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RESOURCE STATUS AND ASSESSMENT BRANCH

Status of Soapweed (Yucca glauca) in Alberta

Donna Hurlburt

Alberta Wildlife Status Report No. 35

Alberta Conservation Association

Alberta ENVIRONMENT

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PREFACE

Every five years, the Fisheries and Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991, 1996 and 2000, assign individual species 'ranks' that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general statusing exercises (1996 *Status of Alberta Wildlife, Status of Wild Species in Alberta* 2000*)*, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (At Risk, May be at Risk), that are of uncertain status (Status Undetermined), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fisheries and Wildlife Management Division of Alberta Environment, and are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta Wildlife Act. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Soapweed (Yucca glauca Nuttall) is distributed throughout the southwestern United States and just reaches Canada into the Milk River region . It is considered rare in Canada and in Alberta (Csotonyi and Hurlburt 1999) and has been designated 'vulnerable' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2000). This report is intended to summarize existing information on soapweed and to assist in the management of soapweed, its mutualist pollinator and their habitat in Alberta.

Soapweed is a long-lived arid grassland perennial that is engaged in a unique obligate mutualism with its only pollinator and seed predator, the yucca moth (Tegeticula yuccasella). This species occurs naturally at two confirmed sites in Alberta along the Milk River and its tributary, the Lost River.

The current population of soapweed in Alberta is estimated to be 29 557 plants (rosettes) distributed among 8903 clones. Recent monitoring activities show large annual variation in flowering and moth emergence, an apparent decline of sexual reproduction in one population, and possibly a change in the costs and benefits associated with the obligate mutualism between soapweed and its moth. Threats to the survival of soapweed are most likely related to the northerly location of the plant and include pollinator loss due to unpredictable flowering and moth emergence. Other threats not related to latitude include habitat fragmentation and herbivory.

Soapweed has never been abundant in Alberta given its northern, peripheral distribution; however, it is a representative grassland species, has had historical significance to indigenous peoples as a medicinal and fiber source, and through its relationship with the yucca moth represents the very epitome of food web interactions.

ACKNOWLEDGEMENTS

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INTRODUCTION

Soapweed (Yucca glauca Nuttall), also known as the yucca, is the only member of its genus native to Canada. It is widely distributed in the western United States with its northern limits just crossing the United States/Canada border into the Milk River region. In Alberta, soapweed is restricted to south-facing coulee slopes in the Dry Mixedgrass Subregion (ANHIC 2000). There are only two native occurrences in the province and the species is designated S1* by the Alberta Natural Heritage Information Centre (Gould 2000). Soapweed is also designated as 'vulnerable' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2000).

The purpose of this report is to compile and summarize existing knowledge on the soapweed in Alberta in order to update the status of the species in the province.

HABITAT

In Alberta, soapweed is restricted to the Dry Mixedgrass Subregion (ANHIC 2000). This subregion is characterized by a continental climate with extremes of weather and large daily variation. Total annual precipitation is usually between 260mm to 280 mm, with about two thirds of that falling in the spring. Due to warm summer temperatures and a high average wind speed (70 to 90 kph, gusts more than 130 kph are not uncommon) the rate of evaporation is high throughout the summer months. The mean growing season temperature is approximately 16°C. The regional frost-free season (100-120 days) and growing season (180-200 days) are long for the Canadian interior plains (Fairbarns 1984). The mean percentage of daylight hours with bright sunshine is the highest in Canada (50%) or 2200 hrs/year.

At the northern limits of its range in Alberta and Montana, Yucca glauca is found on well-drained mostly south facing coulee slopes. Slopes are generally eroded, dry and sparsely vegetated. Slope aspects in Onefour range from 34° (northeast) to 220° (south-southwest), and except for some sites sheltered by adjacent ridges, generally face away from prevailing southwest winds. Soils tend to be alkaline and regosolic (undeveloped) in nature without shallow hardpan (Milner 1977, Fairbarns 1984).

In Onefour, soapweed is found on eroding kame slopes dominated by sagebrush (Artemisia cana). Major grasses include blue grama (Bouteloua gracilis) and muhly grass (Muhlenbergia cuspidata), while needle and thread grass (Stipa comata), june grass (Koeleria macrantha) and sand grass (Calamovilfa longifolia) are locally common. Major forbs include prickly pear cactus (Opuntia polyacantha), pincushion cactus (Mamillaria vivipara), smooth blue beard-tongue (Penstemon nitidus), and broomweed (Gutierrezia sarothrae) (Wershler and Wallis 1986).

CONSERVATION BIOLOGY

Of crucial importance to the survival and sexual reproduction of soapweed is the survival of its pollinator, the yucca moth (Tegeticula yuccasella) (see Pellmyr 1999 for taxonomy of the yucca moth). The plant and moth have an obligate mutualistic relationship and neither species can survive without the other. Obligate mutualistic systems are those relationships in which each partner requires the other to survive or reproduce, and as a result, benefit from the interaction (Addicott 1995). Adult female yucca moths actively collect pollen and fly to

* See Appendix 1 for definitions of selected status designations

another inflorescence. Upon finding a fresh flower, a female first inserts her ovipositor through the carpel wall and lays an egg next to the developing ovules. She then climbs to the tip of the style, and using her maxillary tentacles, appendages unique to yucca moths, she actively transfers pollen into the stylar canal. Upon hatching, a larva feeds on developing seeds. At maturity it emerges from the yucca fruit, drops to the ground, and burrows into the soil where it enters a prepupal diapause (Riley 1873, Keeley et al. 1984). This interaction is obligate for both yuccas and yucca moths, because there is no other consistently successful mechanism of pollen transfer and because yucca moth larvae feed only on yucca seeds.

There is little, if any, literature available on the conservation biology of soapweed or its pollinator, the yucca moth. This is most likely because soapweed is a common species throughout most of the United States. However, it is the peripheral populations of soapweed that provide conservation biologists with unique factors to take into account.

Although peripheral populations are routinely given special consideration in conservation (Lesica and Allendorf 1995), few researchers have given thought to the survival of interactions, such as mutualism, between species at the periphery of their ranges. Co-evolved mutualisms can only persist in places that both partners can reach, survive and reproduce, so the persistence of mutualisms at edges is apt to be more precarious than that of individual species making up the interaction (Bronstein 1989). The obligate interaction between the peripheral populations of yuccas and yucca moths in Alberta are of particular interest to the study of mutualistic interactions since neither the presence of regular flowering of the yucca, nor the emergence of the yucca moth can be guaranteed. It has been suggested that species that are limited in access to their mutualists may be unable to invade (Cruden et al. 1976), may interact with an alternate partner (Cox 1983) or may stop relying on mutualism entirely (Janzen 1973). It is plausible that the yucca/yucca moth mutualism in Alberta may be less obligate and is becoming uncoupled over time; alternately, the relative costs and benefits within the mutualism may be changing but the partnership remains tight. Recently, the importance of plant/pollinator interactions to society has been documented; several works have called attention to pollination as one of the most critical ecological interactions in the provision of food supply in agriculture and in nature (Bond 1994, Buchmann and Nabhan 1996, Kearns and Inouye 1997). Pollination systems are under increasing threat from human disturbance, including habitat fragmentation, changes in land use and agricultural practices, use of chemicals, and invasions of alien species; as a result, the world is in a "pollination crisis" (Buchmann and Nabhan 1996). Despite being ecologically, aesthetically, and potentially economically important, we know little about wild pollinators not deemed important in commercial agriculture (Kearns and Inouye 1997). Mutualistic relationships, such as those between plants and pollinators, epitomize the essence of food-web interactions. The fate of many plants may depend on preserving their mutualistic relationships with pollinators and with the web of organisms that affect both plant and pollinator (Bond 1994, Kearns and Inouye 1997).

Yucca glauca has a direct effect on the survival of the yucca moth, but may also contribute to the survival of other insects in the prairie community. At northern latitudes, flowering by many species of plants is apt to be unpredictable. Soapweed may act as an alternate source of nectar for pollinators of other plant species during periods of delayed

or absent flowering. Y. glauca may also be important in maintaining pollinators for other prairie plant species that are also at their northern edge, in particular, prickly-pear (Opuntia polyacantha) and pincushion cacti (Mamillaria vivipara). Such a supporting role may be particularly important at northern latitudes because of the unpredictable nature of flowering in stressful environments. Pollinator species, such as the skippers, Megathymus streckeri, Polites rhesus and Pyrgus scriptura, may also be associated with soapweed, and at present are only known by single specimens in Canada from the Lost River site (Norbert Kondla, pers. comm.).

With the exception of a single high elevation population in Colorado (Dodd and Linhart 1994), Y. glauca is predominantly an out-crossing species, although some individuals seem to be able to self-pollinate (Webber 1953, Fuller 1990). At the northern edge of the Yucca's spp. range, neither the presence of moths, nor the presence of other individual plants in flower are reliable; and the maintenance of a highly out-crossing system is apt to be energetically expensive and costly to survival. Self-fertilization has obvious advantages in maintaining high and reliable seed production, even when pollinators are scarce or unpredictable. It is possible that in isolated populations in Alberta, where moth numbers are low and unreliable from year to year, Y. glauca has selected for a self-pollination mating system; supporting evidence are not conclusive at this time as some plants appear to be able to self-pollinate and others do not (D. Hurlburt, unpubl. data).

The patchy distribution of northern yucca populations, coupled with the limited dispersal ability of yucca moths, may reduce gene flow among its populations relative to that of more continuously distributed populations (Massey and Hamrick 1998). Isolation and extreme environmental effects may introduce selective pressures to the populations that are unique or more severe (Lesica and Allendorf 1995), leading to a more rapid genetic divergence than expected. Presuming that central populations are established in more favourable environments, the environment would become less favourable as one moves away from the centre of the range, resulting in peripheral populations experiencing the most severe environmental conditions for any given species (Lesica and Allendorf 1995). In comparison with populations occupying the range centre, peripheral populations should be adapted to a greater variety of environmental conditions. Thus, peripheral populations should be pre-adapted to anthropogenic disturbance or climate change that may threaten populations across the remainder of the species range (Lomolino and Channell 1998).

DISTRIBUTION

***1. Alberta.* -** Soapweed exists in only two known natural populations in southeastern Alberta (Figure 1, Appendix 2). The Lost River (Alberta) population is primarily distributed along a 2 km stretch of south-facing coulee slope of a tributary of the Milk River (Figure 1, Appendix 2) on land owned by the Lethbridge Agricultural Research Substation in Onefour, Alberta. The Pinhorn (Alberta) population is located on the Pinhorn Grazing Reserve along a 200 m stretch of southwest-facing coulee on the Milk River drainage (Figure 1, Appendix 2). Additionally, several isolated plants are located in Bull Trail and Botterill Bottom Parks, Lethbridge (Ernst and Saunders 1998) and Police Point Park, Medicine Hat (Carol Porter, pers. comm.), presumably as transplants (Figure 1, Appendix 2). An additional population in the Pinhorn Grazing Range was reported by Olson (1976); however to date, this population has not been confirmed. These populations collectively

Figure 1. Known occurrences of soapweed in Canada (Alberta and Saskatchewan). Numbers correspond to detailed descriptions of locations included in Appendix 2.

represent the northern limits of the species range.

2. Other Areas. - An additional Canadian population consisting of approximately 50 non-reproducing plants is located in Fox Valley, Saskatchewan (Figure1, Appendix 2); it is speculated that these plants were transplanted from the Onefour population in the early twentieth century (Maher et al. 1979). Yucca glauca is abundant throughout most of its range, which extends from Texas north to Alberta and from the Rocky Mountains east to the Mississippi River (Figure 2, Fairbarns 1984). Records of soapweed exist from Montana, North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kansas, Oklahoma, Texas, Wyoming, Colorado and New Mexico (Webber 1953), although it is likely that the New Mexico plants are hybrids between Yucca glauca and Yucca elata.

POPULATION SIZE AND TREND

1. Alberta. - Two native populations of Y. glauca exist in Alberta representing a total potentially reproducing population size of 29 557 rosettes in 8903 clones (Csotonyi and Hurlburt 1999). Populations do not appear to be in decline when compared to a 1977 estimate of 55 000 plants (Milner 1977, Csotonyi and Hurlburt 1999), disparities in estimates between 1977 and 1998 are due to differences in sampling methods. Other seemingly transplanted plants scattered throughout southern Alberta are not known to reproduce sexually, most likely due to the absence of the yucca moth.

The Lost River population is estimated at 28 174 rosettes distributed among 8499 clones (Csotonyi and Hurlburt 1999), densely concentrated along a 2 km stretch of the south-facing coulee. Each clone is made of a number of genetically related rosettes that at one point were interconnected by roots. The Lost River population is one of the most densely populated and one of the most isolated populations of soapweed observed in its entire range. Several hundred plants have colonized the prairie, mostly occurring in a deep belt downwind (northwest) of the coulee in the direction of prevailing winds.

There has been some speculation that the population may be spreading onto the prairie; however the plants are all roughly the same age and size indicating that they are a result of some other process besides dispersal. It is possible that the plants are capable of residing on the prairie flats, but must first be released from competition with other species by regular occurrences of fire. The last grass fire in the area was in the mid 1970s (Allan Ross, pers. comm.), which seems to correspond with the age of the plants. Due to the sparsely vegetated nature of the slopes, plants growing on the slopes would not be affected by fire routinely.

The Pinhorn population is comprised of approximately 1383 rosettes among 404 clones (Csotonyi and Hurlburt 1999) that are not known to have reproduced sexually in recent years (D. Hurlburt, unpubl. data), despite a possible increase in population size (Csotonyi and Hurlburt 1999). Frequently during times when no sexual reproduction is occurring, yuccas will reproduce asexually by increasing the numbers of rosettes in a clone (Kingsolver 1986).

2. Other Areas. - As stated in the previous section, the Saskatchewan soapweed population consists of approximately 50 non-reproducing plants and is extremely susceptible to eradication. In the United States, however, soapweed is, on the whole, widespread and abundant under present conditions (see Status Designation).

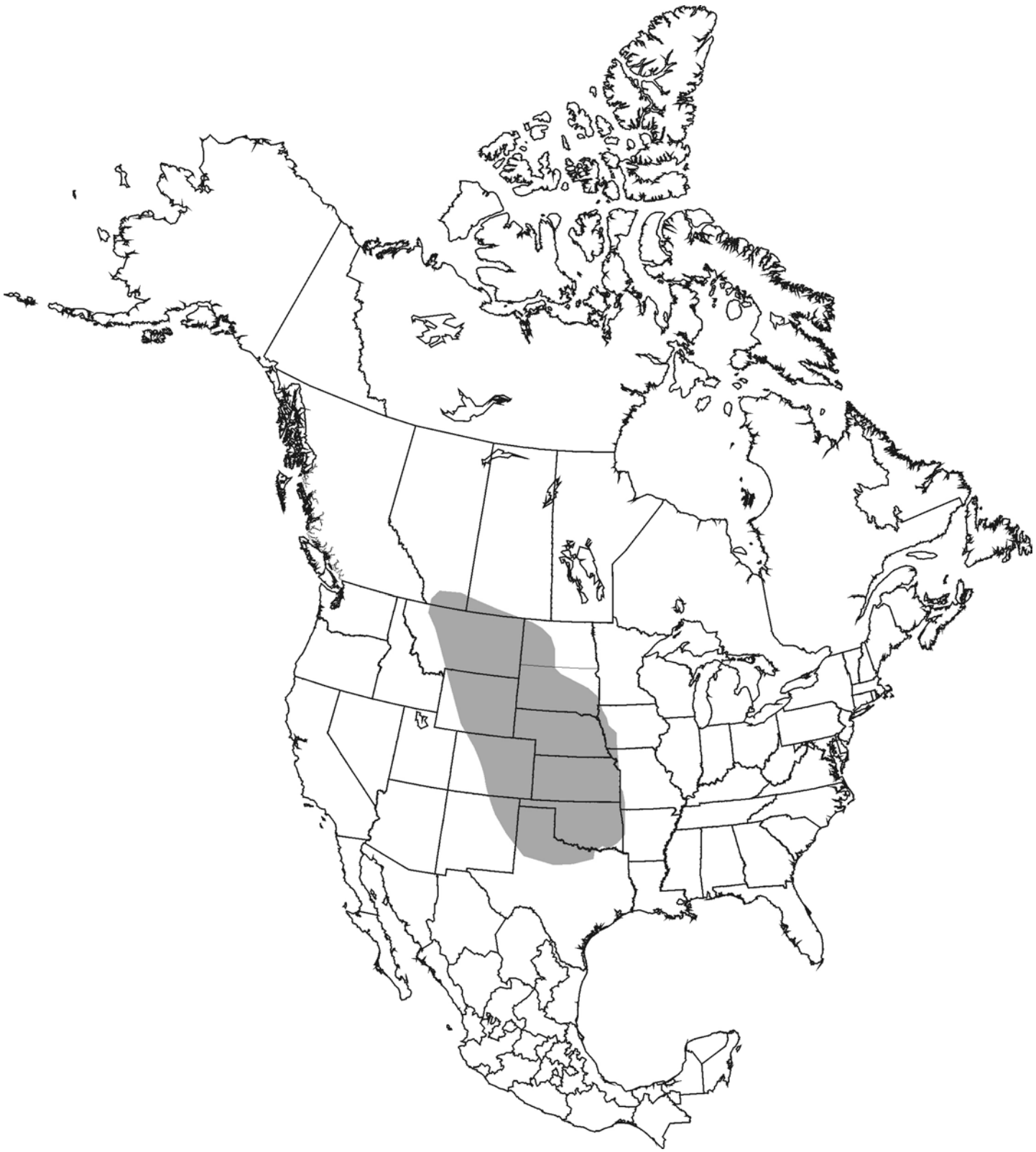

Figure 2. Distribution of soapweed (Yucca glauca) in North America.

LIMITING FACTORS

1. Pollinators and Pollen Dispersal. - At present, the status of the yucca moth has not been assessed in Canada, nor does it have any special protection, despite its intimate connection with the 'vulnerable' soapweed. Although yucca moths are widely distributed in the southwestern United States, it is suspected that its status is more precarious in Canada because of its isolation, short life span relative to the yucca, and the apparent reduction in fecundity in the Pinhorn soapweed population. There has been an absence of fruit production, lack of pollination, and low emergence of moths from fruit in Pinhorn in recent years (Csotonyi and Hurlburt 1999, D. Hurlburt unpubl. data); all indicative of the yucca moth declining locally.

Preliminary studies (Csotonyi and Hurlburt 1999, D. Hurlburt, unpubl. data) indicate that the Onefour population may be suffering from pollen limitation, a rare condition in the genus Yucca. Through most of the soapweed range, plants are resource limited, having more pollinated flowers than can be matured into fruit (Wilson and Addicott 1998). Therefore, plants can afford to selectively shed flowers that receive low qualities or quantities of pollen; or flowers receiving more ovipositions. In most yuccas, 6% to 10% of flowers will mature as fruit (Wilson and Addicott 1998). With the exception of a single high elevation population of soapweed in Colorado (Dodd and Linhart 1994), the Alberta populations may be unique because of a lack of fruit production in some years (<1% of flowers), low pollination and low emergence of moth larvae from fruit. One probable explanation for these differences is that Alberta populations tend to be pollen limited. Pollen limitation occurs when the total number of pollinated flowers is low, and may result for a number of reasons: low temperatures may restrict activities of yucca moths (Dodd and Linhart 1994) and possibly their over-wintering survival; flowering is unpredictable and may not occur on an annual basis or coincide with moth emergence; and/or yuccas have high flower loss because of herbivory or wind, which may directly influence larval survival. Pollen limited plants commit fewer resources to seeds and produce a higher percentage of asymmetrical fruit (John Addicott, pers. comm.) where seeds do not fully develop in locules or sections of locules that do not receive sufficient pollen. Even during an extremely high flowering year, the Onefour population shows some indication of pollen limitation in that a high proportion (~1% to 2%) of fruit are misshapen relative to other populations and have decreased numbers of viable seeds (D. Hurlburt, unpubl. data).

2. Flowering Phenology. - The maintenance of the yucca/yucca moth mutualism is dependent upon the degree of overlap of appropriate life history stages between the plant and its pollinator. In this case, pollinating moths must be active when flowers are receptive to pollen. Flowering in populations of Y. glauca in Alberta is highly asynchronous, having the longest flowering season (approx. 83 days in 1998) of any documented population of Yucca spp. In species of Yucca with similar numbers of flowers, flowering typically lasts about 40 to 50 days (James et al. 1994, Addicott and Tyre 1995). Asynchronously flowering individuals (i.e., plants flowering earlier or later than average) are expected to have a lower reproductive fitness than yuccas flowering more synchronously because of decreased pollinator visits, lower rates of pollen deposition and a smaller potential for out-crossing. From a pollinator's perspective, mismatched life history stages may lead to decreased fitness from an absence of flowers in which to lay eggs.

3. Habitat Fragmentation and Alteration. - Alberta populations of Y. glauca are isolated from other populations in the main range by a minimum of 100 km, with most of the intervening native habitat destroyed by intensive strip farming in Montana. At a glance, it appears that soapweed is physiologically (due to more sun exposure on south-facing slopes) restricted to coulee slopes however, these slopes are also the only areas not readily reached by farm machinery. It is plausible that soapweed have been artificially restricted to these slopes. Regardless of how the current distribution arose, the isolation of Alberta's soapweed populations will prevent re-colonization of yucca moths in these sites should they become extirpated, because yucca moths are particularly weak flyers, are short-lived and are not thought to have the ability to travel long distances over inhospitable terrain. Further, small peripheral populations of yucca may not contain enough plants to sustain yucca moths.

4. Herbivory. - Domestic livestock or wild ungulates may reduce reproductive success of Yucca species (Kerley and Whitford 1993, Csotonyi and Hurlburt 1999). Browsing ungulates may consume the flowers, parts of, or whole inflorescences, thereby arresting sexual reproduction. In southern Alberta, this appears to be a routine phenomenon with great variation among years. Fairbarns (1984) found no evidence of herbivory in Onefour in 1984 and in 1999 only a few flowers or inflorescences were consumed (D. Hurlburt, unpubl. data). However, in 1998, Csotonyi and Hurlburt (1999) discovered that 80% of inflorescences in Pinhorn were clipped or entirely consumed by large herbivores. In the summer of 1999, less than 1% of flowers at Pinhorn were eaten during the flowering season, although an increase in herbivory did occur later in the season after unpollinated flowers were shed. Artificial removal of flowers in a unpredictable population of flowering plants can cause a decline in fruit production and moth survival, and has the potential to, through decreased recruitment, lead to long term population decline in isolated peripheral populations.

Efforts are being made to increase numbers of Pronghorn antelope in the prairie ecosystem; it is plausible that increasing the population size of this herbivore may have substantial implications for the survival of Y. glauca and its moth. Antelope were observed eating individual flowers in Onefour in the summer of 1999, however at no point did they stray from their usual travel routes to obtain flowers. In Onefour, cattle do not have access to yuccas during the flowering season and in Pinhorn, although cattle are present at the site, there is no evidence to suggest that they are feeding on soapweed. There was no cattle dung, or tracks surrounding recently browsed soapweed inflorescences.

Herbivory by insects did appear to significantly affect those plants residing on the prairie in Onefour where up to 50% of flowers were damaged by grasshoppers (D. Hurlburt, unpubl. data). Grasshoppers generally consumed the style and anthers, necessary reproductive parts, of individual flowers. This did not appear to be a problem for plants located on coulee slopes nor at Pinhorn Grazing Reserve. Soapweed is also frequently inhabited by high densities of aphids and ants (which tend the aphids); although there is no sign that the aphids are adversely affecting plant fitness.

5. Wind. - Periodic intense winds can greatly affect the reproductive success of soapweed. Large numbers of flowers and young fruit were blown off inflorescences at periodic intervals throughout the summer of 1999 at both Onefour and Pinhorn sites. In Pinhorn, over 50% of the flowers were lost during

windstorms in 1999. Individual plants located at the tops of coulee slopes or on the prairie flats were particularly susceptible. It is suspected that the yucca moth is also negatively affected during such adverse conditions since they can not easily fly among inflorescences to collect pollen or to pollinate.

6. Horticultural and Medicinal Uses. - There are numerous examples of transplanted wild soapweed in household gardens throughout southern Alberta. Soapweed is an attractive garden plant and appears to thrive in fertilized gardens with routine watering (J. Dormaar, pers. comm.). Soapweed populations in Alberta have been receiving a moderate amount of publicity in recent years, and during the last flowering season (1999), people visited the Onefour site daily. Although the soapweed populations in Alberta are not under direct threat from being removed from their natural habitat by gardeners, their habitat may be threatened by increased vehicle traffic (Wershler and Wallis 1986). Off road traffic destroys cryptogamic soil crusts and causes an increase in erosion. In addition, there are a number of cases of individual plants being run over by trucks on the prairie flats.

There has been recent interest in the collection of seed for the development of nursery stock in Canada. Although there is no legal way to discourage such collecting, the practice was discouraged. Fruit production is extremely low some years, and when combined with seed collection, could very well jeopardize the viability of Alberta populations. To date, the relative importance of the few, high fruiting years to the more frequent, low fruiting years in maintaining soapweed populations is unknown.

The popularity of herbal remedies and drugs, of which Yucca spp. are a common component, has increased in recent years. Yucca roots contain high concentrations of saponins (a chemical used in soaps, hence the name soapweed), a precursor to cortisone. Yucca root is a therapeutic anti-inflammatory phytosterol with the ability to break up inorganic obstructions and deposits and is commonly used to treat arthritis, gout, cystitis, skin inflammation and it is also used as a laxative. Although Alberta populations of soapweed will never be harvested by large commercial operations because of their small population size, they could be threatened by smaller, grass-roots based harvesting especially with the recent local publicity on the medical uses of Yucca (Appendix 3).

7. Exploitation by Non-pollinators. - The mutualistic relationship between the yucca and the yucca moth is also confounded by the presence of a non-pollinating moth (a closely related species to the yucca moth, Tegeticula intermedia) that does not pollinate, but lays eggs in early-stage yucca fruit. Non-pollinators may have significant impact on the mutualism by laying enough eggs in the yucca fruit that their larvae consume all the seeds (Addicott 1996), competing with yucca moth larvae for food and limiting sexual reproduction of the yucca. In other systems, the larvae of pollinating yucca moths have been shown to play a large role in limiting exploitation by non-pollinators (James 1998) as the yucca moth larvae outcompete the exploiter larvae. In southern Alberta, however, the asynchrony issue may preclude this regulatory mechanism. There is a notable absence of yucca moths in some years or in some parts of the yucca flowering season and this mechanism cannot serve to limit exploitation. However, there is some anecdotal evidence from the 1999 field season to suggest that the asynchronous phenology may also be a disadvantage to non-pollinators. Non-pollinating larvae laid late in the season may not have sufficient time to develop before the yucca fruit discharges its

seeds, leading to the inevitable demise of the larvae. This will be investigated further in future flowering seasons.

STATUS DESIGNATIONS

1. Alberta. - Soapweed has been recognized as a 'rare' plant in Canada and a 'very rare' plant in Alberta, as defined by Argus and White (1978) and Packer and Bradley (1984). Argus and White (1978) defined a 'rare' species as one that fits one of the following criteria: 1) has a small population size within the province, 2) is restricted to a small geographical area, or 3) occurs sparsely over a wide area. Packer and Bradley (1984) further quantified this definition and additionally defined a 'rare' species as one known from five or fewer locations. Currently, soapweed has an S1 designation in Alberta (Gould 2000), meaning it is found in five or fewer locations in Alberta or has few remaining individuals (Appendix 1).

2. Other Areas. - In October 1999, COSEWIC and consequently Canadian Wildlife Service directors reassessed the status of a number of species using new criteria adapted from the IUCN Red List (IUCN 1994). As a result, Canadian yucca populations were changed from 'vulnerable' to 'threatened' status. Nothing about this species' population changed, just the status criteria. Soapweed had been listed as 'vulnerable' by COSEWIC since 1985. The species is of special concern because of characteristics that make it particularly sensitive to human activities or natural events, and in particular, because it occurs in few locations (COSEWIC 2001). In Saskatchewan, soapweed has been designated as SE, due to its exotic nature and because it is native to nearby regions in Alberta (Csotonyi and Hurlburt 1999, Nature Serve 2000; Appendix 1). Soapweed's National Heritage Status rank in Canada is 'N1'(Nature Serve 2000; see Appendix 1 for status definitions).

The Global Heritage Status rank for soapweed is G5, meaning it is demonstrably secure given current situations, known from a hundred or more locations, and has in excess of 10,000 individuals (Nature Serve 2000). In the United States, its National Heritage Status rank is 'N5', meaning the species is secure and ineradicable under present condictions (Nature Serve 2000). It is not considered to be rare in any other states in which it occurs, and in many places is considered widespread, abundant and weedy.

RECENT MANAGEMENT IN ALBERTA

No steps have been taken to manage or protect the soapweed since it received its 'vulnerable' designation by COSEWIC. Further, the designation of COSEWIC status confers no legal protection for the species, although it does provide a moral awareness. The species is however on the tracking list of plant species of special concern of the Alberta Natural Heritage Information Centre to monitor population trends over time (Gould 2000).

Csotonyi and Hurlburt (1999) recommended that soapweed remain designated as 'vulnerable' in Canada. In was also recommended that the status of the yucca moth also be evaluated and if necessary, that the species be considered for protection. Finally, to preserve the Pinhorn population, it was recommended that a fence be placed around the site to restrict feeding by ungulates.

At present, there is ongoing research in Alberta to assess how environmental variation at the edge of the yucca/yucca moth range influences the strength, and costs/benefits of the mutualism, relative to centre of the species'

ranges. Alberta's population of soapweed, the yucca moth and the interaction between the two is unique. This relationship is being quantified for the purposes of gaining insight into the evolution of mutualisms and so that optimal management decisions can be made for the conservation of the yucca, the yucca moth and their surrounding habitat in Canada.

SYNTHESIS

At present little is known about northern populations of soapweed in Alberta. Recent studies indicate that Alberta's populations are unique relative to other populations from the centre of the species range, however, it is not known if these differences are adaptive or as a result of decreased fitness from extrinsic factors. To discern between the two, detailed studies of population dynamics through time and associated changes in reproductive fitness of both the soapweed and the yucca moth are necessary. Studies on the genetic diversity and population structure of central and peripheral populations of Y. glauca are necessary to determine the significance of Alberta's isolated peripheral populations. The ecological status of the mutualism in this northern, peripheral location must be assessed. Lastly, the effect of external factors such as grazing, the maintenance of high levels of wild ungulates and vehicle traffic needs further investigation. Regardless of current status, the management of soapweed, the yucca moth and their habitat will not be possible without the cooperation of government, range managers and the public.

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APPENDIX 1. Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife rank lists (after Alberta Wildlife Management Division, in prep)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be at risk after formal assessment and designation as Endangered in Alberta or in Canada (in the part of the range that includes Alberta).
May be at Risk	Blue	Any species believed to be at risk. These species will require a detailed assessment for possible formal designation as Endangered or Vulnerable.
Sensitive	Yellow	Any species known to be, or believed to be, particularly sensitive to human activities or natural events.
Secure	Green	Any species known to be, or believed to be, not at risk.
Status Undetermined	Status Undetermined	Any species where not enough information exists to adequately use the ranking system (exceptional cases only).
Not Assessed	n/a	Any species known or believed to be present but which have not yet been evaluated.
Exotic/Alien	n/a	Any species that have been introduced as a result of human activity.
Extirpated/Extinct	n/a	Any species no longer thought to be present in the jurisdiction or are believed to be extinct.
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably outside their usual range.

B. Alberta Wildlife Act

Species designated as 'endangered' under the Alberta Wildlife Act include those defined as 'endangered' or 'threatened' by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade.
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed.

C. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

D. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2001)

Extinct	A wildlife species that no longer exists.
Extirpated	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
Endangered	A wildlife species that is facing imminent extirpation or extinction.
Threatened	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern (Vulnerable)	A wildlife species of special concern because it is particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species.
Not at Risk	A wildlife species that has been evaluated and found to be not at risk.
Indeterminate	A species for which there is insufficient scientific information to support status designations.

E. Heritage Status Ranks (after Nature Serve 2000)

G1/S1	**Critically Imperiled**: Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2/S2	**Imperiled**: Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).
G3/S3	**Vulnerable**: Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
G4/S4	**Apparently Secure**: Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.
G5/S5	**Secure**: Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10,000 individuals.
GX/SX	**Presumed Extirpated**—Element is believed to be extirpated from the nation or subnation*. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH/SH	**Possibly Extirpated** (Historical)—Element occurred historically in the nation or subnation*, and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An element would become NH or SH without such a 20-year delay if the only known occurrences in a nation or subnation were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, NH or SH-ranked elements would typically receive an N1 or S1 rank. The NH or SH rank should be reserved for elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all elements not known from verified extant occurrences.

APPENDIX 2: Soapweed occurrences in Canada.

Location	Co-ordinates	Number of clones	Reproductive Status (Sexual=Fruit Prod.)	Moths	Origin (Natural or Transplanted)	Source
Lost River, AB	49°00' 00" N 110°26' 00" W	8499	Sexual most years	Yes	Natural	Milner 1977 Csotonyi & Hurlburt (1999)
Site 1: Pinhorn Grazing Reserve, AB	49° 05' 12" N 110° 50' 04" W	404	Non-reproductive in 1997-99; appears to be in decline	Few	Natural	Csotonyi & Hurlburt (1999)
Site 2: Pinhorn Grazing Reserve, AB (Unconfirmed)	49° 05' 12" N 110° 50' 04" W	Unk.	Unknown	Unk	Natural	Olson (1976)
Police Point Park Medicine Hat, AB	50° 03' 00" N 110° 40' 00" W	1	Non-reproductive	No	Transplant	Carol Porter, pers. comm.
Site 1: Sugarbowl Coulee, Lethbridge, AB	49.697 ° N 112.871 ° W	8	Non-reproductive	Unk	Unknown	Ernst & Saunders (1998)
Site 2: Sugarbowl Coulee Lethbridge, AB	49.697 ° N 112.871 ° W	2	Non-reproductive	Unk	Unknown	Ernst & Saunders (1998)
Fox Valley, SK	50° 28' 00" N 109° 29' 00" W	50	Non-reproductive	No	Transplant	Maher et al. (1979)
Lethbridge Agricultural Station	49° 42' 00" N 112° 47' 00" W	1	Non-reproductive	No	Transplanted (From Lost River)	J. Dormaar, pers. comm.

Appendix 3: Example of recent interest in the herbal properties of yucca in Alberta.

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