SUMMARY of THREATS AND CONSERVATION GUIDELINES

Dakota Skipper

Hesperia dacotae (Skinner)
(Lepidoptera: Hesperiidae)

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U.S. Fish and Wildlife Service
Twin Cities Field Office

For further information or to comment on these conservation guidelines, contact Phil Delphey, U.S. Fish and Wildlife Service, Bloomington, Minnesota.

Summary of Guidelines to Conserve Dakota Skipper Populations

The bulleted items below comprise summary guidelines for conserving Dakota skipper populations. For a detailed description of the species, its biology, habitat, and historical and current status, see Cochrane and Delphey (2002) and refer to report sections Threats to Dakota Skipper Populations and Conservation Recommendations below. For additional assistance and site-specific consultations, contact the U.S. Fish and Wildlife Service Ecological Services Field Office in your state (Appendix A).

Use Fire Carefully to Manage Dakota Skipper Habitat

- If you plan to burn Dakota skipper habitat, divide the Dakota skipper habitat at the site into as many burn units as feasible, use the maximum length fire return interval that is adequate to maintain or restore high-quality native prairie habitat on each unit, never attempt to burn the entire management area in any single year, and allow fires to burn in a patchy (”fingering”) pattern within units. Allow at least 3-4 years before re-burning any area (i.e., four- or five-year rotations) to allow Dakota skippers to rebuild populations in burned areas.
- Conduct surveys and evaluate other applicable information to understand the distribution and relative abundance of Dakota skippers within and among burn units. Surveys are especially important the year before a planned burn. Be aware that poor weather or other conditions may reduce the likelihood of adequate survey conditions during the flight period in any given year. Therefore, it may be prudent to plan surveys for two consecutive years before a planned burn.
- Spring burns should be conducted as early as possible to limit larval mortality. Dakota skipper larvae are less vulnerable to fire before they have resumed activity in the spring and after they have ceased activity in the fall (i.e., when they are in sub-surface shelters). Moreover, late spring burns may delay flowering of early and midsummer blooming forbs, thereby limiting nectar sources for Dakota skippers during their flight period (Dana 1991:56). Fall burns, however, may result in higher soil temperatures than early spring burns and greater mortality of

larvae, even after they have retreated for the season to sub-surface shelters. In addition, the removal of plant material by fall burns may expose larvae to greater temperature extremes during winter, which may reduce their survival. If a site is managed with prescribed fire, subdivide Dakota skipper habitat into rotational burn units (see above) even if all burning will likely be done when Dakota skippers are in sub-surface shelters. Other species of butterflies that rely on native prairie (e.g., Iowa skipper, *Atrytone arogos iowa*, and poweshiek skipperling, *Oarisma poweshiek)* may still be vulnerable to high fire mortality even during early spring fires because these species' diapausing (dormant) larvae may be present in the foliage, above the ground surface. Moreover, subsurface temperatures may reach lethal levels where fuel loads are especially high (see below).

- Do not use prescribed fire to manage Dakota skipper habitats if the smallest feasible burn unit would burn most or all of their habitat in one year unless you can identify an area from which you are reasonably certain Dakota skippers will recolonize the burned area. This requires a good understanding of the Dakota skipper populations in the potential source area and of the management planned for that area during the relevant time period. Acquisition and restoration of adjacent habitat or alternate management strategies (e.g., light grazing or late summer/fall haying) may be necessary to conserve Dakota skippers on relatively small and isolated sites.

- If you plan to change the configuration of burn units or make other changes to your prescribed fire plan, review the location and timing of recent burns to understand the potential effects of these previous fires on the current abundance and distribution of Dakota skippers on the management area. Always conduct surveys of burn areas at least one year before the planned burn.

- Be sure to consider any other rare, prairie-dependent species present on sites when designing burn plans.

- Plan for a reasonable worst-case scenario with regard to the escape of fires out of burn units. That is, plan for the contingency that the burn will escape a burn unit and burn one or more additional units that contain Dakota skipper habitat. Determine how the Dakota skipper population would persist despite such a reasonable worst-case scenario.

- High fuel levels increase the likelihood that fires will kill Dakota skippers, even during early spring burns when larvae are still in their subsurface shelters. Therefore, consider reducing fuel levels (e.g., with haying the previous fall) before conducting burns where fuel levels seem to be high.

Use of Haying to Manage Dakota Skipper Habitats

- There is a variety of ways in which to hay or mow Dakota skipper habitats (see report section Haying for further information) that have evidently allowed for the persistence of Dakota skipper populations at various sites in South Dakota, North Dakota, and Manitoba. These guidelines would also apply to mechanical collection of native prairie seed.
- Hay or mow after early or mid-August to reduce the likelihood of removing or destroying Dakota skipper eggs and to avoid removing nectar sources during the flight period. In general, hay or mow as late as feasible after early or mid-August to reduce the likelihood of adverse effects to any life stage. The ideal time to mow may be after Dakota skipper larvae have entered diapause (i.e., have become dormant in preparation for winter). The senescence of native warm-season grasses may be a good indication that Dakota skippers have entered diapause. Mowing early in the spring during the time that burning should be conducted (see above) would also reduce the likelihood of adverse effects to Dakota skipper.
- Annual haying may reduce plant diversity in Dakota skipper habitat. Therefore, hay in alternate years if feasible or subdivide the habitat into multiple units and leave at least some of the units unhayed each year. Resting hay units may also reduce the impacts of any adverse effects that may occur from haying that is conducted early enough to adversely affect Dakota skippers or other species dependent on native prairie (e.g., Ottoe skipper, *H. ottoe*).

Use of Grazing to Manage Dakota Skipper Habitats

- Grazing may be a feasible management alternative, if properly managed, to conserve Dakota skippers, at least in parts of their range. Dakota skippers persist on some native prairie sites that are grazed every year, although overgrazing has likely led to the extirpation of the species from numerous sites.
- Beyond a certain point, grazing is likely to adversely affect Dakota skipper populations in proportion to its intensity, due to trampling of Dakota skippers, removal of floral nectar resources, degrade native prairie plant communities, soil compaction, and other causes. See the report sections about grazing under both Threats to Dakota Skipper Populations and Conservation Recommendations.
- Avoid grazing regimes that remove floral nectar resources during the flight period.
- Adverse effects may occur at lower grazing intensities in the wet-mesic prairies that Dakota skippers inhabit in parts of North Dakota and Manitoba than in the dry-mesic habitat type. Virtually all of the sites with the wet-mesic habitat type at which Dakota skippers still occur are managed with fall or late-summer haying. To ensure the persistence of Dakota skippers at these sites, they should not be grazed unless grazing methods are developed that are shown to not threaten the Dakota skipper populations at these sites.

Preserve Prairie Habitats and Connections among Populations; Attempt or Investigate Habitat Restoration

- Whenever feasible, avoid any destruction or conversion of Dakota skipper habitats to other uses. Successful restoration of Dakota skipper habitat has not been demonstrated. Therefore, there is no evidence to support a presumption that destroyed Dakota skipper habitat could be restored through planting or other means. Nevertheless, lost or degraded Dakota skipper habitats may be recoverable, especially if the adverse management has not been especially intense or if it is recent. For example, good quality Dakota skipper habitat that is intensively grazed for one year may be likely to recover if more appropriate management is resumed and if a source population is nearby or if the species persisted on a significant portion of the site. Restoration of destroyed (e.g., plowed) or severely degraded Dakota skipper habitat, however, should be considered experimental.

- As stated above, very little is known about the restoration of Dakota skipper habitat. Nevertheless, habitat restoration could be very beneficial to the species and experimental attempts to restore habitat could yield valuable information. To experiment with the restoration of habitat for Dakota skippers, the location must be close enough (e.g., less than 250 m) to an area that would provide immigrants to the restored habitat. Sites adjacent to occupied habitats or connected to occupied habitats by suitable habitat corridors are best for restoration experiments. Techniques to attempt restoration could consist of a variety of activities (e.g., rest from grazing, tree or brush removal, etc.), depending on the site conditions and land-use history. Restoration experiments should be designed to mimic the floral diversity of Dakota skipper's native prairie habitats and should emphasize Dakota skipper nectar and larval food sources, as appropriate (see Cochrane and Delphey 2002).
- Road rights-of-way containing native prairie habitat may serve as corridors for grassland butterflies (Ries & Debinski 2001), but the cooperation of the highway managers is very important to prevent untimely mowing or spraying of these areas.
- If Dakota skippers are extirpated from a site or likely once occurred there, manage the site to favor the recolonization of the species, especially if it has retained significant characteristics of Dakota skipper habitat. Depending on the quality of the habitat, recolonization may be feasible if source sites are nearby or if artificial reintroduction may become an alternative in the future. If recolonization is possible, monitor the sight during the flight period to detect any Dakota skippers. See report section Management of "Extirpated" Sites for further details.

Coordinate Management with Owners and Managers of Nearby Populations

- Conduct surveys to delineate local populations to enable coordination and management of populations that may cross one or more management units or ownerships.
- Coordinate management activities with property owners and managers of nearby Dakota skipper habitats. For example, plan burns and other potential adverse management activities during years when nearby habitats will not be burned.

Survey Habitats and Monitor for Dakota Skippers

- Effective management of sites to conserve Dakota skippers depends on knowledge of the distribution and relative abundance of Dakota skippers. Employ qualified persons to survey known and potential habitats and to monitor Dakota skipper populations. This is especially important when first devising management plans, changing management plans, and for ongoing evaluation of the effects of management on Dakota skipper populations.

Maintain Genetic Diversity of Populations

- Dakota skipper populations show signs of inbreeding (Britten & Glasford 2002). Manage Dakota skipper habitat to maximize genetically effective population sizes -- the number of individuals reproducing each year. For example, do not disturb habitats during the Dakota skipper flight period, connect isolated populations, expand suitable habitat patches, etc. Consider how various management practices may affect the number of breeding adults in both the short- and long-term. For example, activities that kill Dakota skippers during larval or pupal stages will also affect the number of breeding adults.

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Conversion of Dakota Skipper Habitat to Non-Grassland

Within the historical range of Dakota skipper (Fig.1), the extent of native prairie habitat has declined sharply since approximately 1830 (Royer and Marrone 1992, Table 1). Smith (1992) states that in 1900 most of the prairie in Iowa had been converted to cropland and that the prairie ecosystem in Iowa "was close to extinction." "Two hundred and forty million acres of tallgrass prairie were converted to agricultural land in about seventy years" in Iowa, beginning about 1850 (Smith 1992). Similar settlement and destruction of Illinois prairie began about twenty years earlier (Smith 1992). Samson and Knopf (1994) reported that >99% of the original tallgrass prairie in Iowa, Minnesota, and North Dakota is destroyed (from 21 million total has down to 43,000 ha), while 85% of South Dakota's original 3 million ha of tallgrass prairie is gone. Mixed grass prairies in North Dakota have declined by approximately 72% (data are not available for South Dakota mixed grass prairie, Samson and Knopf 1994). These figures do not, of course, account for the amount of remaining tallgrass and mixed grass prairie that is degraded (e.g., by overgrazing, invasion by smooth brome, plant succession, etc.) to the point that it is no longer suitable for Dakota skippers.

A. Agriculture

Dakota skipper populations have evidently survived in areas that are relatively unsuitable for row crop agriculture (McCabe 1981) due to steep terrain (e.g., in the Prairie Coteau of South Dakota), relatively poor soils, or both. Nevertheless, since approximately 1980 observers have recorded the extinction of several populations of Dakota skipper as a result of conversion of their habitat for agricultural use. Royer and Marrone (1992) documented loss of four sites in North Dakota that were converted to irrigated potato fields and one in South Dakota that was also converted for crop production. One site in Manitoba at which Dakota skipper was last recorded in 1991 (Fannystelle) was subsequently converted to row-crop agriculture (Webster 2003). Although conversion of prairie for agriculture may be the single most important factor in the decline of the species' abundance since Euro-American settlement, the threat of such conversion to extant populations is not well known. In North Dakota, further conversion is a threat in the important Towner-Karlsruhe complex (Royer and Royer 1998, Lenz 1999) where the flat topography and high water table facilitate conversion to irrigated crop production (Gary Erickson, J. Clark Salyer National Wildlife Refuge, North Dakota, pers. comm. 2001; R. Royer, Minot State University, Minot, ND, pers. comm. 2001). Webster (2003) states that "nearly all" extant populations of Dakota skipper in Manitoba occupy flat terrain that may be vulnerable to conversion for agriculture, although soil conditions "may make some of these sites unsuitable to row crops (Kennedy *cited in* Webster 2003).

B. Mining and Other Causes

Conversion of prairie for non-agricultural land uses, such as gravel mining and housing (New 1981), also has caused recent extirpation of Dakota skipper populations and threatens others. Gravel mining threatens habitat of Dakota skipper at some Minnesota sites (Dana 1997); for example, the progressive loss of habitat to gravel mining is a significant threat at Felton Prairie sites (Braker 1985, R. Dana, pers. comm. 2001, B. Winter, The Nature Conservancy, Glyndon, MN, pers. comm. 2001), although a recent stewardship plan appears to have alleviated the immediacy of this threat at Felton Prairie (P. Buesseler, Minnesota DNR, pers. comm. 2003). Skadsen (pers. comm. 2001, 2002) also reported that one site in South Dakota (Mundt Pasture, in the One Road Lake-Oak Island Prairie complex) would be at least partly destroyed by a planned 4-lane highway and that the project's need for gravel may exacerbate the threat posed by gravel mining in the project's vicinity.

Increasing water levels in South Dakota may also threaten some Dakota skipper habitat. Skadsen (1997) reported loss of one site to flooding due to rising water levels at Bitter Lake, South Dakota.

Finally, wind energy turbines and associated infrastructure (e.g., maintenance roads) likely threaten Dakota skipper habitat, at least on private land in South Dakota (Skadsen 2002:39).

Degradation of Dakota Skipper Habitat

Degraded sites support proportionally fewer native plant species, particularly nectar plants (R. Dana, pers. comm. 2001). Dana (1991) concluded that "(R)egular access by adults to nectar is clearly important" for Dakota skippers. Nectar provides critical water, but also provides carbohydrates to supplement larval fat reserves to meet the energetic demands of flight (Dana 1991). Moreover, fecundity would likely decline in Dakota skippers with inadequate access to nectar, as has been observed in other butterfly species (Dana 1991). Dakota skippers appear to prefer plant species whose nectar resources are unavailable to nectarivores that lack "a slender trophic apparatus about 5 mm in length or longer" (Dana 1991). Such plant species, such as *Echinacea angustifolia, Astragalus adsurgens, Verbena stricta, and Oxytropis lambertii,* may contain a more dependable "standing crop" of nectar for Dakota skippers (Dana 1991:48). Dakota skippers appear to be nectar-generalists, however, when apparently preferred species are absent (Dana 1991). The absence or paucity of preferred nectar species, however, may reduce adult survival, female fecundity, or both.

Royer (*in litt.* 2000) suggests that habitat degradation may affect larval survival more than adult survival or reproduction. Soil compaction and vegetation removal, whether by extensive grazing, mowing, or fire, may substantially alter soil water movement, evaporation, and near-surface humidity, which in turn affect larval survival. To test these hypotheses, Royer (*in litt.* 2000) is currently implementing a study to "identify and analyze edaphic microhabitat features within occupied sites across the species' remaining U.S. range and in both occupied hay meadows and adjacent grazed units in North Dakota."

Prairie habitat may also be degraded by invasion of exotic plants, by methods used to control plant and invertebrate pests, by improperly managed grazing, haying, or burning, or by suppression of natural disturbance regimes that lead to accumulation of plant litter and succession. All these threats are greatly exacerbated by habitat fragmentation (see below) because it reduces or eliminates the likelihood that immigrants from other populations may immigrate into formerly occupied sites.

A. Invasion by exotic or alien species

Invasion of native prairie habitats by species such as leafy spurge, Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), and Canada thistle (*Cirsium arvense*) threatens Dakota skippers throughout their current range. Skadsen (2002) surveyed 51 known and prospective Dakota skipper sites in South Dakota in 2002, including Waterfowl Production Areas, a National Wildlife Refuge, state game production areas, state parks, and privately and tribally owned sites, and found that invasive plants threatened the native prairie habitat at each site. Once these plants invade a site they often become dominant and replace native forbs and grasses used by Dakota skipper adults and larvae, respectively. Dana (1991) suggested that Dakota skipper larvae probably would not be able to survive on grasslands dominated by smooth brome because of its large widely spaced stems and because it becomes senescent in mid- to late-summer, when larvae need palatable plant tissue. These traits may preclude efficient larval feeding due to the distance between the larvae' ground-level shelters and the portions of the plant (large and widely spaced stems), reduce the effectiveness of larval shelters (widely spaced stems), and limit the availability of high-quality larval food sources (mid- to late summer senescence). Kentucky bluegrass is also senescent during the summer when Dakota skipper larvae are feeding (Dana 1991).

B. Pest Control

Broadcast spraying of insecticides to control grasshoppers kills butterflies and is greatly harmful to small Dakota skipper populations (Royer and Marrone 1992). Grasshopper outbreaks may also adversely affect small and isolated butterfly populations through their short-term destruction of prairie vegetation (John Payne, Animal and Plant Health Inspection Service, Hyattsville, Maryland, *in litt.*1994).

Broadcast chemical control of exotic plants such as aerial spraying of leafy spurge also eliminates native forbs that are skipper nectar sources (Royer and Marrone 1992). In repeated surveys, Royer and Marrone (1992:33) observed what "appears to be a correlation between disappearance of *Hesperia dacotae* and the advent of chemical spurge control methods in Ward, Barnes and Ransom Counties of North Dakota" including the Sheyenne National Grasslands area in the last ten to twenty years. Dana (1997) concluded that herbicide use for weed and brush control on private lands is the principal threat to skippers at the Hole-in-the-Mountain complex, Minnesota.

C. Grazing

Bison (*Bos bison*) grazed Dakota skipper habitats historically (Bragg 1995, Schlicht and Orwig 1998), but cattle (*Bos taurus*) is now the principal grazing ungulate in these habitats. Cattle's grazing differs substantially from bison grazing patterns (Matlack et al. 2001). Both species may adversely affect Dakota skippers by removing forage for larvae (i.e., palatable grass tissue) and adults (i.e., nectar-bearing plant parts), trampling larvae, and, hypothetically, by altering larval microhabitats (Royer *in litt.* 2000, see above). Dana (1997) reported that in Minnesota, grazing by cattle reduces skipper numbers in direct proportion to grazing intensity. This is likely also true for bison. As with fire, however, Dakota skipper populations may survive even intensive grazing episodes if a sufficient portion of the habitat patch remains suitable (e.g., left ungrazed or lightly grazed) for reproduction or if nearby populations are not simultaneously extirpated and provide immigrants to refound extirpated populations. Dakota skippers are able to coexist with cattle grazing in tallgrass prairie, depending on the qualities of the grazing management (duration, intensity, etc.; see below).

1. <u>Effects of Grazing on Dakota skippers in the Mixed Grass Prairie Region</u>

In the mixed grass prairie region of North Dakota, Dakota skippers may be able to tolerate little to no grazing (McCabe and Post 1977, Royer and Marrone 1992, Royer and Royer 1998). McCabe (1981) observed that grazing eliminated Dakota skippers on alkaline prairies in North Dakota; nectar plants such as tooth-leaved primrose (*Oenothera serrulata*) and harebell rapidly diminished with light grazing whereas heavy grazing eliminated long-headed coneflower (*Ratibida columnifera*) and purple coneflower (*Echinacea angustifolia*). Long term grazing of sufficient intensity (i.e., proportion of plant biomass removed), duration, or both often leads to the replacement of native plants with exotic, cool-season species, such as Kentucky bluegrass and smooth brome, and greatly reduces floral diversity; absent intensive human intervention, floral diversity is not restored when grazing pressure declines (Dana 1997, Jackson 1999). Cattle also likely physically destroy larvae (McCabe 1981) in proportion to their density and duration of grazing. Royer (*in litt.* 2000) suggests that adverse grazing impacts to Dakota skipper in mixed grass prairie may stem more from altered soil and moisture characteristics caused by cattle trampling than from direct mortality or changes to vegetation.

2. Effects of Grazing in Tallgrass Prairie

Overgrazing is a significant threat to Dakota skippers in tallgrass prairie, although the species may persist in grazed tallgrass prairie when grazing management (intensity, duration, etc.) allows for the persistence of important habitat components. Livestock grazing is the dominant use of privately owned tallgrass prairie remnants in South Dakota (except for property owned by private conservation groups), Higgins 1999). According to Dakota skipper experts, grazing threatens Dakota skipper populations on most of the privately owned sites on which the species occurs. Grazing is likely to adversely affect Dakota skippers when it significantly reduces the density and diversity of important nectar and larval host plant species or eliminates them entirely. In overgrazed native prairie in Minnesota, exotic grasses are “major to dominant”, native forb species richness and diversity decline, and “foliage height is often less than 10 cm” (Dana 1997). In South Dakota, Higgins (1999) found that vegetation height and litter depth were lower on privately owned prairie remnants, which are mostly grazed. Land managers also frequently use herbicides to control weeds and brush on grazed remnant prairies, which evidently further reduces native forb diversity (Dana 1997). At Felton Prairie in Minnesota, Braker (1985) and Schlicht (1997b) each found significantly higher numbers of Dakota skippers in ungrazed than in grazed tallgrass prairie.

In tallgrass prairie Dakota skipper populations can be eliminated by overgrazing within one year, but grazing does not necessarily lead to their decline at a site (Dana 1983, Dana 1991). Dakota skipper densities have remained relatively high at some grazed sites (Tim Orwig, personal observation in Schlicht 1997b:3). In tallgrass prairie, Dakota skippers may benefit from light grazing that maintains areas of mixed grass vegetation structure (Dana 1991). Schlicht (1997b) found that Dakota skipper was relatively abundant on prairies subjected to light grazing regimes, but absent on nearby idle prairies that were no longer used for grazing; moreover, he observed more Dakota skippers per hour on the lightly grazed prairies than on nearby habitat managed with fire (Schlicht 1997b). Similarly, in eastern South Dakota, Dakota skipper populations were deemed secure at sites managed with light rotational grazing, which retained vegetative diversity (Skadsen 1997).

D. Haying

As with grazing, haying (i.e., mowing grasslands and removing the cuttings) can either adversely affect or benefit Dakota skipper populations, depending on how it is implemented. Haying generally maintains prairie vegetation structure. If done before or during the Dakota skipper's flight period it may adversely affect nectar availability, favor growth of Kentucky bluegrass, and kill adult Dakota skippers or cause them to emigrate (Royer and Marrone 1992, McCabe 1979, 1981, Dana 1983, Dana 1997). In the Dakotas, late season (mid-August to October) haying appears to minimize adverse affects, although Lenz (1999) concluded that annual haying may diminish the vigor of native, warm season grasses and reduce forb density in north-central North Dakota habitats.

Most remnant Dakota skipper populations in the eastern Dakotas are found on fall-hayed prairies (McCabe 1979, 1981, Skadsen 1997), as are many of the sites in Manitoba (Webster 2003). Webster (2003) found "healthy populations" of Dakota skipper in Manitoba on sites used as hay fields. He described the habitat on these sites as follows:

> "The mowed sites are characterized (during the flight season of the adults) by the absence of standing dead grass and low numbers of shrubs, often extensive areas with shorter bunch grasses (bluestem grasses), and abundant and readily

observable nectar flowers, as compared to un-mowed sites. Small shrubs such as *P. floribunda*[1] occur along the margins of the hayed prairies and often on un-mowed prairies."

McCabe (1981) suggested that late season haying is highly beneficial to maintaining Dakota skipper populations and Webster (2003) suggested that Dakota skipper populations might be more common on hayed prairies than on idle (unmowed) prairies. Moreover, Swengel and Swengel (1999) observed significantly greater relative abundance of Dakota skippers on hayed tracts compared with either idle or burned tracts in Minnesota.

[1] Shrubby cinquefoil, *Pentaphylloides floribunda.*

E. Controlled Burning

Historically, fire was an important element in sustaining native grasslands (Bragg 1995). Today, managers often use prescribed or controlled fires to retain native grassland structure and species and to achieve other objectives (e.g., limit invasion of smooth brome). Controlled fire, however, frequently differs from historical wildfire in its relative patchiness, frequency, intensity, and seasonality. For example, controlled fires are often set during dormant periods for warm-season native grass species whereas wildfires mostly occurred during the summer (Bragg 1995). Moreover, remnant prairies are often burned more frequently and thoroughly than occurred historically (Schlicht and Orwig 1998). The latter is partly a function of the relatively small patches in which native prairie now occurs. Before widespread prairie destruction began in about 1830, native grasslands were relatively continuous from Illinois to Manitoba. Therefore, even in years when fire may have been extensive, the area of unburned prairie was likely also immense relative to the extent of native prairie today.

Among "duff-dwelling" insects, Dakota skippers exhibit all of the characteristics that Panzer (2002) found were likely to result in negative population responses to fire – remnant dependence (i.e., native prairie remnants), upland inhabitance, low ability to disperse, and univoltism (having only one generation per year, Panzer 2002, Swengel 1996). He considered insects with at least one of these characteristics to be "fire-sensitive" and would characterize Dakota skippers as "hypersensitive". Panzer (2002) found that populations of remnant-dependent species "tended to decline sharply following dormant season fires" and that mean declines of "fire-negative" species was 67%; actual mortality among fire-negative species was likely higher, however, due to some immigration during the interval between the fires and population sampling. When prairie remnants are burned in large units or even from border to border, a large proportion of skippers may be eliminated at once, although complete extirpation of a population may not happen very often after a single burn event (Panzer 2002). Historically, Dakota skipper populations probably persisted because burns and other intense disturbances (e.g., intensive bison grazing) likely affected only a relatively small proportion of the occupied habitat, allowing for recolonization from unburned areas during the subsequent flight period (Swengel 1998a).

Without careful design and implementation, prescribed burning on isolated remnant prairies can extirpate local populations of Dakota skipper, especially after repeated events (McCabe 1981, Dana 1991, Swengel 1998a, Orwig and Schlicht 1999).

Fire on prairie remnants may decrease the abundance or even contribute to the extirpation of Dakota skipper. In systematic surveys of Minnesota prairies, Swengels (Swengel and Swengel 1999; Swengel 1998a) observed significantly lower relative abundances of Dakota skipper on sites that had been burned, compared with otherwise similar hayed sites. Similarly, Schlicht (1997b) counted fewer Dakota skippers per hour along transects in burned than on grazed sites in the Minnesota Valley area. Orwig and Schlicht (1999) speculated that burning eliminated Dakota skippers from the last known population in Iowa, at Cayler Prairie, despite 20 years of legal protection on this 64-ha (160 acre) preserve. Similarly, Schlicht (2001) attributes a marked decline in Dakota skipper observations at Prairie Coteau Preserve in Minnesota to repeated fires. In 2003, Webster (2003) found fewer Poweshiek skipperlings (*Oarisma poweshiek)* in sections of Manitoba's Tall-grass Prairie Reserve burned in 2001 or 2002 (0.8/15 min count, n = 10) than in portions of the Reserve not burned for two or more years (15.9/15 min count, n = 7). Moreover, the mean number of butterfly species observed during these counts was 1.6 and 9.6 in sites burned in 2001 or 2002 versus sites unburned for two or more years, respectively. Dakota skipper also occurs at this site. Webster (2003) cautioned, however, that pre-burn data were not available to control for other factors that may have influenced butterfly abundance and species richness.

Rotational burning has been hypothesized to benefit Dakota skippers by increasing nectar plant density and by positively affecting soil temperature and near-surface humidity levels due to reductions in litter (e.g., Dana 1991). Swengel (1996), however, found lower relative abundances of Dakota skipper and other prairie-specialist butterfly species in burned units than in otherwise similar hayed units four years after burns. Panzer (2002), however, concluded that "Regimes that allow for 3 years of recovery (4-year rotations) must be considered conservative in terms of insect conservation." At Prairie Coteau Preserve in Minnesota, Schlicht (2001) found greater flower abundance on regularly burned than rarely burned sites although Dakota skipper abundance had declined most on the burned sites. In summary, the long term, population level effects of rotational, controlled fire on Dakota skippers remains a subject of scientific debate (e.g., Ann Swengel, Baraboo, WI, *in litt*, 1993, 1994, R. Dana, *in litt.* 1994, Panzer 2002, Panzer & Schwartz 2000). It is clear, however, that under at least some conditions and when too frequent or extensive relative to the area of suitable habitat, fire is a threat to Dakota skipper populations.

Timing of burns may be important in determining effects to Dakota skipper populations. At Hole-in-the-Mountain Prairie in southwestern Minnesota, Dana (1991) conducted several experiments to evaluate the effects of early- vs. late-spring fires and different fuel levels on Dakota skipper mortality. In one experiment, he conducted the early-spring burn on April 25 when larvae were "still in buried shelters" and the late-spring burn on May 30 "when they were in shelters on the surface." Despite higher ambient temperatures during the early spring burn, temperatures 5 mm below the soil surface (the estimated average depth of buried shelters, Dana 1991:11) were 10° C higher during the late-spring burn. In other experiments Dana (1991) found that fuel load was positively associated with subsurface soil temperature and that fuel load influences whether temperatures reach levels that are likely lethal for Dakota skipper larvae. Fuel loads that were clearly associated with lethal subsoil temperatures, however, were more typical of mesic tallgrass prairie – approximately twice the fuel loads that Dana found in the dry-mesic habitats of Dakota skipper in southwestern Minnesota (Dana 1991). Although he found the results of his experiments "unsatisfactory" for evaluating "the question of how much the timing of spring burns relative to larval phenology affects the risk of mortality", he concluded that a late-spring burn (conducted on June 5) in "moderate" fuels (430 – 440 g/m^2) would have "a devastating effect" on Dakota skipper populations and that early spring burning (i.e., before May 1 in southwestern Minnesota) would afford "some amelioration". His moderate fuel level was slightly higher than the fuel load he measured in a nearby dry-mesic prairie that had not been burned for several years.

F. Lack of Management/Disturbance

Although inappropriate or excessive grazing, haying, and burning threaten Dakota skipper populations, their persistence depends on some type of disturbance implemented at appropriate frequencies and intensities. Prairies that lack periodic disturbance undergo succession to woody shrubs, accumulate litter, have reduced densities of nectar plant flowers, and may face increased risk of exotic species (e.g., smooth brome) invasion (McCabe 1981, Dana 1983, 1997). Braker (1985) found reduced Dakota skipper numbers at Felton Prairie, Minnesota in tracts that had not been hayed or burned for several years. In systematic surveys of Minnesota prairies, Swengel and Swengel (1999) observed significantly lower Dakota skipper abundance on unmanaged or idle sites, compared with abundance on hayed sites, but found higher abundance on idle than on burned sites. Skadsen (1997) reported deterioration of several unburned and unmowed South Dakota prairies in just a few years due to encroachment of woody plants and exotic grasses.

On some sites game managers intentionally facilitate succession of native prairie communities to woody vegetation or plant trees. This effectively converts prairie habitats to shrubland, forest, or semi-forested habitat types and facilitates invasion or expansion of adjacent grasslands by exotic, cool-season grasses. Moreover, the trees and shrubs provide perches for birds that may prey on Dakota skippers (for example, Hole-in-the-Mountain County Park, Minnesota [Dana 1997]).

G. Prairie Plant Harvesting

A potential threat to Dakota skipper populations is collection of purple coneflower for the commercial herbal remedy market (Skadsen 1997). Purple coneflowers are an important nectar source for Dakota skippers in much of their range. Biologists surveying skipper habitats have not reported signs of *Echinacea* collecting, but illegal or unregulated harvest could become a problem in Dakota skipper habitats due to economic demands (Skadsen 1997).

H. Habitat Fragmentation

What may have been a single population of Dakota skippers spread across formerly extensive tallgrass and mixed grass prairie (McCabe 1981, Fig. 1) is now fragmented into approximately 62 isolated populations (Fig. 2, Cochrane and Delphey 2002). Britten and Glasford (2002) studied seven populations in the southern portion of the species' range and found that the small genetic differences among them suggest that these populations, now isolated from one another to varying degrees, were formerly connected. Each Dakota skipper population is now subject to "genetic drift that will erode its genetic variability over time" (Britten and Glasford 2002). Britten and Glasford (2002) also found heterozygote deficiencies relative to Hardy-Weinberg expectations and high inbreeding coefficients. Reduced genetic diversity could lower the capacity of local populations to adapt to environmental changes.

Dakota skippers are not likely to disperse over long distances. Interviews with five experts (Cochrane and Delphey 2002) suggests that typical movements from one prairie patch to another may be less than 1 km. Isolated populations that are eliminated by fire, overgrazing, exotic plant invasion, untimely haying, or other causes will not be refounded by immigrants (McCabe 1981, Swengel 1998a). Extirpation of small, isolated populations may take many years, but may be inevitable where immigration from nearby populations is not possible (Hanski et al. 1996). In systematic surveys on Minnesota prairies, Swengel and Swengel (1997, 1999) found no Dakota skippers on the smallest remnants (<20 ha), and significantly lower abundance on intermediate size (30-130 ha) than on larger tracts (>140 ha). These differences were not caused by vegetative characteristics, because site size did not correlate significantly with vegetation type, quality, or topographic diversity.

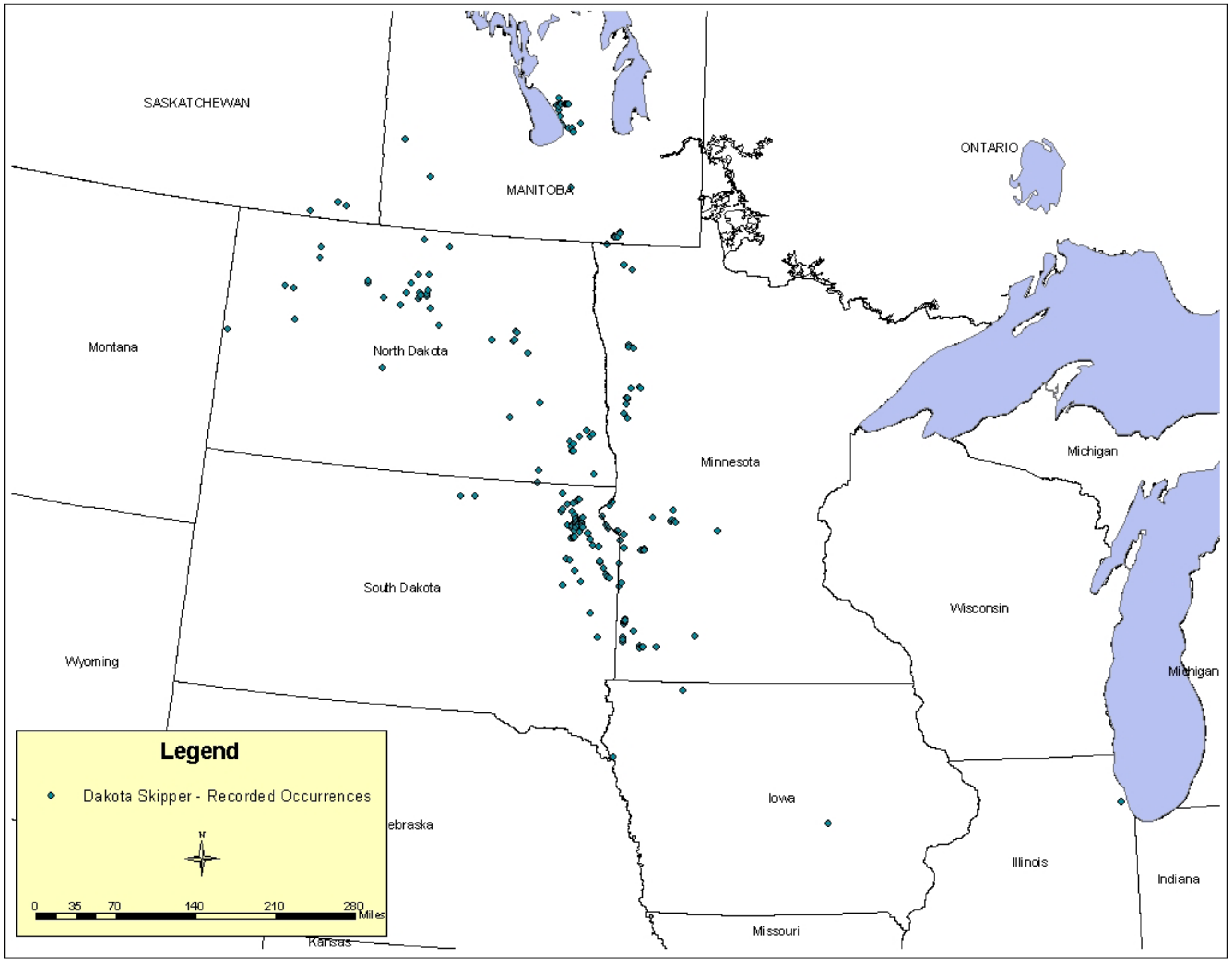

Fig. 1. All recorded populations of Dakota skipper.

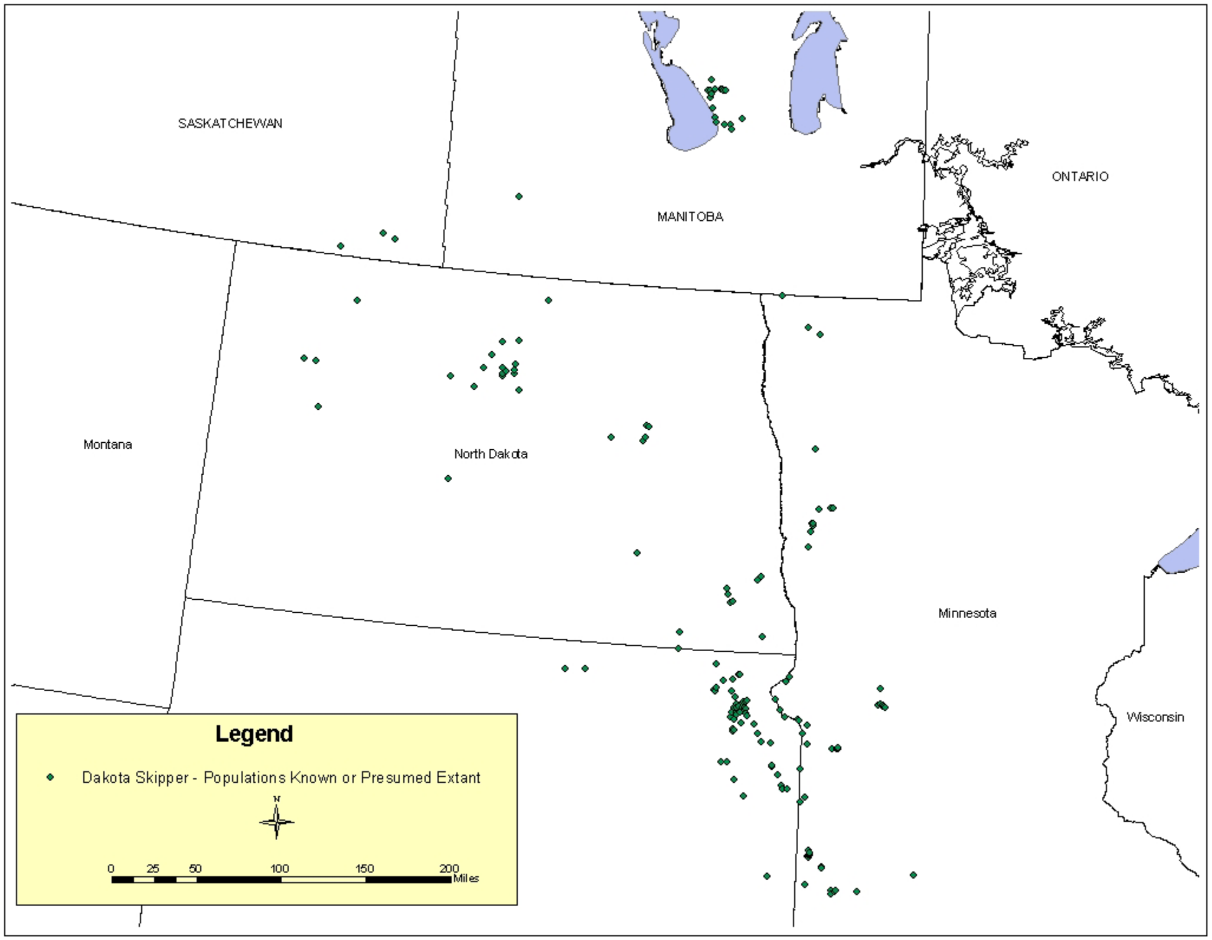

Fig. 2. Dakota skipper occurrences that are known or presumed to be extant. This includes some occurrences whose status is unknown. Some occurrences may be near enough to be part of the same population.

I. Other natural or manmade factors affecting the conservation of Dakota skipper

Interspecific competition does not appear to limit Dakota skipper distribution or population size because co-occurring species use different plant species as nectar sources (McCabe 1979, 1981). Further, hybridization involving Dakota skippers has not been reported (Royer and Marrone 1992).

Global climate change, with projections of increased variability in weather patterns and greater frequency of severe weather events, as well as warmer average temperatures, would affect remnant prairie habitats and would likely be detrimental for Dakota skippers (Royer and Marrone 1992). The effects of gradual shifts in plant communities and catastrophic events, such as severe storms, flooding, and fire, are exacerbated by habitat fragmentation. Populations that are isolated demographically and genetically beyond dispersal distance from other sites cannot recover from local catastrophes.

Even with proper prairie management, small populations are vulnerable to weather conditions and an accidental event when restricted to isolated sites (Schlicht and Saunders 1994). Dakota skipper numbers may decline in coming decades due to the extirpation of isolated local populations where recolonization is no longer possible, even without further habitat destruction (Schweitzer 1989). Long term (e.g., ≥50 year) persistence is only possible where metapopulations composed of interacting demes are large enough to persist when at least some local populations persist.

Summary of Status and Threats

In 1995, the U.S. Fish and Wildlife Service (1995) concluded that the Dakota skipper faced loss and degradation of its prairie habitat due to harmful burning, haying, grazing, and pesticide use. Invasion of prairie by alien plants, plant succession, and habitat loss through physical conversion of prairie were also negative factors. The Dakota skipper and its habitat were in long term decline, but the demise of the species was deemed not imminent. Expert advice to the U.S. Fish and Wildlife Service suggested that additional survey work was needed in Minnesota (R. Dana, *in litt.* 1994) and South Dakota (Skadsen 1999b) and that generally more surveys and trend analysis were needed (A. Swengel, *in litt.* 1994). Numerous additional surveys have been conducted throughout the range of Dakota skipper since that time and those surveys' positive findings are reported in this document. Based on comments from Dakota skipper experts throughout the species' range, eastern South Dakota may be the only area in which significant areas of potential habitat remain unsurveyed (see below). Royer (*in litt.* 1994) contended that declines in North Dakota habitat, however, were clearly threatening the species in that state. The U.S. Fish and Wildlife Service determined that listing Dakota skippers under the Endangered Species Act was not warranted in 1995 and stated its intent to bring sufficient management and protection to the species to enable its removal from the candidate species list.[1]

Since the early 1990s, Dakota skipper populations have been lost from seven North and South Dakota sites documented in Royer and Marrone (1992) (Royer 1997, Skadsen 1997) and threats at many remnant sites are unabated. Due to substantial survey effort, however, numerous previously unrecorded locations have been documented since 1991, including at least 30 site records in South Dakota (Skadsen 1997, 1999, 2002), 15 in Minnesota (Schlicht and Saunders 1994, Schlicht 1997a,b, Minnesota Natural Heritage Program database), 11 in North Dakota (Royer and Royer 1998, Royer 2002) and several in Manitoba in 2002 (Webster 2003). Many of these sites are within complexes, however, and may only comprise local populations within metapopulations. Further surveys are still needed in South Dakota, because viable populations may exist south and west of the species' current documented range (Skadsen 1998, 1999a, 2002).

Also since 1995, at least four Dakota skipper sites have been protected, at least from some threats, via acquisition or conservation easement. The Nature Conservancy has purchased one site in the Sheyenne Grasslands region of North Dakota (Brown Ranch preserve) and the U.S. Fish and Wildlife Service has purchased easements preventing grassland conversion at three sites in North Dakota. Most easements are located in these important metapopulations: Glacial Lakes area, Minnesota, Towner-Karlsruhe complex in North Dakota (4) and One Road Lake-Oak Island Prairie complex in South Dakota (6). Fish and Wildlife Service easements do not provide legally binding protection from overgrazing, but do preclude conversion and haying before July 15.

More than a decade ago Schweitzer (1989) concluded, "This species is extirpated from a significant portion of its range… Its continued survival…is now threatened by fragmentation of its habitat. …Several decades into the future…the best that can be hoped for is the survival of a few metapopulations on some of the larger prairie preserves and gradual disappearance of the small remnant colonies." Royer and Marrone (1992) similarly concluded that because of ongoing trends the Dakota skipper was very likely heading to eventual extinction throughout its range unless extensive reserves were managed for this species.

Dakota skippers are adversely affected by a variety of activities that threaten to endanger the species throughout a significant portion of its range. The vast reduction and fragmentation of the formerly extensive prairie grasslands exacerbates these threats. Dakota skippers are likely to persist only in native tall- and mixed grass prairie remnants where (1) they have survived since the onset of rapid prairie destruction following Euro-American settlement on-site or where extant populations are near enough to facilitate immigration (approximately 0.5 km); (2) management facilitates the persistence of a plant community dominated by a species rich assemblage of native grasses and forbs; (3) grazing, if conducted, is managed to allow for abundant larval and adult food sources present during the larval and adult flight periods, respectively, at least in a

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[1] Dakota skippers were removed from the candidate species list in 1996 when the list of category 2 candidates was eliminated (Federal Register 61:64481-64485).

sufficient portion of the site; (4) haying, if conducted, is done only while adults and larvae are absent or in diapause, respectively, at least in sufficient portions of the site; (5) tallgrass prairie is managed by fire, grazing, or mowing that prevents invasion of exotic, cool-season grasses and woody plants; (6) managers ensure that the frequency, timing, and relative coverage (e.g., patchiness) of prescribed fires allow for sustained recolonization of burned areas by Dakota skippers from unburned patches within isolated populations or metapopulations; (7) conversion of Dakota skipper habitat by gravel mining, agriculture, or other activities is prevented or effectively mitigated; and, (8) genetically effective population sizes are sufficient to avoid deleterious effects of genetic drift on population growth (i.e., extinction).

Conservation Recommendations

Background

Dakota skippers are now highly dependent on the management of their habitat. Dakota skippers are distributed among highly fragmented remnants of the once vast native prairie. Without management, most or all Dakota skipper populations will gradually disappear due to plant succession. On both public and private sites, however, management activities frequently adversely affect Dakota skippers due either to conflicting management objectives or lack of knowledge about conserving Dakota skippers. Therefore, it is important to understand how to manage habitats of this species to ensure the persistence of remaining populations. Skadsen (1999b) emphasized that improved prairie management on public lands, improved cooperation among land management agencies, improved communication between agencies and private landowners, and easement and cost-share incentive programs were necessary to conserve Dakota skipper.

Habitat Protection and Restoration

Opler (1981) recommended that prairie preserves should be at least 400 ha (1,000 acres) in extent to conserve insect populations. He based this on observations reported from Iowa and Minnesota where invertebrate prairie obligates were often missing from tracts under 40 ha (100 acres) and in tenuous status on tracts between 40 and 400 ha. As previously described, Swengel and Swengel (1997, 1999) found the highest Dakota skipper densities on sites >140 ha (346 acres) in Minnesota. Smaller reserves connected by migration corridors of suitable habitat, such as highway and railroad right-of-ways if maintained in native vegetation, may suffice where large reserves are not possible (Opler 1981, Moffat and McPhillips 1993). These collections of small sites presumably allow butterflies to disperse between sites or local populations to recolonize disturbed areas, thus replicating historical population dynamics and movements among local populations. Although not specific to Dakota skippers, Ries et al. (2001) found preliminary evidence that managing roadsides for native vegetation benefits butterfly communities.

Prairie Management

Moffat and McPhillips (1993) and Swengel (1998b) provide good general overviews on managing prairie habitats to benefit butterflies. The following sections of this report use their guidance plus additional references more specific to Dakota skippers. Management prescriptions must be tailored to the specific ecological region (Madden et al. 2000) and the desired ecological outcomes or goals for each site (e.g., plant and animal species composition, exotic plant invasion threat, etc.) (Swengel 1998b, Willson and Stubbendieck 2000).

Dakota skipper populations are largely isolated from one another. As a result, populations are likely to experience genetic drift that will erode their genetic variability over time (Britten and Glasford 2002). Therefore, management should strive to maximize genetically effective population sizes -- the number of individuals reproducing each year -- to reduce or avoid the deleterious effects of genetic drift. This may be achieved, in part, by minimizing habitat disturbances throughout the breeding (i.e., flight) period and by connecting isolated populations. Such connections may be feasible at some sites, such as between the Hole-in-the-Mountain sites and Prairie Coteau SNA in Minnesota, which are geographically close (Britten and Glasford 2002).

Britten and Glasford (2002) also recommend devising plans for managing groups of semi-isolated populations, or metapopulations. They suggest first conducting field studies similar to that of Dana's (1991), where necessary to delineate local populations, then devising management plans to maximize the size of each population while maintaining connections among them. Finally, the plans should describe how management would occur to avoid disrupting mating during the peak flight period and to consider impacts to larvae.

A. Prescribed Burning

Periodic fires prevent succession of prairie plant communities from grassland to woody or shrubland types, which would render the site unsuitable for Dakota skippers. Fire can also increase plant nutritional qualities and flowering rates (Dana 1991, Bragg 1995) and decrease fuel loads. Fires and bison grazing were essential to maintaining prairie grasslands (Bragg 1995). To persist, species endemic to prairies must be able to either survive fires in place or to recolonize burned areas. Although fires kill Dakota skipper larvae (Dana 1981) and kill or displace adult butterflies, adults in contiguous or nearby populations —where they exist—may recolonize burned areas. When Dakota skipper populations are isolated, however, potential immigrants are not available to restore local populations eliminated by fire or other intense disturbances (e.g., overgrazing) (McCabe 1981, Royer and Marrone 1992, Swengel 1998a, Orwig and Schlicht 1999).

Timing and frequency of prescribed fire treatments and the proportion of the site burned in any year or series of years, are critical considerations for conserving remnant butterfly populations on isolated prairie fragments. When managers prescribe burns in isolated prairie remnants, the timing, frequency, and proportion of the site burned are all critical to remnant butterfly populations. Moffat and McPhillips (1993) recommended using and timing fires only to meet specific management objectives (e.g., control exotic grasses), but to otherwise minimize prescribed burning. Swengel's (1998b) observations suggest, however, that burned prairies, even those burned rotationally, typically support fewer butterfly species than prairies managed without fire. Although long term population effects of prescribed fire remain subject to debate and research, a precautionary assumption is that all individual Dakota skippers within the area actually burned will be killed and that local populations may be depressed.

More specific to Dakota skippers, McCabe (1981) recommended that fires be directed away from the previous season's main oviposition sites, but this assumes substantial knowledge about site use by skippers. In controlled trials, Dana (1991) found evidence that early spring burns caused less mortality to Dakota skipper larvae than late spring burns. He also found that fires with relatively light fuel loads caused less mortality. He recommended early spring burning, especially when fuel loads are high. Depending on their exact timing and annual phenological variations, late spring through mid-July burns kill late instar larvae, which are either in the litter or on exposed plant parts, force adults to emigrate, or destroy Dakota skipper eggs (Dana 1983). Fall burns may also be detrimental because soil temperatures are typically warmer than in early spring, possibly causing greater mortality of larvae (Dana 1983). Moreover, fall burns may allow for greater subsurface temperature fluctuations during winter. McCabe (1981) suggested that night burns would likely destroy adults while slow back-burns may destroy any larval stage. Schlicht (2001) concluded that Dakota skippers are vulnerable to fire throughout their life cycle.

When fire is necessary at a Dakota skipper site, managers must carefully design burn units and rotations to minimize effects to butterfly populations and their host and nectar plants (Opler 1981, Panzer 1988, Swengel 1991, 1996, Moffat and McPhillips 1993, Dana 1997). Thus, managers should delineate Dakota skipper habitat within management areas and divide it between or among burn units. The unburned portions must provide true refugia with adequate habitat and space to ensure the persistence of the population while part of its habitat is effectively eliminated for a season or more. Because populations fluctuate naturally due to weather and other events, this refugium must be sufficiently large and should be left undisturbed long enough to assure sustaining these source populations through phases of low abundance. This will likely require that surveys be conducted before prescribed burn design to estimate Dakota skipper abundance and to delineate habitat locations within the management area.

Panzer (1988), Swengel (1991, 1996) and others suggest that patchy burns that leave mosaics of unburned spaces within burn units may also provide some refuge for butterflies and speed local recolonization following fires. Orwig (1996) observed that use of patchy, “fingering” fires on small portions of Hartleben Prairie, North Dakota, resulted in increased nectar sources while sustaining Dakota skippers. Uniform treatments affecting a large proportion of the Dakota skipper habitat at a site should always be avoided (Swengel 1996) and contiguous units should not be burned in consecutive years. Opler (1981) recommended dividing reserves into at least three units, with attention to local variation (micro-geographical scale) in species’ distributions.

Panzer (1988) suggested burning no more than 25-50% of reserves at once unless the habitat was highly degraded. More conservatively, Swengel (1991, 1996) recommended burn units covering no more than 20-25% of the total preserve distributed evenly among habitat types. Alternatives to burning, such as haying, grazing, and brush cutting, should be considered for maintaining prairie butterfly populations where burning is not essential to other conservation objectives. Dakota skipper populations appear stable; for example, on tallgrass prairie remnants owned by the Sisseton-Wahpeton Sioux Tribe that are managed with annual, fall haying (D. Skadsen, pers. comm. 2002). Webster (2003) also observed apparently strong Dakota skipper populations in Manitoba on prairies that were hayed every other year during the fall or late summer.

The numbers of years between burns to best conserve Dakota skipper populations varies based on numerous factors. In vigorous Minnesota prairies, Dana (1991) suggested that rotational burns every three years would beneficially remove accumulated litter. Swengel (1991, 1996) and Schlicht and Saunders (1994) recommended longer intervals of 5-10 years, to allow populations to recover between burns. Reduced fire frequency generally increases fire intensity due to greater fuel loads, although grazing and haying implemented between burns would reduce litter accumulation. Therefore, managers must weigh the trade-offs between increased fire intervals and the risks of high-intensity and widespread fires. For each site, managers have to balance management that is optimal for Dakota skippers with other critical site conservation objectives, such as efficiently controlling exotic plant invasions, while ensuring that Dakota skippers persist. For areas that are too small to meet both objectives, managers should consider acquiring and, if necessary, restoring adjacent habitat.

B. Haying

Swengel (1996) found that Dakota skipper populations responded positively in the year after haying (grass mowing and clipping removal) and were always more abundant in hayed than comparable burned units. Late season haying may forestall or retard succession of prairies to woody plants, thus maintaining skipper habitat (Royer and Marrone 1992). Fall haying may be the single best method for maintaining Dakota skipper populations, although it may not be adequate by itself in more mesic tallgrass habitats (Schlicht 1997) and is not always feasible. For mesic tallgrass prairie, Swengel (1998b) recommended rotational midsummer haying as a general management tool for prairie-specialized butterflies because it removes bulk and height from warm-season grasses that may suppress forb flowering. The stubble left after cutting provides some vegetation for egg-laying and larval feeding, although managers must be careful to leave sufficient nectar resources for adults (Swengel 1998b). Dana (1991) thought annual haying during the growing season in Minnesota tallgrass prairie could benefit Dakota skippers by reducing productivity of relatively robust species and litter accumulation and by favoring plant communities with stature more typical of mixed grass prairie. In mixed grass prairie in the Dakotas, very late (October) mowing is optimal to maintain prairie plant communities, while avoiding adverse effects to invertebrates and ground-nesting birds (McCabe 1981). At least six inches of grass stubble should be left, however, to protect overwintering larvae (R. Royer, pers. comm. in Moffat and McPhillips 1993). Because fall (post-growing season) haying leaves very little plant cover over winter, Swengel (1998b) recommended either rotational fall haying or leaving permanent unmowed areas.

Swengel (1991) recommended mowing no more than annually. Lenz (1999) observed that annual haying in central North Dakota may reduce native grass vigor and forb abundance and recommended occasional annual rests from haying to allow plant species recovery in the mixed prairie of North Dakota. Division and rotation of hay units, as recommended for prescribed burning, may be necessary to ensure persistence of Dakota skippers at some sites. (Moffat and McPhillips 1993). Swengel (1998b) recommended cutting no more than one third of mesic tallgrass prairie and no more than one-quarter of drier habitats occupied by Dakota skipper each year. Spreading the mowing over a few weeks may also reduce impacts (Swengel 1998b).

C. Grazing

Grazing may be the least understood prairie management tool relative to butterfly conservation (Moffat and McPhillips 1993, Swengel 1998b). Grazing of sufficient intensity or duration eliminates Dakota skippers from all types of habitat in which it occurs. Dakota skippers are able to persist, however, on some grazed lands. Grazing may be the only reasonable alternative to maintain prairie vegetation on rocky or steep areas and is an acceptable alternative in tallgrass prairie if well managed (Royer and Marrone 1992). In Minnesota, grazing may help maintain habitat structure preferred by Dakota skippers (Schlicht 1997), although grazing may be less beneficial than haying (Swengel 1998a, Swengel and Swengel 1999). Intensive (high stocking density and long duration or across seasons) and, in mixed grass prairie, even moderate grazing is highly detrimental to Dakota skippers (Royer and Royer 1998). Therefore, only carefully managed grazing should be used when it is necessary for prairie management on Dakota skipper sites (Moffat and McPhillips 1993). Dakota skippers have persisted on some privately owned and managed tallgrass prairie on which grazing is the principal management tool, most notably in the One Road Lake-Oak Island Prairie Complex in eastern South Dakota. The manner in which grazing is implemented (e.g., stocking rates, duration, etc.) is key to whether Dakota skippers will persist or become extinct at a given site. It is not uncommon for Dakota skippers to be common on one site, but extinct on an adjacent site where grazing has been more intense (D. Skadsen, pers. comm., 2002).

D. Brush control

On sites that will not be mowed, grazed, or burned, or where brush persists despite these disturbances, brush control may be a practical alternative to conserve prairie butterflies (Moffat and McPhillips 1993). Conifers can simply be cut, but most deciduous species will resprout and even spread if cut (Swengel 1998b). For resprouting species, Swengel (1998b) recommended direct application of herbicides in treatments spread over time.

E. Exotic species control.

In no case should pesticides that may be harmful to Dakota skippers or their nectar plants be broadcast or widely applied in Dakota skipper habitat (but see below). The first approach to exotic species control should be to address the underlying causes for the invasion. Methods to control exotic species once they are established can be more harmful to butterflies than the presence of exotic species.

In all cases, site-specific ecological (e.g., phenological) and species composition information should be considered when making plans to control or eradicate invasive species [e.g., see Willson and Stubbendieck (2000)]. Authors disagree on whether fire (Dana 1991) or haying (Swengel 1996) is preferable for simultaneously controlling exotic grass invasion and conserving Dakota skippers at a site. Willson and Stubbendieck (2000) found that the relative coverages of smooth brome and native, warm-season tallgrasses and the phenology of smooth brome are the key site-specific factors to consider in devising plans to successfully restore tallgrass prairie degraded by this exotic grass. Royer and Marrone (1992) suggested that mowing or, where mowing is not possible, controlled grazing can forestall invasion of Kentucky bluegrass, smooth brome and buckbrush, in tallgrass prairie. Where these practices are not practical or sufficient, hand removal or spot spraying may be justified (Orwig and Schlicht 1999, Olson 2000).

Moffat and McPhillips (1993) emphasized spot-herbiciding and spot brushing as overlooked tools to fight woody succession and invasion of exotics, such as leafy spurge. Biological control is another promising option (J. Payne, *in litt*. 1994), including release of flea beetles (*Aphthona spp.*) for leafy spurge on Dakota skipper habitat at Big Stone National Wildlife Refuge, Minnesota (Olson 2000). Use of chemicals to control leafy spurge and Canada thistle is likely to destroy other broad-leaved plants, many of which serve as nectar sources for Dakota skippers and other prairie insects (Royer and Marrone 1992). Widespread (e.g., aerial) applications of pesticides to Dakota skipper habitat should be avoided. Where such techniques seem unavoidable to control exotic species, managers should strive to avoid or minimize direct and indirect adverse effects to Dakota skippers through the development of new or modified control techniques or by finding alternatives to pesticides.

Management of "Extirpated" Sites

Sites from which Dakota skippers have evidently been extirpated, but still provide suitable habitat, should be managed with the assumption that the species may still be present. Dakota skippers may be overlooked during surveys (Britten 2001); only highly trained individuals can document the presence of the species and they must be present during its relatively short flight period. Moreover, recolonization of suitable habitats may occur naturally and these "extirpated" sites may be suitable for intentional attempts to reintroduce the species in the future if artificial propagation is implemented. Sites we describe as extirpated were described as such by Dakota skipper experts familiar with the sites. If there was significant doubt about the status of a population, we described its status as "unknown."

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