit was collected from the Etzikom Windmill Museum garden and translocated to the Pinhorn location (AESRD 2013). Surveys conducted in 2011 indicated that 70 Soapweed plants found within the exclosures produced fruit (40.63 % of clones and 10.08 % of the rosettes); only one additional fruit was located outside the exclosures (Hurlburt 2011). Although these recent fruit production observations indicate that the Yucca Moth population is slowly recovering at the Pinhorn location, it is not yet clear if

these reproductive rates indicate a viable Yucca Moth population (D. Hurlburt pers. comm. 2009, AESRD 2013).

Much less is known about the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth populations at Pinhorn. In August 1998 a single live adult Non-pollinating Yucca Moth was captured in flight (Csotonyi and Hurlburt 2000), and in 2000, several cocoons with larvae in prepupal diapause were sifted from the soil (COSEWIC 2013a). No adults were observed in 2011, however the survey was conducted during a time when direct observations were unlikely (Hurlburt 2011). Although there have been no observations of the Non-pollinating Yucca Moth at Pinhorn since 2000, it does not indicate that the species is not present at the location. Timing of the survey is one reason for lack of observations, as visits to the location generally occur in late September or early October when Soapweed plants have set fruit and live adults are no longer present (C. Linowski pers. comm. 2016).

The Five-spotted Bogus Yucca Moth was first confirmed from the Pinhorn location in August 2011 by examining oviposition scars on flower stalks from Soapweed plants located within exclosures (Hurlburt 2011, COSEWIC 2013a). No adults were observed, however surveys were conducted during a time when direct observations were unlikely (Hurlburt 2011). Although the oviposition rate (50.78%) was significantly lower than that recorded at the Onefour location (>92 %), this observation illustrates that the species is present, and if Soapweed plants are protected from herbivory, the species can reproduce successfully. Five-spotted Bogus Yucca Moth population at Pinhorn is still considered low due to the lack of fruit production (and inflorescences in which to lay eggs) as a result of herbivory for many generations (COSEWIC 2013a) and is unknown if these reproductive rates indicate a viable Five-spotted Bogus Yucca Moth population.

Soapweed and Yucca Moths Trends

It was believed that since the first systematic population survey completed in 1976 the Soapweed population, and thus its associated yucca moths, at the Onefour Research Ranch has expanded from the coulee slopes onto the upland prairie (Hurlburt 2001). However, further investigation indicated that there is no evidence of new Soapweed seedlings within the upland prairie and a recent flowering event between 1999-2003 places the plants at about of age 20-25 years, the age when flowering first occurs (Hurlburt 2007, COSEWIC 2013b). It is speculated that a prairie fire that occurred in the area in the late 1970s might have created favourable seed germination conditions for seedling establishment (Hurlburt 2007).

The Pinhorn Soapweed population is spreading both vegetatively and sexually on the west facing coulee slopes especially in eroded areas where seedlings can become established (C. Linowski pers. comm. 2016). Furthermore, within the exclosures a steady positive trend in fruit production and moth emergence holes has been recorded (Hurlburt 2011, C. Linowski pers. comm. 2016).

3.3 Needs of Soapweed and the Three Yucca Moths

Soapweed, and thus the three associated yucca moth species, inhabit a variety of habitats throughout their North American range. The habitat needs of Soapweed and Yucca Moth are discussed in the provincial recovery plan (Part 2: Habitat Requirements). Habitat needs of the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth are less well known but assumed to be similar to that of the Yucca Moth with a few exceptions.

A crucial element in the survival of both the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth is the survival and sexual reproduction of its host plant, Soapweed. The Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth have an obligate parasitic relationship with Soapweed. Soapweed provides oviposition sites for adults of all yucca moth species, seeds as food for developing Non-pollinating Yucca Moth larvae, inflorescence stem tissue as food for developing Five-spotted Bogus Yucca Moth larvae, and inflorescence stems as shelter during prepupal diapause for the Five-spotted Bogus Yucca Moth.

Soapweed with fruit are often inhabited by aphids, which are tended by several species of ants. While ants can inflict damage on Soapweed by chewing on Soapweed buds, ants are less likely to damage Soapweed when aphids are present (Perry 2001, Perry et al. 2004; Snell and Addicott 2008b). In Alberta, Soapweed inhabited by ants experienced a 60% increase in the number of viable seeds produced per fruit, because ants reduced ovipositing by Non-pollinating Yucca Moths (Snell and Addicott 2008b). Therefore, the presence of ants can decrease Non-Pollinating Yucca Moths, but may increase the number of Yucca Moths as they will have less competition for food.

The survival of Five-spotted Bogus Yucca Moth larvae is dependent upon the presence of Yucca Moth to pollinate Soapweed flowers in order to successfully reproduce and produce fruit. The species may also benefit from the presence of aphids feeding on the sap associated with the stalk. Five-spotted Bogus Yucca Moth larvae only survive while the Soapweed stalk is green, although their eggs may be spread throughout the stem. Soapweed stalks, however, only remain ‘green’ up to the highest position of fruit along the stalk, unless aphids are present which allows the stalks to remain green for longer (Snell and Addicott 2008a). Aphids may therefore enhance the survival of Five-spotted Bogus Yucca Moth larvae. The flowers on non-pollinated Soapweed stalks wither faster than pollinated stalks, resulting in almost complete mortality of immature life stages of Five-spotted Bogus Yucca Moth (COSEWIC 2013a).

4. Threats

4.1 Description of Threats

Threats to Soapweed and the Yucca Moth are discussed in the provincial recovery plan (Part 2: Threats and Limiting Factors) and these are believed to be similar to those faced by the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth with a few clarifications. Horticultural and medicinal uses (Threat 3.2) and off-road vehicle use (Threat 3.3) were identified in the provincial recovery plan as threats, particularly at the Onefour location; however these threats have been mitigated and have not been a concern for more than 10 years, thus they are currently not considered a threat to these species (COSEWIC 2013 a,b).

In addition to the threats listed in the provincial recovery plan, lack of disturbance has been identified as a threat to Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth populations in Canada (COSEWIC 2013a,b). Natural disturbances, such as climatic, pyric (fire), and biotic disturbances, have played an important role in the maintenance, diversity, and productivity of North America's mixed-grass prairie ecosystem. These disturbances maintain open habitat and prevent establishment of competitive grasses or woody vegetation. In Alberta, Soapweed is associated with sandy loam soils, protected and sparsely vegetated south-facing coulee slopes that are influenced by some level of disturbance (COSEWIC 2013 a). The level of tolerance of Soapweed to fire in terms of frequency, intensity, and timing is unknown however laboratory trials indicate that Soapweed seeds are not fire-dependent, and high heat intensity for only 5 minutes can reduce germination (Keeley and Meyers 1985). Since Soapweed seedlings are poor competitors, it is possible that fire plays an important role in creating suitable habitat rather than stimulating germination (COSEWIC 2013b).

Furthermore, the continual survival and recovery of the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth strongly depends on the survival, abundance, and continual pollination of the Soapweed by the Yucca Moth. This is because the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth have an obligate relationship with Soapweed such that neither species can reproduce without sexual reproduction in Soapweed. This dependency is exacerbated by the fact that Soapweed and Yucca Moth populations in Canada are small, have a small area of occupancy, and are isolated.

At Pinhorn, high wild ungulate herbivory rates and reproductive failure of Soapweed continue to occur outside the enclosed fenced areas (Hurlburt 2011) and this remains a key threat at this location (AESRD2013). In addition, invasion by Japanese Brome (*Bromus arvensis*) and Downy Brome (*Bromus tectorum*) which are spreading from oil and gas access roads has been identified as an additional potential future threat at this location (C. Linowski pers. comm. 2016).

5. Population and Distribution Objectives

The provincial recovery plan contains the following recovery goal for Soapweed and Yucca Moth (Part 2: Recovery Goal):

- The long-term goal of the recovery plan is to maintain the existing habitat and distribution of Soapweed and Yucca Moths in Alberta and to enhance the Yucca Moth population at the Pinhorn site. This will require the maintenance of naturally, self-sustaining populations of Soapweed and Yucca Moth at the Onefour site and an increase in the reproductive capacity at the Pinhorn site.

Under SARA, population and distribution objectives must be established for endangered or threatened species. Consistent with the recovery goal set out in the provincial recovery plan, Environment and Climate Change Canada establishes the following short and long term population and distribution objectives for Soapweed and Yucca Moth, and also includes the addition of two species, the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth:

- In the short term (5 years): at the Pinhorn location increase Soapweed and Yucca Moth reproductive capacity[9]; and
- In the long term (>10 years): maintain the current distribution of all four species at the two naturally occurring locations, Pinhorn and Onefour, as well as at any additional naturally occurring populations discovered in the future.

At this time, it is not feasible to establish more quantitative population objectives for any of the four species. Soapweed population size estimates over the years have been inconsistent due to survey techniques, making it difficult to apply differences in size estimates to actual changes in population abundance. Very few population surveys have been completed for the three yucca moths, and these estimates cannot be compared at this time. In Canada, all four species exist at the northern fringe of their global range, and likely have always been limited by the restricted availability of suitable habitat and climate. Thus, it can be concluded that a species that was never historically widespread in Canada is unlikely to become widespread in the future and will probably always have a limited distribution and area of occupancy in Canada.

Regarding the Rockglen Soapweed population, unless genetic studies indicate that this population is genetically similar to the native populations found in Alberta, this population is considered by ECCC as being introduced, not self-sustaining, and thus not necessary for achieving the survival and recovery of the Canadian Soapweed population.

[9] Reproductive capacity for Soapweed refers to the number of flowers and fruit produced in a given year. Reproductive capacity for Yucca Moth refers to an increase in individuals. Fruit emergence holes and Soapweed fruit production has been used as an index of Yucca Moth abundance.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

The provincial recovery plan outlines actions already completed or currently underway for Soapweed and the Yucca Moth (Part 2: Recent Recovery and Conservation Efforts). Additional actions completed or underway for the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth include:

- Soapweed plants at the Onefour site were monitored to estimate Non-pollinating Yucca Moth abundance from 1999 to 2003 (Hurlburt 2004).
- In 2002 - 2003, Soapweed plants at the Onefour site were monitored for the presence of Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth (Snell 2004; Snell and Addicott 2008 a,b).
- Yucca Moth, Non-pollinating Yucca Moths and Five-spotted Bogus Yucca moths were counted at the Onefour site during a week-long visit in 2007 (Hurlburt 2007).
- An inventory of the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth population was undertaken at the Pinhorn site in 2004 to determine the size of the population and level of larval emergence (Foreman et al. 2006);
- Completion of an inventory of the Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth populations at the Onefour and Pinhorn sites by an independent biological consultant in 2011 for the updated COSEWIC status report for both species (see Hurlburt 2011, COSEWIC 2013a).
- Additional exclosures at the Pinhorn site to protect Soapweed plants form wild ungulate herbivory will be installed in spring 2017 (S. Robertson pers. comm. 2016).

6.2 Narrative to Support the Recovery Planning Table

The provincial recovery plan identifies recovery strategies for Soapweed and Yucca Moth (Part 2: Recovery Strategies). These strategies are also appropriate and sufficient to support recovery of the Non-pollinating Yucca Moth and the Five-spotted Bogus Yucca Moth in Canada, due to their obligate relationship with Soapweed in Canada, and as such are adopted as ECCC broad strategies.

7. Critical Habitat

This section replaces section 4: “Critical Habitat” in the provincial recovery plan.

Section 41(1)(c) of SARA requires that recovery strategies include an identification of the species’ critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under section 2(1) of SARA, critical habitat is “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”.

Yucca Moth, the Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth have an obligate relationship with the host plant, Soapweed, and the moths do not occur outside the distribution of Soapweed. Given this, the critical habitat for the three yucca moth species is considered the same as the critical habitat identified for Soapweed.

Critical habitat for Soapweed and Yucca Moth was first described in *Alberta’s 2006 Soapweed and Yucca Moth Recovery Plan* (ASYMRT 2006) and re-adopted in the updated 2013 provincial recovery plan (Part 2: Critical Habitat). Critical habitat was identified as the area occupied by the two known naturally occurring Soapweed populations as of 2006 boundaries. The total area identified in the provincial recovery plan consisted of 1.8 km² (182 ha) at Onefour and 0.02 km² (2.65 ha) at Pinhorn (Part 2: Figure 2 and 3). However, since several plants on the upland were undocumented during the 2006 survey this critical habitat identification was considered incomplete and necessitated revision (Hurlburt 2007).

7.1 Identification of the Species’ Critical Habitat

Critical habitat is fully identified in this recovery strategy and encompasses all naturally occurring Soapweed populations[10] known to exist in Canada. Critical habitat is identified at two locations (Onefour Research Ranch and Pinhorn Grazing Reserve) and is

[10] Soapweed population data known to Environment and Climate Change Canada as of August 2016.

considered sufficient to achieve the population and distributions objectives at this time. Data collected during field surveys conducted in 2004, 2006, and 2007, and occurrence[11] information obtained from Alberta Environment and Parks and Alberta Conservation Information Management System were used to identify critical habitat (Foreman et al. 2006, Bradley et al. 2006, D. Hurlburt unpubl. data).

Critical habitat identification is amended in this recovery strategy for two reasons. First, since 2006 when Soapweed and Yucca Moth critical habitat was first described in the Alberta provincial recovery plan, several Soapweed plants have been found outside the boundaries designated as critical habitat at the Onefour location (Hurlburt 2007). These mature plants, which were missed during the original inventory rather than being new recruits (Hurlburt 2007) were not included in the updated provincial recovery plan (Part 2: Critical Habitat). Secondly, the approach used to identify Soapweed critical habitat was inconsistent with the approach used for the identification of other prairie plant species at risk (e.g., Tiny Cryptantha *Cryptantha minima*, Small-flowered Sand-verbena *Tripterocalyx micranthus*). As such, identification of critical habitat for Soapweed is based on best available information and follows the decision tree developed by the Recovery Team for Plants at Risk in the Prairie Provinces as guidance for identifying critical habitat for all terrestrial and aquatic prairie plant species at risk (Appendix A). This approach fulfills the reproductive, dispersal, range expansion, and long-term persistence requirements of the Soapweed and yucca moth populations in Canada.

The decision tree first requires consideration of the quality of available information on Soapweed occurrences in Canada, with the choice of accepting or rejecting any given occurrence for consideration as critical habitat based on three criteria that were used to define the quality of information (Appendix A). The three criteria relate to the number of years since the last known occurrence was relocated and/or revisited, the precision and accuracy of the geographic referencing systems used to locate the occurrence and an evaluation of whether the habitat, in its current condition, remains capable of supporting the species. If the result of this first decision is that a given occurrence is not accepted for consideration, then the location of the postulated occurrence is excluded from consideration as critical habitat at this time. However, it may be considered in future identification of critical habitat, depending on the outcome of future surveys.

The second decision is based on how well the habitat requirements of the plant are defined. Soapweed habitat is restricted to coulees and semi-arid grasslands on coarse-textured soils. These areas are influenced by some level of disturbance and are poorly defined in space. Thus, identification of critical habitat for Soapweed is occurrence-based rather than habitat-based (Appendix A). Based on Criteria 2a (Appendix A), critical habitat is identified as the Soapweed occurrence and an addition of 300 m as a critical function zone extending from each plant occurrence.

[11] Occurrence refers to an individual Soapweed plant as recorded in the field

Although the exact extent of habitat required by Soapweed to fulfill the reproductive, dispersal, and long-term survival needs is not fully known, the 300 m critical function zone is based upon a detailed literature review that examined edge-effects of various land use activities that could affect resource availability and contribute to negative population growth for native prairie plants (Environment Canada 2012, Appendix D). Thus, to ensure the long-term persistence, and where feasible, the natural expansion of Soapweed in Alberta, the 300 m critical function zone is thought to be the minimum distance needed to maintain the habitat required to meet the population and distribution objectives. As new information on species' habitat requirements and site-specific characteristics become available, this distance may be refined.

In this recovery strategy, critical habitat is fully identified for the two naturally occurring Soapweed populations in Alberta and the three associated yucca moth species; the Yucca Moth, the Non-pollinating Yucca Moth, and the Five-spotted Bogus Yucca Moth. Critical habitat was identified to include all of the area where Soapweed occurs plus a 300 m critical functional zone around each occurrence. Critical habitat totals 4.12 km² (412 ha) and is found within Pinhorn Grazing Reserve (0.56 km²) and Onefour Research Ranch (3.56 km²)(Figure 5; Appendix C).

Occurrence data for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth is considered sensitive due to the potential risks of human disturbance and collection of Soapweed for horticultural and medicinal uses (Part 2 Threats and Limiting Factors). Critical habitat identified for the these four species is therefore presented using 10 X 10 km UTM grid squares to indicate the general geographic areas containing the actual critical habitat polygons in order to minimize risks to these species. More detailed information, such as a critical habitat map, may be requested by contacting Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

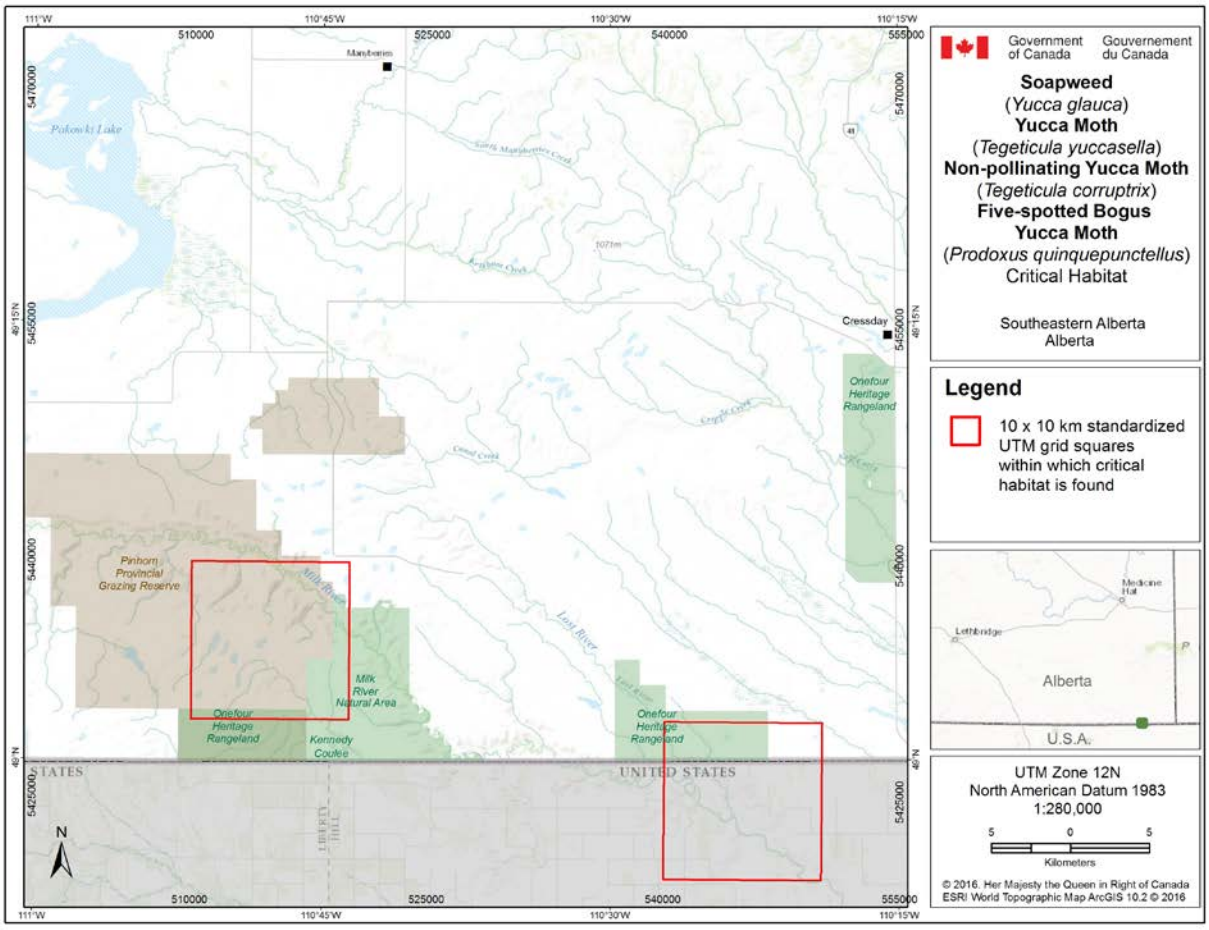

Figure 5. Critical habitat for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth occurs within the 10 km x 10 km UTM grid squares (red outline) where the criteria set out in Section 7.1 are met while the US landbase (shaded grey) is excluded. This standardized national grid system indicates the general geographic area containing critical habitat and detailed critical habitat polygons are not shown. Based on the identification criteria, the grid squares indicated contain approximately 4.12 km^2 (412 ha) of critical habitat.

Biophysical Attributes of Critical Habitat

Biophysical attributes of critical habitat include, but are not limited to, soils and bedrock geology, surface and sub-surface hydrology, vegetation and vegetation community composition, and landforms that occur within the two polygons (Table 3). Rivers, lakes, wetlands and forests are exempt from this definition and are therefore not considered critical habitat. Existing human infrastructure such as buildings, roads and trails, fences, and dugouts within the area identified as critical habitat do not possess the biophysical attributes of critical habitat and are therefore not included in the critical habitat identification.

Within the areas identified as critical habitat, one or more biophysical attributes may occur at a site (Table 3).

Table 3. Summary of critical habitat and biophysical attributes for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth in Alberta.

Critical Habitat	**Details**
Locations	Alberta: 1) Pinhorn Grazing Reserve; 2) Onefour Research Ranch where Soapweed plants occur plus a 300 m critical functional zone around each plant
Map	Figure 5 (detailed critical habitat polygon maps may be obtained from ECCC upon request)
Biophysical Attributes for Soapweed (one or a combination of)	• sparsely-vegetated south- or east-facing coulee slopes [slope rage from 34º (northeast) to 220º (south-southwest)]; • sparsely-vegetated semi-arid native grassland • coarse-textured soils, alkaline and regosolic (undeveloped) without a shallow hardpan
Biophysical Attributes for Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth	• occurrence of native Soapweed plants
Exceptions	• rivers, lakes, wetlands and forests • existing human infrastructures such as buildings, roads and trails, fences, and dugouts

7.2 Activities Likely to Result in the Destruction of Critical Habitat

Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time. Activities described in Table 4 outline examples of activities likely to cause destruction of critical habitat for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth; however, destructive activities are not limited to those listed.

Some activities that result in a temporary alteration of critical habitat (e.g., fires) may have the potential to contribute to the future quality of critical habitat, given proper management. Some disturbance to Soapweed habitat may be beneficial to the species by maintaining open habitat and managing invasive species or woody vegetation growth within a given site. Activities required to manage, inspect, and maintain existing infrastructures that are not critical habitat but whose footprints may be within or adjacent to critical habitat units are not examples of activities likely to result in the destruction of critical habitat provided that they are carried out in a manner consistent with critical habitat conservation. The impact of management activities on critical habitat may be lessened or avoided if activities take place when yucca moths are not active such as prior to flowering or after seed production. More detailed information on the specific

activities likely to destroy critical habitat may be requested by contacting Environment and Climate Change Canada – Canadian Wildlife Service at ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

Table 4. Activities likely to result in the destruction of critical habitat for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth.

Description of activity	**Description of effect (on biophysical attribute or other) in relation to function loss of critical habitat**	**Additional information**
Conversion of native prairie to cropland or non-native grassland	Activity would result in the direct loss of critical habitat by removing or disturbing the substrate within which Soapweed grows, and altering soil biophysical conditions (e.g. structure, porosity, temperature, moisture) required for germination, establishment, and growth. This activity leads to vegetation community changes such that the area becomes dominated by crops, non-native plants, and invasive species.	This activity must occur within the bounds of critical habitat to cause destruction, may result in destruction either directly or cumulatively, and is applicable at all times of the year.
Covering of soils, which can be caused by activities such as construction of infrastructure, including oil and gas wells, pipelines, buildings, and roads.	Activity would result in the direct loss of critical habitat by removing or disturbing the substrate within which the Soapweed grows, and altering soil biophysical conditions (e.g. structure, porosity, temperature, moisture) required for germination, establishment, and growth. These activities result in increased foot and road traffic by humans which could also lead to vegetation community changes such that the area becomes dominated by non-native plants and invasive species.	This activity must occur within the bounds of critical habitat to cause destruction, may result in destruction either directly or cumulatively, and is applicable at all times of the year.
Off-road vehicles	Soapweed plants may be damaged through direct crushing by vehicles. Continuous traffic may increase potential for soil compaction and erosion. Plant build-up under vehicles or within tires can be source of non-native or invasive alien plant species; once established, invasive species can alter hydrology, soil nutrient and moisture availability, and create shade, resulting in direct competition with Soapweed, such that population declines occur, effectively destroying the critical habitat.	This activity must occur within the bounds of critical habitat to cause destruction, may result in destruction either directly or cumulatively, and is applicable at all times of the year.

Description of activity	Description of effect (on biophysical attribute or other) in relation to function loss of critical habitat	Additional information
Prolonged cattle over-grazing (high intensity and/or duration during Soapweed flowering and seed development)	If activity was undertaken during Soapweed flowering and seed development, it would result in the direct consumption or trampling of Soapweed inflorescence, which are the single larval host plant for the three yucca moths. Activity could result in the direct consumption of Yucca Moth, which is the single pollinator of Soapweed.	This activity must occur within the bounds of critical habitat to cause destruction, may result in destruction either directly or cumulatively, and is applicable at all times of the year.
Indiscriminate application of fertilizers or pesticides, which can be caused by activities such as: non-selective spraying of broad-leaf herbicide and insecticide, or arbitrary additions of fertilizers to soil	Herbicide and fertilizer can alter soil or water nutrient status, creating conditions suitable for some plant species and unsuitable for others, such that species composition in the surrounding plant community can change. Changes to soil or water nutrient status will also influence the outcome of interspecific competition for nutrients. Pesticide runoff and drift can alter plant and pollinator communities, thereby possibly reducing the capability of the habitat to support Soapweed.	This activity may result in destruction of critical habitat whether it occurs within or outside the bounds of critical habitat (e.g. chemical drift, groundwater or overland flow of contaminated water), may result in destruction either directly or cumulatively, and is applicable at all times of the year.
Spreading of wastes or release of deleterious materials, which can be caused by activities such as: spreading or release of materials such as manure and septic fluids	These substances have the potential to change soil nutrient status and availability of these nutrients for uptake by plants; species composition; and increase surrounding competitor plants, effectively destroying the critical habitat. These liquid or semi-liquid materials can infiltrate the surface in the short-term, but leave little long-term evidence at the surface that could point to the cause of negative changes observed thereafter.	This activity may result in destruction of critical habitat whether it occurs within or outside the bounds of critical habitat (e.g. drift, groundwater or overland flow of contaminants), can be a direct or cumulative effect, and is applicable at all times of the year.
Introduction or promotion of invasive species, which can be caused by activities such as, but not limited to: intentional dumping or spreading of feed bales containing viable seed of invasive non-native species; seeding invasive species within critical habitat; transporting invasive	Once established, invasive plant species and woody vegetation can alter hydrology, soil nutrient and moisture availability, and create shade, resulting in direct competition with Soapweed, such that population declines occur, effectively destroying the critical habitat. Critical habitat may be destroyed by invasive alien species as well as by other noxious prohibited weeds and aggressive opportunistic species. It may also be	This activity can occur within or adjacent to the bounds of critical habitat to cause its destruction, can be a direct or a cumulative effect, and is applicable at all times of the year.

Description of activity	Description of effect (on biophysical attribute or other) in relation to function loss of critical habitat	Additional information
species (e.g., on wheel tires); or planting of woody vegetation (shrubs and trees).	destroyed by the following species which are not restricted by any legislation due to their economic value: Smooth or Awnless Brome *Bromus inermis)*, Kentucky Bluegrass (*Poa pratensis*), Crested Wheatgrass (*Agropyron cristatum*), Yellow Sweet Clover (*Melilotus officinalis*), White Sweet Clover (*Melilotus alba*).	
Alteration to hydrological regimes, which can be caused by activities such as: temporary or permanent inundation from construction of impoundments downslope or downstream; releases of water upslope and upstream, including but not limited to damming, ditching, drainage, culvert installation, road widening or straightening; or residential/cottage developments that affect the hydrology of critical habitat	As the seed bank and plants of Soapweed are adapted to well-drained soils, flooding or inundation by substances like water, even for a short period of time, can be sufficient to alter habitat enough to be unsuitable for survival and re-establishment. Altering hydrology can also result in too dry conditions, mimicking drought. For example, road construction can interrupt or alter overland water flow, altering habitat conditions and threatening the long-term survival of the species at a particular location. An increase in moisture may also lead to increased encroachment by woody vegetation and some invasive plant species.	This activity may result in destruction of critical habitat whether it occurs within or outside the bounds of critical habitat, may result in destruction either directly or cumulatively, and is applicable at all times of the year

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

- In the short term (5 years): the reproductive capacity of Soapweed and Yucca Moth at the Pinhorn location has increased; and
- In the long term (>10 years): distribution of all four species has been maintained at the two naturally occurring populations (Onefour and Pinhorn), and at any additional natural occurring populations discovered in the future.

9. Statement on Action Plans

One or more action plans for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca will be completed by 2021. It is important to note that these four species form a web of highly interdependent, specialized organisms. Because of these complex food web interactions, it is recommended that a multi-species action plan be developed for Soapweed and its associated yucca moths. Recovery actions for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth may be adopted from the recovery actions described in the provincial recovery plan (Part 2: Action Plan). Coordination with other recovery teams should be considered when developing multi-species action plans at the landscape or ecosystem level and when managing large tracts of land. Other species at risk found within Soapweed and Yucca Moth habitat are listed in Appendix B.

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Appendix A: Decision Tree for Determining the Type of Critical Habitat Identification Based on Biological Criteria

This decision tree was developed by the Recovery Team for Plants at Risk in the Prairie Provinces, to guide the approach for identifying critical habitat for all terrestrial and aquatic prairie plant species at risk.

The first decision is regarding the quality of available information on the species occurrences in Canada, with the choice of accepting or rejecting any given occurrence for consideration as critical habitat based on three criteria.

The second decision is based on how well the habitat is defined. If habitat is not well defined, critical habitat consists of the area encompassing the occurrence and all natural landform, soil, and vegetation features within a 300 m distance of the occurrence.

For species that occupy well-defined and easily-delineated habitat patches, a third decision relates to the ease of detection of the species and the spatial and temporal variability of their habitat.

Decision Tree:

1a. Occurrences have not been revisited for >25 years, **or** use imprecise and/or inaccurate geographic referencing systems, **or** the habitat no longer exists at that location to support the species (no critical habitat will be defined until more is known about the population and location)

1b. Occurrences have been relocated and revisited in the past 25 years, **and** habitat has been revisited in past 5 years to confirm it has the potential to support an occurrence, **and** geographic reference is accurate and precise (go to 2)

2a. Species is a generalist associated with widespread habitats, **or** a specialist that occupies dynamic disturbance regimes difficult to delineate as patches in space, **or** occupies habitat that is otherwise poorly defined (***critical habitat area = occurrences +*** all natural landform, soil, and vegetation features within a 300 m distance of each occurrence)

2b. Species occupies well-defined and easily delineated habitat patches in space (go to 3)

3a. Habitat patches are spatially static in the medium to long term, **or** species is easy to reliably detect (***critical habitat area = occupied habitat patches +*** all natural landform, soil, and vegetation features within a distance of 300 m of the habitat patches)

3b. Habitat patches are spatially dynamic in the medium to long term, **or** species is difficult to reliably detect (***critical habitat area = occupied and potentially occupied***

habitat patches + all natural landform, soil, and vegetation features within a distance of 300 m of the habitat patches).

Notes

Criterion 1a is consistent with NatureServe guidelines for data quality, in that records >25 years old with no subsequent revisit record are least accurate.

Criterion 1b is consistent with SARA Sections 46 and 55 which require reporting on progress towards meeting recovery objectives at five-year intervals.

Criteria 2a, 3a and 3b are consistent with recommendations in Appendix D. In some cases a large barrier exceeding 150 m in width creates a discontinuity in the natural habitat within the 300 m like a major river channel or cultivated field. These barriers effectively overwhelm other edge effects at the distal end of the 300 m, or prevent effective dispersal of the plant at the proximal end closest to the occurrence. In these particular cases, some patches of natural vegetation on natural landforms within a distance of 300 m, but discontinuous from the habitat occupied by the plants, may be exempt from consideration as critical habitat.

Criterion 3 will be applied only if information is sufficient to classify the habitat as spatially static or dynamic and to classify the species' detectability as easy or difficult. If information is not sufficient, critical habitat will be identified as per 2a until studies are completed to obtain the necessary information.

Appendix B: Effects on the Environment and Other Species

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[12]. 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 and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[13] (FSDS) goals and targets.

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 upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

This recovery strategy will benefit biodiversity in Canada by promoting the recovery of the Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth. 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 Species Biology, Threats, and Critical Habitat sections found in the *Recovery Plan for the Soapweed and Yucca Moth in Alberta (2012-2022)* for more information (Part 2).

The conservation approaches identified in this recovery strategy will not jeopardize the survival, distribution, or abundance of other species; rather, this recovery strategy has the potential to benefit several rare and endangered species. Soapweed is an obligate host for the Strecker's Giant Skipper (*Megathymus streckeri*), a rare butterfly known to occur in Canada only at the Onefour location (Hurlburt 2007). Management and research activities would have a positive effect on federally-listed species including the Swift Fox (*Vulpes velox*, threatened), Burrowing Owl (*Speotyto cunicularia*, endangered), Sprague's Pipit (*Anthus spragueii*, threatened), Loggerhead Shrike (*Lanius ludovicianus excubitorides*, threatened), Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris,* threatened), Greater Short-horned Lizard (*Phrynosoma hernandesi,* endangered), Tiny Cryptantha (endangered), Small-flowered Sand Verbena (endangered) and Smooth Goosefoot (*Chenopodium subglabrum,* threatened). Consequently, the promotion of Soapweed, Yucca Moth, Non-pollinating Yucca Moth and Five-spotted Bogus Yucca Moth recovery will certainly assist the conservation of these rare and at risk species as well as a wide range of native plant species that occur in the area.

[12] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[13] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=CD30F295-1

Appendix C: Critical Habitat for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth in Canada

Table 4. Critical habitat units **(**10 x 10 km standardized UTM squares) within which critical habitat for Soapweed, Yucca Moth, Non-pollinating Yucca Moth, and Five-spotted Bogus Yucca Moth is found in Alberta. Critical habitat occurs where the criteria described in Section 7.1 are met.

Population	10 x 10 km Standardized UTM grid square ID[1]	Province	UTM Grid Square Coordinates[2]		Land Tenure[3]
			Easting	Northing	
Pinhorn Grazing Reserve	12UWV13	Alberta	510000	5430000	Non-federal Land
Onefour Research Ranch	12UWV42	Alberta	540000	5420000	Non-federal Land

[1] Based on the standard UTM Military Grid Reference System (see http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789) where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid followed by 2 digits to represent the 10 x 10 km standardized UTM grid. The last 2 digits represent the 1 x 1 km standardized UTM grid containing all or a portion of the critical habitat unit. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See http://www.bsc-eoc.org/ for more information on breeding bird atlases).

[2] The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 10 x 10 km standardized UTM grid square containing all or a portion of the critical habitat unit. The coordinates may not fall within critical habitat and are provided as a general location only.

[3] Land tenure is provided as an approximation of the types of land ownership that exist at the critical habitat units and should be used for guidance purposes only. Accurate land tenure will require cross referencing critical habitat boundaries with surveyed land parcel information.

Appendix D: Rationale for Including a Distance of 300m from Plant Occurrences in Critical Habitat Identification

Terrestrial plants are sessile and their propagules (seeds, rhizomes, or stolons) are more dispersal-limited than the offspring of mobile organisms like vertebrates and invertebrates. Terrestrial plants also compete for the same primary resources of space aboveground for sunlight and gas exchange, and space belowground for water and nutrients. To protect habitat required for survival or recovery of a plant, it is also necessary to protect the current distribution of these resources where the plants are known to occur. Any human activity that could disrupt this otherwise natural distribution of resources could effectively destroy the critical habitat of a plant species at risk. Often human activity may occur at one site but the effects of that activity occur at another site. Alternatively, the effect of human activity may decline with distance from the site where the activity took place, or the effects of human activity could be cumulative over time (Ries et al. 2004). The question then becomes, what is a reasonable minimum distance from a plant species at risk that may encompass habitat required for its survival or recovery? The answer will define the area requiring protection as critical habitat under the *Species at Risk Act* (SARA).

Protection of Habitat Subject to Edge-Effects of Human Activities

An area including a distance of 300 m from detectable occurrences will be critical to ensure long-term survival of plant populations.

Edge Effects of Soil Disturbance

The only research to describe edge effects on short-term survival of plant species at risk indicated 40 m was the minimum distance needed to avoid negative impacts of road dust on plant health and population growth (Gleason et al. 2007); however, that was also the maximum distance at which measurements were made. In detailed reviews by Forman and Alexander (1998) and Forman et al. (2003), most roadside edge effects on plants resulting from construction and repeated traffic have their greatest impact within the first 30 to 50 m. However, salinity, nitrogen and hydrological effects could extend 100 to 200 m from a road, and invasive alien species may spread up to 1 km. Invasive alien species have the potential to competitively exclude plant species at risk, and alter the ecosystem such that the plant species at risk can no longer use the habitat. This particular threat may then destroy critical habitat, without some active restoration.

Hansen and Clevenger (2005) observed no decline in the frequency of invasive alien species up to 150 m away from roads and railways in a grassland environment, although sampling did not extend further than 150 m. Gelbard and Harrison (2005) concluded that edge effects of roads on the plant and soil habitat was such that invasive alien species could more readily establish and survive within 10 m of roads compared with plants up to 1000 m from roads. Of course, not all roads are the same and Gelbard and Belnap (2003) found that paved or graded roads tend to have a higher cover and

richness of invasive alien species compared with 4 x 4 vehicle tracks. All classes of road created habitat for the dispersal and establishment of these species in roadside verges and 50 m beyond. The difference was that greater frequency of traffic and intensity of disturbance on improved roads increased the process of invasion.

The road density typical of the Canadian prairies is one road every 1.6 to 3.2 km. As such, it is unlikely that source populations for invasive alien species can be accurately identified beyond 800 m from roadside or cultivated field edges (the center of a 1.6 x 1.6 km section assuming it is surrounded by roads or cultivated lands). Considering that significant effects of invasive alien species can currently be detected up to 150 m from roads and other developed sites, but can occur >800 m from a source population, some compromise distance between 150 and 800 m seems reasonable to ensure the maintenance of critical habitat attributes.

Edge Effects of Atmospheric Industrial Emissions

Atmospheric emissions from industrial activity, including intensive agriculture, can lead to a cumulative deposition of nitrogen on surrounding soils. Elevated concentrations of nitrogen and sulphur become analytically detectable in plants and soils up to 1 to 2 km away (Meshalkina et al. 1996, Hao et al. 2006). It is not clear if these detectable increases in macronutrients are biologically meaningful, but since most prairie plant species at risk occupy nutrient-poor, early to mid-successional grassland habitats, any increase in soil nutrient availability is likely to intensify competition, speed succession, and eliminate habitat critical for the species survival.

Reich et al. (2001) observed an increase in the productivity of Hairy Prairie Clover (*Dalea villosa*) in response to nitrogen fertilizer, but in a mixed community any positive effect would be offset by the greater productivity response of other competing species. Kochy and Wilson (2001) observed nitrogen deposition in Elk Island National Park several kilometers downwind of petroleum refineries and an urban center to be 22 kg ha-1 year-1, while background rates in the wilderness at Jasper National Park were only 8 kg ha-1 year-1. These increased deposition rates appeared to promote forest encroachment at the expense of native grasslands at Elk Island, moreso than rates at Jasper. Experiments by Plassmann et al. (2008) found that low additions of nitrogen (15 kg ha-1 year-1) to sand dunes increased germination rates of annual plants from the seedbank, which risks depleting the seedbank and eliminating a species from a low-nitrogen site to which it is adapted.

Similar to the effects of industrial emissions, some invasive alien species like the legume sweet clover (*Melilotus* spp.) can elevate soil nitrogen through biological fixation and facilitate invasions by other invasive alien species (Jordan et al. 2008, Van Riper and Larson 2009). This particular plant has become one of the most widespread invasive alien species in the northern Great Plains, due initially to deliberate planting in roadside edges, forage crops, and other reclaimed areas (Lesica and DeLuca 2000). These findings reinforce the idea that an area greater than 150 m to avoid invasive alien legumes, and possibly greater to avoid negative effects of industrial nitrogen and

sulphur emissions, is necessary to ensure the maintenance of habitat critical attributes for prairie plant species at risk.

Edge Effects of Fluid Spills

Water, hydrocarbons or other fluids leaking from pipeline ruptures will have edge effects that vary greatly depending upon topography of the site. For example, an Alberta Energy Resources Conservation Board (ERCB) investigation during 2008 at CFB Suffield found a surface leak of crude oil spread 165 m along ungulate trails and ultimately covered 1200 m^2 of native grassland, killing more than 200 migratory birds (ERCB Investigation Report 2009-06-18). A second incident investigated by ERCB involved a natural gas blowout that released “lower explosive levels” of gas at 100% within 50 m of a wellhead decreasing to 0% at 500 m. This incident also involved a spill of fluids up to 25 m from the wellhead that resulted in excavation and removal of 540 tonnes of soil for remediation (ERCB Investigation Report 2009-06-01). ERCB investigations elsewhere have found oil spills that spread 1.6 km across the surface from rupture points before clean-up could begin (ERCB Investigation Report 2007-05-09).

As plants are not mobile, flooding and inundation for any period of time may be sufficient to destroy critical habitat for several months, years, or decades. The probability of such a rupture is unknown, particularly in proportion to the density of all existing and planned pipelines, and in proportion to habitat availability and species at risk occupancy in the area. The risk of an irreversible change to the habitat is high, so the addition of pipelines within several hundred meters of plant occurrences should not be permitted.

Summary

All of the factors discussed above are potentially cumulative, particularly in the more industrialized parts of southern Alberta and south-western Saskatchewan. Industrial emissions, road construction, and fluid spills are logically co-located land use activities, and land spreading of agricultural wastes can add to the effects. Given the uncertainty regarding the outer distance for possible edge effects exceeding 150 meters, and the difficulty of identifying a point source for effects beyond 800 m, a precautionary approach is to include a distance of 300 m from the plant species at risk occurrences as habitat critical to survival of the species. This value of 300 m is simply twice the 150 m value for which published evidence indicates that significant negative effects can occur to the habitat of plant species at risk. A doubling of the 150 m value is intended to be precautionary to ensure critical habitat attributes are maintained.

Research is needed to more specifically address the edge-effects of major land use activities on habitat critical to survival of prairie plant species at risk. A smaller or larger distance may be suggested based on the results of that research, and changes to the definition of habitat critical to the survival of prairie plant species at risk could result from that work.

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Part 2 – *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022*, prepared by the Alberta Environment and Sustainable Resource Development

Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022



Alberta Species at Risk Recovery Plan No. 25

Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022

Prepared by:

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PREFACE

Albertans are fortunate to share their province with a diverse variety of wild species. Populations of most species of plants and animals are healthy and secure. However, a small number of species are either naturally rare or are now imperiled because of human activities. Recovery plans establish a basis for cooperation among government, industry, conservation groups, landowners and other stakeholders to ensure these species and populations are restored or maintained for future generations.

Alberta's commitment to the *Accord for the Protection of Species at Risk* and to the *National Framework for the Conservation of Species at Risk*, combined with requirements established under Alberta's *Wildlife Act* and the federal *Species at Risk Act*, has resulted in the development of a provincial recovery program. The overall goal of the recovery program is to restore species identified as *Threatened* or *Endangered* to viable, naturally self-sustaining populations within Alberta. The policy document: *Alberta's Strategy for the Management of Species at Risk (2009-2014)* provides broader program context for recovery activities.

Alberta species at risk recovery plans are prepared under the supervision of the Species at Risk Program, Alberta Environment and Sustainable Resource Development. This often includes involvement of a recovery team composed of a variety of stakeholders including conservation organizations, industry, landowners, resource users, universities, government agencies and others. Membership is by invitation from the Director of Wildlife Management, and may include representation from the diversity of interests unique to each species and circumstance. Conservation and management of these species continues during preparation of the recovery plan.

The Director of Wildlife Management provides these plans as advice to the Minister responsible for fish and wildlife management. Alberta's Endangered Species Conservation Committee also reviews draft recovery plans, and provides recommendations to the Minister. Additional opportunities for review by the public may also be provided. Plans accepted and approved for implementation by the Minister are published as a government recovery plan. Approved plans are a summary of the Department's commitment to work with involved stakeholders to coordinate and implement conservation actions necessary to restore or maintain these species.

Recovery plans include three main sections: background information that highlights the species' biology, population trends, and threats; a recovery section that outlines goals, objectives, and strategies to address the threats; and an action plan that profiles priority actions required to maintain or restore the *Threatened* or *Endangered* species. Each approved recovery plan undergoes regular review, and progress of implementation is evaluated. Implementation of each recovery plan is subject to the availability of resources, from within and from outside government.

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ACKNOWLEDGEMENTS

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Funding and support for the preparation of the recovery plan was provided by the Species at Risk Program of Alberta Environment and Sustainable Resource Development and recovery team member organizations and individuals. This recovery plan update was developed from the original plan by Kathryn Romanchuk in consultation with Joel Nicholson and others.

EXECUTIVE SUMMARY

Soapweed (*Yucca glauca*), commonly known as yucca, is an arid-region perennial that grows as a single rosette or cluster of rosettes of long, narrow, spear-shaped leaves. A tall flowering stalk grows from the centre of each rosette and produces large, white flowers. The yucca moth (*Tegeticula yuccasella*) is a small, white, nocturnal moth. Soapweed and yucca moths have an obligate mutualistic relationship such that neither species can survive and sexually reproduce without the other; although soapweed can reproduce asexually on its own. Moth larvae feed only on soapweed seeds and soapweed can only produce seeds if pollinated by yucca moths. A number of factors, including ungulate and insect herbivory, uncoupling of interactions among soapweed and yucca moths, pollen limitation, habitat destruction or alteration, and collection of soapweed for horticultural or medicinal uses may threaten the persistence of these species

In February 2003, the Minister of Environment and Sustainable Resource Development approved the listing of soapweed and yucca moths as *Endangered* in Alberta. Soapweed was listed as *Endangered* under Alberta's *Wildlife Act* in November 2007; whereas yucca moth has not yet been listed. These designations were based on the species' occurring at only two sites and occurring over a small area, and a small and declining yucca moth population at one of the locations (Pinhorn Grazing Reserve). In addition, both sites are isolated from soapweed and yucca moth populations in the United States.

The *Initial Conservation Action Statement* recommended formation of a multi-stakeholder recovery team to produce a recovery plan. The *Recovery Plan for Soapweed and Yucca Moth in Alberta 2006-2011* was produced with the goals to: (1) maintain the existing habitat and distribution of soapweed and yucca moths in Alberta; (2) maintain naturally, self-sustaining populations of soapweed and yucca moths at the Onefour site; and (3) increase the reproductive capacity of soapweed and yucca moth populations at the Pinhorn site. Implementation of recovery actions outlined in that plan resulted in progress being made on all three goals. The conservation and management activities undertaken assisted in maintaining the existing habitat and soapweed and yucca moth populations at both locations in Alberta, and enhanced the yucca moth population at the Pinhorn site; although it still remains uncertain as to whether or not the reproductive rate is indicative of a viable population.

This updated version, the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022*, represents a continuation and refinement of recovery and conservation efforts for soapweed and yucca moths in Alberta. The goals and objectives of this plan will be achieved through implementation of the following specific strategies: (1) conservation and management of soapweed and yucca moth populations, and management of native ungulate populations to reduce losses due to herbivory; (2) conservation and management of habitat in order to maintain the quality and quantity of habitat used by soapweed and yucca moths; (3) provision of information and educational materials to the public and stakeholders to promote the conservation of soapweed and yucca moths; (4) research to elucidate aspects of the life history of soapweed and yucca moths to better understand how to conserve these species; (5) acquisition of resources needed to implement the recovery plan; and (6) development of provincial regulations to protect soapweed and yucca moths and their habitat. It is expected that implementation of activities to conserve soapweed and yucca moths, combined with stakeholder cooperation and commitment, will allow for the long-term persistence of these two species in Alberta.

1.0 INTRODUCTION

1.1 Provincial and Federal Status

In February 2003, the Minister of Alberta Environment and Sustainable Resource Development (AESRD) approved the listing of soapweed (*Yucca glauca*) and yucca moth (*Tegeticula yuccasella*) as *Endangered* under the *Wildlife Act* in Alberta on the recommendation of the Alberta Endangered Species Conservation Committee (ESCC). Soapweed was listed as *Endangered* in November 2007; whereas yucca moth has not yet been listed.

The designation for soapweed was based on a small distribution and decline of the Alberta population, combined with a limited occurrence of the species at only two sites. In addition, populations at both sites are isolated from soapweed populations in the United States (Hurlburt 2001). The yucca moth appears to be declining in one of the two Alberta populations (Pinhorn), and both populations are isolated from moth populations in the United States (Hurlburt 2001).

A recovery plan was developed to set goals, objectives, strategies, and management actions to guide the management of these two species. The focus of the initial plan was the identification and conservation of existing populations. The *Initial Conservation Action Statement* for soapweed/yucca moth further stated that government regulated activities and land use management systems should be strengthened. As soapweed and yucca moths have an obligate mutualistic relationship, the development of a joint recovery plan for these two species was both practical and appropriate.

In 2006, the initial *Recovery Plan for Soapweed and Yucca Moth in Alberta, 2006-2011* (Alberta Soapweed and Yucca Moth Recovery Team 2006) was developed to meet provincial requirements for recovery planning as described in Alberta's *Wildlife Act*. The updated plan, which will guide recovery efforts through 2022, represents a continuation and refinement of recovery and conservation efforts for soapweed and yucca moths in Alberta.

In May 2000 and 2002, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated soapweed and the yucca moth as *Threatened* and *Endangered*, respectively, due to their restricted occurrence and distribution in Canada (COSEWIC 2000, 2002, 2005). Both species are protected under the federal *Species at Risk Act* (SARA). The federal recovery strategy for soapweed and yucca moths was approved, and subsequently published in 2011 (Environment Canada 2011).

In December 2007, two additional moth species in Alberta that are entirely reliant on the mutualistic relationship between soapweed and yucca moths, the five-spotted bogus yucca moth (*Prodoxus quinquepunctellus*) and the non-pollinating yucca moth (*Tegeticula corruptrix*), were listed as *Endangered* under the federal *Species at Risk Act* (Environment Canada 2011). Given these species are not currently listed under Alberta's *Wildlife Act*, they are not being directly addressed in this provincial recovery plan.

1.2 Recovery Team

At the direction of the Minister of Environment and Sustainable Resource Development, the Soapweed and Yucca Moth Recovery Team was initiated in October 2003 by the Director of Wildlife Management. The team's primary responsibility was to develop the initial provincial recovery plan. Recovery team membership included parties likely to affect or to be affected by recovery actions, and consisted of the following member organizations: Alberta Environment and Sustainable Resource Development, Alberta Tourism, Parks and Recreation (Alberta Conservation Information Management System), Agriculture and Agri-Food Canada, University of Lethbridge, Alberta Native Plant Council, and the Pinhorn Grazing Association.

2.0 SPECIES BIOLOGY

2.1 Life History and Adaptations

Soapweed (commonly known as yucca) is an arid-region perennial that grows as a single rosette or cluster of rosettes of long, narrow, spear-shaped leaves 25 to 40 cm long (Kingsolver 1984). A rosette may reproduce asexually resulting in a clone plant growing near the original rosette. An inflorescence (flowering stalk) 30 to 85 cm tall grows from the centre of each rosette and produces 15 to 75 large, fleshy, downward-nodding flowers (Kingsolver 1984). Flowers are generally white or pinkish-white (Kingsolver 1984). Soapweed plants mature at 15 to 20 years of age and flower only every 2 or 3 years. Individual rosettes flower only once and die after flowering (Kingsolver 1984). The plant can reproduce sexually through the production of seeds or asexually through the production of rhizomes (Hurlburt 2001). Plants are tolerant of self-pollination but still require moths for this process to occur (Hurlburt 2004). Flowers that are pollinated become fruit and mature into woody pods during July and August. Seedpods open in September and release thin, flat, black seeds (Kingsolver 1984; Kershaw *et al.* 2001). Seeds are primarily gravity dispersed and fall near the parent plant, creating the clumped distribution of this species (D. Hurlburt, pers. comm.). Seeds have a low germination rate and are viable only for one year (Webber 1953; Milner 1977), resulting in a seed bank that cannot ensure the persistence of the species (ASRD 2002).

Yucca moths are small night-flying moths. Forewings are generally white with a wingspan of 18 to 28 mm (Pellmyr 1999). Hind wings are brownish-grey, gradually turning white toward the hind corner (Pellmyr 1999). Females have fully developed tentacles that they use to gather pollen and to pollinate soapweed flowers (ASRD 2002). Yucca moths do not appear to be strong flyers and probably cannot disperse over long distances (Hurlburt 2001).

Soapweed and yucca moths have an obligate mutualistic relationship such that neither species can survive on a long-term basis and/or reproduce sexually without the other. Moth larvae feed only on soapweed seeds and soapweed can only produce seeds if pollinated by yucca moths (Hurlburt 2001, 2002). Adult yucca moths emerge from the soil between mid-June and mid-July (Hurlburt 2004). After emergence, moths gather and mate in soapweed flowers that open at night (Riley 1892, Baker 1986, Addicott *et al.* 1990). Following mating, a female yucca moth collects pollen from one plant using her tentacles and typically flies to a flower of another plant. The female deposits her eggs next to the developing ovules (Aker and Udovic 1981; Addicott and Tyre 1995). She then actively transfers pollen using her tentacles. By pollinating the

flower, the female ensures that seeds will develop and will provide food for her young (Kershaw *et al.* 2001). Adult moths do not feed and they die 3 to 5 days after emerging from the soil (Kingsolver 1984). Moth eggs hatch 7 to 10 days after they are laid. Upon hatching, larvae feed on developing seeds. Developing larvae may consume a significant number of seeds (D. Hurlburt, pers. comm.). Plants may develop strategies to reduce larval loads, however in Canada this is not the case as plants may even employ strategies to encourage high larvae production (Hurlburt 2004). After 50 to 60 days, larvae chew their way out of the yucca fruit leaving a distinct hole in the pod and drop to the ground via a silken thread (Riley 1892). Larvae burrow into the soil, spin a cocoon of silk and sand particles, and enter diapause (Davis 1967; Fuller 1990; Hurlburt 2001). After a minimum diapause of one year (range 1-4 years), larvae pupate and emerge from the soil as adults, typically coinciding with flowering by soapweed (Fuller 1990). This prepupal diapause is quite rare in insects. Larvae have low survival rates; up to 50% of larvae from Alberta populations commonly fail to pupate, and of those that do pupate, up to 50% die in the cocoon (D. Hurlburt, unpubl. data).

2.2 Habitat Requirements

Soapweed is restricted to the Dry Mixedgrass Subregion (Hurlburt 2001). Plants primarily occur on eroded south- or east-facing coulee slopes with sparse vegetation (Milner 1977). Soils tend to be alkaline and regosolic (undeveloped) without a shallow hardpan (Milner 1977). Details on vegetation commonly associated with soapweed can be found in Milner (1977), Wershler and Wallis (1986), and Hurlburt (2001). The habitat requirements of yucca moths are less well understood. Yucca moths use soapweed flowers for mating and oviposition, but the selection habits of moths for specific flowers to undertake these activities are not known. Yucca larvae require soapweed fruit for feeding. Once larvae emerge from fruit, they burrow into the soil around the plant and remain dormant for up to four years (Fuller 1990; Hurlburt 2004). Generally, the upper 20 cm of soil in a radius of approximately 25 cm from the edge of the outermost leaves of the plant may harbour dormant larvae (D. Hurlburt, pers. comm.). Larvae are not likely to exist where there is no remaining evidence of decayed plants (D. Hurlburt, pers. comm.).

2.3 Population Size, Distribution, and Trends in Alberta

The only naturally occurring populations of soapweed and yucca moths are found at two locations in southeastern Alberta. One site is near Onefour along the Lost River drainage within the boundaries of the Agriculture and Agri-Food Canada Onefour Research Substation. The second site is on the Pinhorn Grazing Reserve south of Manyberries (Figure 1). Both locations are on provincial land under lease to the federal government and to the Pinhorn Grazing Association, respectively. The Onefour site is within the boundaries of the Onefour Heritage Rangeland Natural Area designated by Alberta Tourism, Parks and Recreation (Parks Division).

Several isolated plants, presumably originating as transplants, occur in numerous gardens across southern Alberta (Fairbarns 1985; Hurlburt 2001). Of particular interest are several plants in the town of Etzikom at the Etzikom Windmill Museum and in Police Point Park in Medicine Hat that have been observed to produce fruit, suggesting moths are also present (D. Johnson and J. Nicholson, pers. obs.).

The extent of occurrence of soapweed and yucca moths in Alberta is 400 km^2 and the area of occupancy is less than 2 km^2. The Onefour and Pinhorn populations of soapweed and yucca moth are isolated from one another by a distance of approximately 15 km. There is no evidence that moths migrate between populations, probably because yucca moths and seeds are not capable of long distance dispersal (Hurlburt 2001). The closest population in the United States is approximately 200 km from the Onefour population (ASRD 2002).

Population trends of soapweed are difficult to determine and have not yet been established. Variability in population size estimates over the years appears to be due to differences in survey techniques rather than a decline in population size (Csotonyi and Hurlburt 2000; Foreman *et al.* 2006). Similarly, population trends for the yucca moth in Alberta are unknown; several years of monitoring the yucca moth populations would be required in order for a population trend to be determined (ASRD 2002).

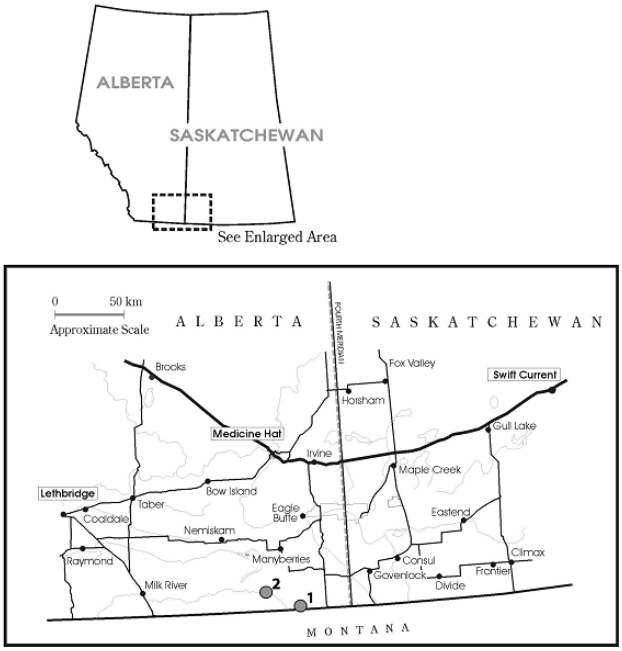

Figure 1. The distribution of soapweed and yucca moths in Alberta. Site 1 is the Onefour population and site 2 is the Pinhorn population. Map modified from Hurlburt (2001).

At the Onefour location soapweed occurs along approximately 2 km of coulee slope, and on the adjacent uplands, and along a stretch of coulee slope approximately 200 m in length at the Pinhorn site (Hurlburt 2001; ASRD 2002). A 1998 census of soapweed revealed a total of 29,577 plants (i.e., rosettes) (8903 clones) in Alberta (Csotonyi and Hurlburt 2000). Of these plants, 28,174 (8499 clones) occurred at the Onefour site and 1383 (404 clones) occurred at the Pinhorn site (Csotonyi and Hurlburt 2000). The number of larvae entering diapause in 1998 at Onefour was 255 (including males) with 75-90 (29-35%) expected to survive to become adults (Csotonyi and Hurlburt 2000). New information suggests survival could sometimes be significantly lower (18%) (Hurlburt 2004). No moths were observed at the Pinhorn site in 1998 or in 2002. The Onefour population has produced fruit each year since 1998, indicating that this population is reproducing sexually (D. Hurlburt, pers. comm.). Fruiting success of flowering plants at Onefour varied between 8-92 % from 1999-2002 (Hurlburt 2004). Prior to an inventory of the Pinhorn soapweed population in 2004, fruit had not been documented at that site since 1997 or earlier, suggesting that the plants were only reproducing asexually (Hurlburt 2004).

The soapweed/yucca moth population at Onefour has been studied extensively since 1998, while much less was known about the Pinhorn population, except that very little evidence of sexual reproduction had been noted at the site (Foreman *et al.* 2006). As a result, a comprehensive inventory of the Pinhorn site was conducted in 2004; this was the first detailed survey since the 1998 census. Results from the 2004 inventory revealed a much larger population of soapweed plants than previously reported. Perhaps even more significantly, evidence of fruit production and larval emergence confirmed that both sexual reproduction of soapweed and reproduction of yucca moths were occurring at the Pinhorn site, albeit at an extremely low rate (Foreman *et al.* 2006). Fruit production could possibly have been about 15 times higher in 2004 than what was recorded, based on the number of enlarged pedicels that were observed, suggesting that additional fruit had been produced but had been browsed (Foreman *et al.* 2006). This was the first evidence of fruiting success since at least 1997. Nevertheless, the limited number of yucca moths could have major implications for the long-term persistence of the soapweed and yucca moth populations at this site.

3.0 THREATS AND LIMITING FACTORS

Several natural and human-caused threats may limit the distribution and population size of soapweed and yucca moths in Alberta and may lead to a decrease in one or both of these species. These include: ungulate and insect herbivory; the uncoupling of interactions between soapweed and yucca moths; pollen limitation; habitat loss, fragmentation, and degradation; the collection of soapweed plants for horticultural or medicinal use; and possibly the effects of wind. Many of the natural limiting factors, such as insect herbivory and weather events, are beyond the control of the Alberta Soapweed and Yucca Moth Recovery Team and this recovery plan.

It is believed that the Onefour soapweed/yucca moth population is more resilient to adverse events than the Pinhorn due to its large population size and because the Onefour population appears to be on a cyclic flowering/fruiting cycle, with periods of very high flowering years followed by low flowering years (D. Hurlburt, pers. comm.). During peak flowering at the Onefour site, it would be unlikely that most herbivory or weather events could have a significant impact on the soapweed population because there are numerous flowers spread over many different microclimates, allowing some to successfully produce seed. Pinhorn, on the other hand,

is a smaller population, dispersed over a much smaller area. Thus, localized threats are thought to be able to have a bigger impact on the Pinhorn soapweed/yucca moth population (D. Hurlburt, pers. comm.).

3.1 Ungulate Herbivory

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are common herbivores of soapweed, removing individual flowers or entire inflorescences (Hurlburt 2001). Grazing of flowers and inflorescences reduces sexual reproduction in soapweed and yucca moths. Fewer flowers are available for moths to pollinate and to lay eggs in, and larvae compete for, and consume, most seeds. In addition, night-flying yucca moths rest within yucca flowers during the day, leading to inadvertent consumption of moths by grazing herbivores (Csotonyi and Hurlburt 2000). Soapweed plants can be heavily grazed by deer and antelope (range 1-100% of flowers across years; COSEWIC 2002), particularly during periods of drought when lower quality forage resources are available (Csotonyi and Hurlburt 2000; Hurlburt 2001, COSEWIC 2002).

In the southern United States, domestic livestock species are common herbivores of soapweed (Webber 1953; Hurlburt 2001). There is some evidence of livestock grazing on soapweed at the Onefour site; however, this appears to be restricted to soapweed plants occurring on upland habitat where cattle can access them easily. Soapweed plants on slopes are less likely to be grazed by livestock (COSEWIC 2002). Cattle grazing at the Onefour site is primarily restricted to winter use, with cows being removed prior to soapweed flowering. In two years (2000 and 2002) where cattle were not removed until 7 to 10 days after flowering, little impact was noted. However, extended periods of livestock grazing during the flowering season may result in considerable loss of inflorescences, and subsequently reduced fruit set (Hurlburt 2007).

Herbivory by native ungulates and/or cattle has been identified as a significant threat to the Pinhorn population of soapweed and yucca moths (Csotonyi and Hurlburt 2000; ASRD 2002, Foreman *et al.* 2006, D. Hurlburt, pers. comm.). An initiative in 2007 of fencing off three small areas supporting soapweed and using range cages to cover individual plants has proven to be an effective method of protecting a small proportion of the soapweed and yucca moth populations from the impacts of ungulate herbivory at this site (C. Linowski, pers. comm.; Environment Canada 2011).

3.2 Horticultural and Medicinal Uses

Previous collection of soapweed is known because of its occurrence in household gardens across southeastern Alberta. However, all plants may not originate from wild stock as soapweed is available at garden centres for purchase. Soapweed is also a common component in a variety of herbal remedies and drugs used to treat a number of ailments including arthritis, gout, cystitis, and skin inflammations (Hurlburt 2001). Soapweed roots contain high concentrations of saponins (a chemical used in soaps, hence “soapweed”) that are precursors to the steroid cortisone and have anti-inflammatory properties. Removal of plants or seeds for horticultural or medicinal use could threaten the viability of the Alberta population, through a loss of plants and potentially viable seeds (Hurlburt 2001). Furthermore, removal of plants could result in the death of any yucca moths or larvae residing within soapweed flowers or fruit, and disturbance to

the soil around the plant during removal could threaten the survival of dormant yucca moth larvae.

3.3 Habitat Loss, Fragmentation, and Degradation

Both the Onefour and Pinhorn sites are on public land and unlikely to be at risk of conversion (e.g., cultivation). However, other activities such as oil and gas activity could result in the loss or degradation of habitat supporting soapweed and yucca moths. At the Onefour site all dispositions (e.g., oil and gas) must receive Ministerial consent given this sites' occurrence within the proposed boundaries of the Onefour Heritage Rangelands Natural Area (Section 13 of the *Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act*). Recently, protective notations have been placed on both soapweed/yucca moth locations, restricting development within the boundaries of critical habitat identified for the species (see Figures 2 and 3 under Section 4.2). Additionally, the Onefour site is under lease to the federal government resulting in additional potential restrictions on surface developments.

There is considerable public interest in these species. Both sites are accessible by road and are often visited daily during the summer (Hurlburt 2001; COSEWIC 2002; Hurlburt 2007). Plants and moths may be threatened by off-road traffic through direct trampling of plants (Hurlburt 2001). Off-road vehicles also may damage the soil crust leading to an increase in erosion (Wershler and Wallis 1986) or may harm dormant larvae in the soils around plants. At both locations, there have been several observations of vehicles parked near or among soapweed plants and occasionally of vehicles driving over plants (D. Johnson and D. Hurlburt, pers. obs.).

3.4 Pollen Limitation

Alberta populations of soapweed show little or no fruit production in some years (< 1% of flowers), low pollination, and low emergence of moth larvae from fruit (Hurlburt 2001). These characteristics are atypical of most soapweed populations in the southern United States. One explanation for these differences is that Alberta populations are pollen-limited. Pollen limitation may be due to low temperatures that restrict moth activity (Dodd and Linhart 1994) or to low abundance of moths. Pollen limitation may also occur if flowering by soapweed is unpredictable, does not occur annually, or does not coincide with moth emergence. Pollen limited plants either produce no fruit and seeds or may produce a higher percentage of asymmetrical fruit. At Onefour, 1-2% of fruit tend to be misshapen and have small numbers of viable seeds, providing evidence of pollen limitation (Hurlburt 2001, 2004). Low numbers of moths and minimal fruit production at the Pinhorn site may suggest that this population is also pollen limited (D. Hurlburt, pers. comm.).

3.5 Uncoupling of Interactions Between Soapweed and Yucca Moths

Mutualism between soapweed and yucca moths requires that moths must be present when soapweed is flowering. Flowering of Alberta populations of soapweed is highly asynchronous resulting in a large number of plants flowering earlier or later than average. For soapweed, this results in flowers receiving fewer visits by pollinators, having lower rates of pollen deposition, and having smaller potential for outcrossing. For yucca moth, this results in low recruitment due to decreased numbers of flowers in which to lay eggs and carry out its reproductive cycle (Hurlburt 2001).

3.6 Insect Herbivory

Another moth, the non-pollinating yucca moth *(T. corruptrix),* lays its eggs in soapweed fruit but does not pollinate the plant. These non-pollinating moths may negatively impact soapweed and yucca moths by depositing enough eggs that many soapweed seeds are consumed by their larvae, limiting the sexual reproduction of the yucca plant (COSEWIC 2006). In Alberta, *T. corruptrix* larvae can consume up to 40% of seeds (Hurlburt 2001). The five-spotted bogus yucca moth (*Prodoxus quinquepunctellus)* lays its eggs in the flowering stalks of soapweed but does not appear to impact the plant (D. Hurlburt, pers. comm.; COSEWIC 2006a).

Ants are common on soapweed plants and negatively impact plants by foraging on the buds, causing premature shedding of those buds. In Alberta, some plants lose up to 90% of their buds through ant damage, resulting in fewer flowers for moths to pollinate and lay eggs in (COSEWIC 2002). Ants also may kill yucca moths that reside in flowers. Some species of grasshoppers also forage on soapweed and often consume the reproductive parts of the flower. Hurlburt (2001) reported that grasshoppers damaged 50% of the flowers on the upland prairie flats at the Onefour site in 1999.

3.7 Wind

Periods of intense wind can result in the loss of flowers and fruit, greatly reducing the reproductive success of soapweed and yucca moths. As an example, at the Pinhorn site in 1999, over 50% of the flowers were lost due to high winds. Windstorms also may limit the ability of moths to fly among plants to lay eggs and to pollinate other soapweed plants (Hurlburt 2001).

4.0 CRITICAL HABITAT

Critical habitat is a legal designation under Canada's *Species at Risk Act* (*SARA*), and is defined 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*" (*Species at Risk Act* 2002 s. 2).

Alberta legislation has no comparable habitat regulation. However, a federal designation of Critical Habitat could lead to the need for changes in Alberta's land and habitat management to ensure effective protection of such designated habitat. The initial recovery team provided recommendations to the federal government on critical habitat descriptions and they were adopted in the national recovery strategy (see Environment Canada 2011). The following subsections describe this more thoroughly.

4.1 Description of Critical Habitat for Soapweed and Yucca Moths

Soapweed is restricted to the Dry Mixedgrass Subregion. This is a region characterized by extremes with a low annual precipitation, usually between 260 mm - 280 mm. Warm summer temperatures (average 16° C) and a high average wind speed translate into a high rate of evaporation throughout the summer months (Hurlburt 2001). The regional frost-free season (100-

120 days) and growing season (180-200 days) are long for the Canadian interior plains (Fairbarns 1984). There are approximately 2200 daylight hours with bright sunshine, making this one of the sunniest regions in Canada (Hurlburt 2001).

As expected, soapweed at Onefour and Pinhorn primarily occurs on eroded south or east facing coulee slopes with sparse vegetation (Milner 1977), although plants have been observed on the upland prairie flats. Coulee slope aspects range from 34º (northeast) - 220º (south-southwest) (Hurlburt 2001). Soapweed favours soil that is alkaline and regosolic (undeveloped) without shallow hardpan (Milner 1977; Fairbarns 1985).

4.2 Identification and Rationale for the Amount and Arrangement

Soapweed exists naturally at two locations in Alberta; the Onefour and Pinhorn sites (as described in Section 2.3). The boundaries of critical habitat on the maps represent the perimeter of the soapweed populations. As a rule, the plants occur in lower densities towards the outside of the polygon, so this area should accommodate population expansion to occur. Because soapweed does not occur naturally outside of these locations and the amount of activity in the region is relatively low, identifying critical habitat outside of these boundaries for protection is not warranted. Thus, the 182 ha at the Onefour site and the 2.65 ha at the Pinhorn site outlined by the polygonal maps can be considered the extent of the critical habitat for soapweed in Canada (see Figures 2 and 3 below). The boundaries will be reassessed periodically to allow for more critical habitat designation if the population expands.

Because yucca moths have an obligate mutualistic relationship with soapweed, the critical habitat should be considered the same for both species. Protection measures related to critical habitat of soapweed will also ensure protection of critical habitat for the yucca moth.

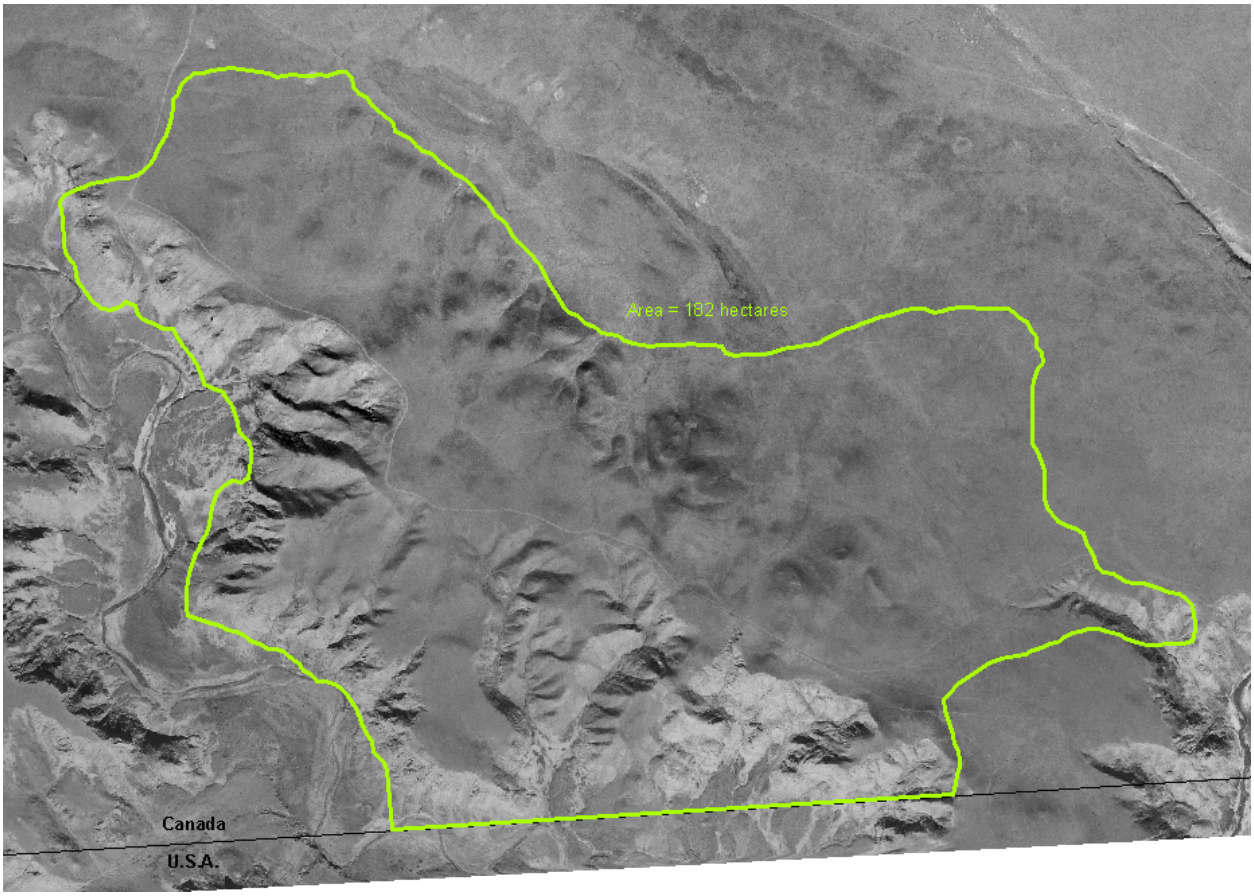

Figure 2. Critical habitat boundary for soapweed at the Onefour site.

Figure 3. Critical habitat boundary for soapweed at the Pinhorn site.

4.3 Critical Habitat Coordinates

Range coordinates of soapweed site locations have been collected and are available to support appropriate conservation and management of the soapweed population in Alberta. However, the specific locations of critical habitat are not identified in this recovery plan so as to minimize potential human disturbance of the sites and protect the species. Range coordinates may be made available to individuals and organizations as needed; i.e. for specific declared purposes related to approved recovery related conservation, management, and research initiatives.

4.4 Destruction of Critical Habitat

Activities that destroy critical habitat for soapweed include anything that would risk conversion of the landscape. This would include cultivation or oil and gas activity such as drilling, conversion for wells or pipelines, or building roads.

Plants and moths may be damaged by off-road traffic through direct trampling of plants (Hurlburt 2001). Off-road vehicles may also increase potential for erosion (Wershler and Wallis 1986).

4.5 Effective Protection of Critical Habitat

Both soapweed/yucca moth sites in Alberta have some protections in place from threats to the species. The Onefour site falls within a Heritage Rangeland Natural Area, which is afforded some protections under the *Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act, R.S.A. 2000.* The Act limits using off-highway or highway vehicles (except on roads), pollution, destroying or damaging plant/animal life, garbage disposal, etc. The federal government also manages the Onefour site; thus it is treated as federal land and the SARA protections would apply. The Pinhorn site is at low risk for conversion as it is on Alberta public land. Protective notations have now been placed on both soapweed/yucca moth locations which will ensure that industrial users are not allowed to develop within the boundary of critical habitat (J. Nicholson, pers. comm.). See section 8.0 for further clarification of recovery actions for protecting critical habitat.

5.0 KNOWLEDGE GAPS AND RESEARCH PRIORITIES

Translocation is one management option for increasing fruit production at the Pinhorn site (see Section 8.0). Thus, research needs to be concentrated on translocation methods and ensuring moth survival. It would be beneficial to conduct research on the factors affecting variation in flowering, fruit production, and moth emergence to help elucidate population dynamics of these species to determine the timing of the translocations. It is also important to know what affects larval survival of yucca moths to help maintain viable populations of this species. In particular, this study would be useful to inform the method for translocating moths to the Pinhorn site. This may be best accomplished by conducting a formal population viability analysis on the yucca moth.

As previously mentioned, there are two other moth species in Alberta that are obligately dependent on soapweed plants, the five-spotted bogus yucca moth and the non-pollinating yucca moth. Given these species' similar requirements as yucca moths, it is believed that the conservation initiatives outlined in this recovery plan should also address the needs of these other moth species. However, when resources become available, inventories for the five-spotted bogus yucca moth and non-pollinating yucca moth could be pursued.

6.0 RECENT RECOVERY AND CONSERVATION EFFORTS

The initial *Recovery Plan for Soapweed and Yucca Moth in Alberta 2006-2011* outlined strategies and actions necessary for the recovery and conservation of soapweed and yucca moths in Alberta. Since its inception, significant progress has been made on implementation of the plan. Initiatives have focused on population monitoring, recovery actions, and information and outreach. Key efforts include:

- An inventory of the Pinhorn soapweed/yucca moth population in 2004 to determine the size of the population, document any evidence of fruit production and larval emergence, and assess the extent of herbivory occurring at the site (see Foreman *et al.* 2006);

- Installation of exclosures at the Pinhorn site in spring 2007 to protect a portion of the soapweed population from ungulate herbivory; three areas supporting soapweed were fenced off and 40 range cages were installed to cover individual plants;
- Translocation of yucca moth larvae from the Etzikom Windmill Museum population to the Pinhorn site in 2008;
- Monitoring of the soapweed/yucca moth population at the Pinhorn site in 2009, 2010, and 2011 by students in the Environmental Land Reclamation Program at Medicine Hat College as part of a cooperative program with the college;
- Ongoing seasonal observations of the soapweed population at the Onefour site by managers and staff of the AAFC Onefour Research Substation;
- Development of standardized population survey and monitoring methodologies for soapweed and yucca moths at the Onefour site (see Hurlburt 2007);
- Installation of interpretive signage at the Etzikom Windmill Museum in Etzikom, Alberta in front of a living display of soapweed plants and yucca moths to promote education and conservation of the two species;
- Placement of protective notations (PNTs) on both the Onefour and Pinhorn soapweed/yucca moth sites as a measure to protect critical habitat; and
- Completion of an inventory of the soapweed/yucca moth populations at the Onefour and Pinhorn sites by an independent biological consultant in 2011 for upcoming updated COSEWIC status reports for both species.

These activities have significantly contributed to meeting several of the objectives outlined in the initial recovery plan. Critical habitat for soapweed and yucca moths has been identified and has been protected through the placement of protective notations (PNTs) on both the Onefour and Pinhorn sites. The initiative of installing exclosures and individual range cages at the Pinhorn location in spring 2007 has effectively protected a portion of the soapweed population from ungulate herbivory. It is still important to recognize, however, that the fenced areas (i.e. exclosures) only represent a small portion of the overall population and herbivory continues to be a key threat, as evidenced by the high level of browsing noted outside of the exclosures (C. Linowski, pers. comm.; D. Hurlburt, pers. comm.). The yucca moth larvae translocation undertaken in 2008 involved the transfer of one soapweed stalk with 14 unripened fruit attached from the Etzikom museum population to the Pinhorn population. This effort, in conjunction with the fencing, has resulted in increased fruit set within the exclosures and an increased number of moth emergence holes being observed from year to year (C. Linowski, pers. comm.), suggesting an enhancement of the yucca moth population at the Pinhorn site. However, it still remains uncertain as to whether or not the reproductive rate is indicative of a viable yucca moth population at this site (D. Hurlburt, pers. comm.). It is hoped that the yucca moths will continue to reproduce within the exclosures, unhindered by herbivory, and eventually disperse out into the surrounding soapweed plants and establish a self-sustaining population (J. Nicholson, pers. comm.).

Monitoring of the Pinhorn soapweed/yucca moth population was conducted in the fall of 2009 2010, and 2011 by students and instructors from the Environmental Land Reclamation Program at Medicine Hat College, and in summer 2011 an additional inventory was completed by an independent biological consultant. Monitoring in 2009 and 2010 confirmed the presence of yucca moths, although still in limited numbers, as indicated by the few number of moth emergence holes observed. However, a much greater number of emergence holes were observed

in 2010 compared to 2009, particularly in the soapweed plants contained within the largest exclosure. In addition to the increased number of emergence holes, there was also a significant increase in the number of new plants (clones), which may be attributed, at least somewhat, to the summer moisture (C. Linowski, pers. comm.). In 2010, many more yucca plants and inflorescence stalks were observed growing outside of the fenced areas and individual range cages than the previous year. Browsing of the flowering stalks was very apparent, as not a single pod was observed, demonstrating the necessity of the exclosures to protect the soapweed and yucca moths from herbivory (C. Linowski, pers. comm.).

Preliminary results from the inventory conducted in 2011 at the Pinhorn site revealed a high degree of fruit production among the flowering soapweed plants within the three fenced off areas and individual range cages, with the majority of plants producing fruit (D. Hurlburt, pers. comm.). Conversely, only one fruit was found outside of the exclosures and range cages, and it had been ripped off and was lying on the ground; a classic sign of herbivory. The degree of herbivory observed during the course of the inventory was noted as being very high (D. Hurlburt, pers. comm.). Another observation was a lack of enlarged pedicels being seen on the flowering stalks of plants situated on the slopes, suggestive of low moth density at the time of flowering. None of the soapweed plants on the slopes produced fruit, which may have more to do with a lack of yucca moths than herbivory by ungulates (D. Hurlburt, pers. comm.). No yucca moths were observed in the flowers, and there were no signs of late ovipositions. Another moth species that relies on soapweed for survival, *Prodoxus quinquepunctellus* (five-spotted bogus yucca moth), was present, although in much lower densities than at the Onefour site (D. Hurlburt, pers. comm.).

In 2011, flowering was very low at the Onefour site (< 1% of clones flowered), and fruiting success was significantly lower than in previous years (D. Hurlburt, pers. comm.). A lack of enlarged pedicels on flowering stalks, other than those that set fruit, suggests that it was not a very successful year for yucca moths. This may have been due to adverse environmental conditions, given the very wet spring and the fact that soapweed plants were still covered in snow in May (D. Hurlburt, pers. comm., I. Walker, pers. comm.). Although it would be considered a year of low reproduction, comparatively speaking, the soapweed/yucca moth population at Onefour is large and very well-established, and a “boom or bust” flowering/fruiting cycle has been noted over the years (D. Hurlburt, pers. comm.; I. Walker, pers. comm.).

The soapweed/yucca moth population at Onefour continues to be monitored on a regular basis, and all observations suggest that both species continue to persist at a sustainable level, in spite of the population’s highly variable flowering/fruiting cycle (i.e. periodic high flowering years followed by very low flowering years) (D. Hurlburt 2007; I. Walker, pers. comm.). Ongoing monitoring is still essential in order to detect any possible declines in the soapweed and/or yucca moth populations that could affect their long-term sustainability, particularly given that low flowering years tend to be more frequent than high flowering years (Hurlburt 2007).

Installation of interpretive signage in front of a living display of soapweed plants and yucca moths at the Etzikom Windmill Museum will enhance the public’s understanding and awareness of these two species at risk, and help promote their conservation. This site also allows those wishing to a see these species an alternate to visiting the natural sites and should help decrease traffic to these areas.

7.0 RECOVERY STRATEGY

7.1 Biological and Technical Feasibility of Recovery

Conservation of soapweed and yucca moths is possible and is compatible with a variety of land use activities. A cooperative management approach involving all stakeholders is the best approach to allow for the persistence of these species in Alberta. Soapweed and yucca moths continue to persist at the Onefour site, and maintaining sustainability of these populations at this site should be feasible with continued cooperation among stakeholders. The yucca moth population at the Pinhorn site could become viable if concerted management practices continue to be employed. The development of regulations under the *Wildlife Act* that protect *Endangered* and *Threatened* plants and invertebrates is needed to help ensure that losses of these species do not occur from horticultural, pharmaceutical, recreational, industrial, and agricultural activities.

7.2 Guiding Principles

There are a number of soapweed plants in numerous towns and cities in southern Alberta. Most of these plants occur in household gardens, and some may be the result of transplants from native populations of soapweed in Alberta. The recovery strategies and actions recommended in this plan do not apply to these transplants.

The recovery and management of soapweed and yucca moths in Alberta will be guided by the following principles that were established in the initial recovery plan:

- Recovery and conservation of soapweed and yucca moths is possible and important.
- Loss of habitat for soapweed and yucca moths is unacceptable and preventable.
- A cooperative approach with land managers, landowners, industry, and other agencies is essential to the success of this plan in conserving soapweed and yucca moth populations in Alberta. This includes shared stewardship, compatible land use, and local commitment to management initiatives.
- Landowners and lessees will not be unduly affected by the costs associated with maintaining or enhancing habitat for soapweed and yucca moths.
- Knowledge gaps will be identified and will be communicated in the recovery plan.
- Management actions will use tools resulting in the most immediate benefits to soapweed and yucca moths and will be based on the best information available. Implementation will not be delayed because of a lack of specific supporting information.
- Recovery actions will embrace an ecosystem (holistic) approach to management.
- Recovery actions will focus on achievable initiatives and on those initiatives deemed most effective in conserving soapweed and yucca moths in Alberta.
- The recovery process will be guided by the concept of adaptive management, whereby specific actions are implemented, evaluated, and altered as necessary, to ultimately improve the outcome.

7.3 Recovery Goal

The long-term goal of the recovery plan is to maintain the existing habitat and distribution of soapweed and yucca moths in Alberta and to enhance the yucca moth population at the Pinhorn site. This will require the maintenance of naturally, self-sustaining populations of soapweed and yucca moth at the Onefour site and an increase in the reproductive capacity at the Pinhorn site.

7.4 Recovery Objectives

The specific population and distribution objectives that will lead to the long-term conservation of soapweed and yucca moths in Alberta are:

1. Maintain reduced herbivory levels by ungulates on soapweed populations, primarily at the Pinhorn site, over the life of the recovery plan.
2. Maintain a reproducing population of yucca moths at the Pinhorn site over the life of the recovery plan.
3. By 2022, attain a value for annual fruiting success for the Pinhorn population of soapweed of at least 5% of flowers, and maintain annual fruiting success for the soapweed population at Onefour of at least 7-10% of flowers as per Hurlburt 2004.
4. Eliminate loss of habitat quantity or quality due to human-caused disturbances.
5. Ensure no loss of soapweed plants due to harvesting for horticultural or medicinal purposes.

7.5 Recovery Strategies

The goals and objectives of the *Alberta Soapweed and Yucca Moth Recovery Plan 2012-2022* will be achieved through the implementation of six distinct strategies listed below, which will be pursued concurrently over the ten-year period.

7.5.1 Population Conservation and Management

In order to conserve and manage the population, the Soapweed/Yucca Moth Recovery Team recommends monitoring Alberta soapweed and yucca moth populations for population size, distribution, and reproductive success. As ungulates pose a threat to the Pinhorn population, management measures will continue to be explored.

7.5.2 Habitat Conservation and Management

Enhancing protection measures and means of limiting human disturbance in the area will be necessary to conserve habitat. This should be done in a cooperative fashion with land users.

7.5.3 Information and Outreach

Measures will be taken to increase public awareness of soapweed and yucca moths and the need for, and importance, to conserve these species in Alberta.

7.5.4 Research

Research will be focused on collecting information necessary for the conservation of soapweed and yucca moths. There will be agency support for researchers in their efforts to secure funding to undertake these investigations.

7.5.5 Resourcing

It is important to secure logistical, financial, and in-kind support to implement the recovery plan.

7.5.6 Plan Management and Administration

Throughout the life of the plan, members of the initial soapweed/yucca moth recovery team may be asked for advice on an as-needed basis. The plan will be updated at the end of term, or at any time during the term.

8.0 ACTION PLAN

8.1 Population Conservation and Management

1. Government agencies, non-government organizations, or universities will conduct annual surveys of soapweed and yucca moth populations to monitor distribution, abundance, and trends of these species. When a sufficient amount of data has been collected, it should be used to undertake a population viability analysis for yucca moth.

2. Government agencies, non-government organizations, or universities will establish a protocol for the translocation of yucca moth larvae and/or adults from the Onefour or Etzikom Museum site to the Pinhorn site and for monitoring the success of translocations. The number of individuals that are translocated each year will be dependent on the annual population size of soapweed (e.g., fruiting success) and yucca moths at the donor site and should not compromise the sustainability of these populations.

3. When the translocation protocol is complete, and if it is deemed necessary, government agencies, non-government organizations, or universities will translocate yucca moth larvae and/or adults from the Onefour or alternate sites to the Pinhorn site following the protocol and will monitor moth numbers and soapweed fruiting success in subsequent years.

4. AESRD will ensure appropriate management of native ungulates in WMU 102 where soapweed and yucca moths occur, including the use of population management techniques such as harvesting goals, ungulate repellents, or fencing, as required.

8.2 Habitat Conservation and Management

1. Maps denoting critical habitat for soapweed and yucca moth will be maintained and used as the basis for permitting/mitigating land use.

2. A variety of agencies and organizations, including AESRD, Agriculture and Agri-Food Canada, and universities, in coordination with land users, will cooperate to develop and deliver best management practices (BMPs) for livestock grazing within habitat supporting soapweed and yucca moths. BMPs will be updated/revised as new information becomes available.

3. Government agencies or non-government conservation organizations will assist lessees and land managers to manage their land in a manner that sustains soapweed and yucca moths through the provision of various improvements.

4. Agriculture and Agri-Food Canada (Onefour Research Substation) and Pinhorn Grazing Reserve, in association with AESRD and Alberta Tourism, Parks and Recreation, will develop access management plans to ensure that vehicles are not used within or immediately adjacent to habitat supporting soapweed and yucca moths.

5. The boundaries of critical habitat will be reassessed periodically to account for population expansion over time.

8.3 Information and Outreach

1. AESRD will update the current fact sheet on soapweed and the yucca moth, as necessary. Fact sheets will be made available to the public, including lessees and land managers, on the Alberta Species at Risk website.

2. Government agencies or non-government organizations will continue to work with the Etzikom Windmill Museum to promote conservation of soapweed and yucca moths to the public.

3. AESRD will make the recovery plan available to the public and interested stakeholders on the Alberta Species at Risk website.

8.4 Research

The following research is recommended, in order of priority, to provide information necessary to help conserve and maintain soapweed and yucca moths in Alberta.

1. Researchers from government agencies, non-government organizations, or universities should monitor currently marked individual soapweed plants across seasons and years to understand the life history of soapweed and yucca moths, including the effects of variation in flowering levels, moth emergence, and fruit production on population dynamics of soapweed and yucca moths.

2. Researchers from government agencies, non-government organizations, or universities should investigate the factors influencing larval survival of yucca moths to understand how larval survival impacts population dynamics and to help develop and refine a translocation protocol for this species.

3. Researchers from government agencies, non-government organizations, or universities should investigate the direct and indirect effects of the moths, *T. corruptrix* and *P. quinquepunctellus*, on the soapweed-yucca moth mutualism.

8.5 Resourcing

1. Government agencies, non-government organizations, and researchers, will periodically approach government, non-government, industry, land managers, leaseholders, universities, and private conservation organizations to participate in, or fund, recovery initiatives for soapweed and yucca moths.

8.6 Plan Management and Administration

1. AESRD may convene previous members of the Alberta soapweed and yucca moth recovery team on as-needed basis.

2. The Alberta Conservation Information Management System (ACIMS) centre staff, in cooperation with other agencies and researchers, will enter all soapweed and yucca moth data into the ACIMS database following each survey season.

3. Research activities will be properly permitted and coordinated each year, in order to maximize benefits from research.

9.0 TIMETABLE FOR IMPLEMENTATION AND SCHEDULE OF COSTS

The following table provides a timeline for implementation and estimate of costs of activities identified as being important to the conservation of soapweed and yucca moths. It is anticipated that a variety of agencies will participate in the funding and implementation of these activities. Costs are not provided for activities that are part of the daily operations of the identified organizations.

Table 1. Implementation timetable and estimate of costs (direct and "in-kind", in thousands) for soapweed and yucca moth recovery actions, 2012-2022.

Plan Section	Action	Lead Agency[1]	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Total
8.1	**Population Management**												
1	Surveys	Various	5	5	5	5	5	5	5	5	5	5	**50**
2	Translocation protocol	AESRD	5										**5**
3	Translocations	AESRD											
4	Ungulate management	AESRD	1	1	1	1	1	1	1	1	1	1	**10**
8.2	**Habitat Management**												
1	Maps	AESRD	2				2						**4**
2	Best management practices	AESRD		5									**5**
3	Habitat improvements	AESRD		2	2	2	2	2	2	2	2	2	**18**
4	Access management	AAFC, PGR		5								5	**10**
8.3	**Information and Outreach**												
1	Fact sheets	AESRD		1								1	**2**
2	Displays	AESRD		1					1				**2**
3	Publish and promote plan	AESRD	1										**1**
8.4	**Research**												
1	Life history		15	15	15								**45**
2	Moth larvae survival		15	15	15								**45**
3	Influence of other moths		15	15	15								**45**
8.5	**Resourcing**												
1	Secure funding	AESRD											
8.6	**Plan Management**												
1	Periodic team meetings	AESRD	1				1					1	**3**
2	Database management	ACIMS											**0**
3	Research coordination	AESRD											**0**
4	Liaise with other recovery teams	AESRD	0.5				0.5					0.5	**1.5**
TOTAL			**60.5**	**65**	**53**	**8**	**11.5**	**8**	**9**	**8**	**8**	**15.5**	**246.5**

[1]Lead agencies: AESRD – Alberta Environment and Sustainable Resource Development, ACIMS - Alberta Conservation Information Management System, AAFC - Agriculture and Agri-Food Canada, PGR - Pinhorn Grazing Reserve

10.0 SOCIO-ECONOMIC CONSIDERATIONS

The approximately 189 ha over which soapweed and yucca moths occur is a small enough area to limit potential socio-economic costs of implementation of the recovery plan. It is a guiding principle of the recovery plan that landowners and leaseholders should not be unduly affected by costs associated with implementation of the plan. Potential economic costs may include minor changes to grazing management that could involve decreased productivity or increased costs for livestock production. Potential costs associated with industrial development may include restrictions on resource extraction or increased costs for extraction or development resulting from mitigation measures. Other potential costs to recreational users and naturalists in the area may include reduced accessibility to view populations of soapweed and yucca moths and prohibition on their collection. The current management regime at Onefour has allowed the population to exist and expand, thus no significant changes to operations at Onefour should be anticipated.

There are several benefits that may be realized from implementation of the recovery plan. There is the potential for leaseholders to obtain improvements that increase the quality and productivity of their rangelands. The need to manage native ungulates in habitat supporting soapweed and yucca moths may increase recreational hunting opportunities in WMU 102. Soapweed and yucca moths are unique prairie species and there is considerable public interest in these species. Information and living displays of soapweed/yucca moth in local towns in Alberta (e.g., Etzikom Windmill Museum) may enhance tourism in these centres and reduce visits and disruption to natural sites.

11.0 PLAN EVALUATION AND AMENDMENT

The life of this plan is 10 years. Periodic reviews will be carried out to monitor the implementation of the plan and to determine the effectiveness of recovery actions. Recovery plans are considered “living” documents and can be amended during these reviews or at any time it is deemed necessary within the 10-year period. At the end of 10 years, an assessment will be done of any amendments that may be required prior to the plan being renewed for another 10 years. This may involve consultation with previous members of the recovery team or additional experts, management agencies, and stakeholders.

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