Ottoe Skipper (*Hesperia ottoe* W.H. Edwards): A Technical Conservation Assessment

Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project

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Author's Biography

Gerald Selby developed an interest in butterflies at an early age while growing up in Pakistan. He received a B.S. in Biology from Sterling College in Kansas in 1976, and an M.S. in Biology (Ecology and Systematics emphasis) from the University of Michigan in 1979. His interest in butterflies was rekindled through contact with Dr. W.H. Wagner (Pteridologist and butterfly enthusiast), and after completing his M.S. he had the opportunity to do additional butterfly collecting in Pakistan during an extended visit. From 1980-1987 he worked for the Clinton County Conservation Board in eastern Iowa, and during that time an exposure to prairie ecology and issues of prairie management gave purposeful direction to what had been a youthful hobby. A work accident left him with paralysis in his right arm, so he entered a Ph.D. program at Iowa State University in 1987, where his dissertation research was focused on the ecology and management of prairie butterflies in southwestern Minnesota. He worked as the Director of Science and Stewardship at The Nature Conservancy in Iowa from 1993-2002, and has been self-employed as an ecological consultant since 2002. Gerald has been actively involved in prairie butterfly surveys and research in Iowa and Minnesota since 1988.

Cover Photo Credit

Ottoe skipper (*Hesperia ottoe*) mating pair (male left, female right) on violet prairie clover (*Dalea purpurea*). Photograph © Robert Dana (used with permission).

Summary of Key Components for Conservation of Ottoe Skipper

Status

The Ottoe skipper (*Hesperia ottoe*) has been assigned a Global Heritage Status Rank of G3G4 (vulnerable to apparently secure). Its National Heritage Status Rank for United States populations is the same as the global rank (N3N4), but it is critically imperiled (N1) in Canada. There is currently no federal protection for the Ottoe skipper in the United States under the Endangered Species Act, but it has been designated as a sensitive species within USDA Forest Service (USFS), Regions 1, 2 and 9. The Ottoe skipper has been documented from 16 states and one Canadian province. State Status Rankings range from critically imperiled (S1), imperiled (S2), vulnerable (S3), and unranked (SNR). It is state/province endangered in one state (Indiana) and one province (Manitoba), state threatened in three states (Illinois, Michigan, and Minnesota), and of special concern in two states (Iowa and Wisconsin). However, it does not currently have state legal protection or special concern designation in any of the states comprising Region 2 of the USFS.

NatureServe summarizes the global status of the Ottoe skipper as "Not imminently imperiled now and certainly not demonstrably secure". This conflicted assessment stems from the fact that while the number of Ottoe skipper occurrences is relatively large and populations can be locally abundant in areas with large high quality prairie remnants, most populations are associated with small isolated remnants in the fragmented prairie landscape where they are highly susceptible to local extinctions. Further habitat loss and degradation, overgrazing, pesticide use, and "non-optimal" fire management programs all place these small isolated populations at risk, and if local extinctions occur, recolonization potential across the fragmented landscape is low.

Primary Threats

Historic loss, degradation, and fragmentation of the prairie landscape have been the primary factors contributing to the decline and current vulnerability of Ottoe skipper populations, and continued habitat loss, degradation, and fragmentation are the greatest potential threats to future populations. Activities that threaten further habitat loss include row crop agriculture, urban development and housing construction, road construction and maintenance, gravel mining, and wind generators. Threats to habitat quality and the availability of critical resources (e.g., nectar plants, larval food plants) include indiscriminant use of herbicides, invasive exotic species, and encroachment by woody vegetation (native and exotic). Fire, grazing, and haying can play important roles in maintaining and shaping prairie ecosystems, so the complete absence of these processes can constitute a threat to the extent and quality of prairie remnants. However, they can also pose direct and indirect threats to Ottoe skippers depending on their timing and intensity. Larvae are extremely vulnerable to direct mortality from fires when they are using aboveground shelters, and improperly timed fires, grazing, and haying can impact the availability of nectar and larval food resources at critical times. Other more direct threats to Ottoe skippers can include extreme weather (e.g., harsh winters, late frosts, unusually cool and wet growing seasons, severe storms), indiscriminant use of insecticides, disease, and predation. A reduction in fitness resulting from genetic isolation may also pose a long-term threat.

Primary Conservation Elements, Management Implications and Considerations

Ottoe skippers require relatively non-degraded, native mixed- and tallgrass prairie, and they cannot survive in the altered landscapes surrounding prairie remnants. They do not migrate and have limited dispersal capability, so if isolated populations are extirpated, it is unlikely that they will be repopulated. Each stage of the life cycle must be completed successfully each year at each site for local populations to persist through time. The small size and isolation of remnant Ottoe skipper populations make them more susceptible to events that might have been survived in the original prairie landscape. Therefore, management activities need to be designed to mitigate, not exacerbate, these increased vulnerabilities. Activities that improve the size, quality, and connectivity of prairie remnants should help to ensure long-term survival by reducing the probability of local extinctions, and increasing the probability of recolonization if local extinctions do occur. The timing, intensity, extent, and duration of management activities such as grazing and prescribed fire need to be adapted to ensure the availability of critical resources (e.g., nectar plants, larval food plants) when they are needed, and to mitigate any direct mortality that might result from them.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for the USDA Forest Service (USFS), Rocky Mountain Region (Region 2) (**Figure 1**). The Ottoe skipper is the focus of an assessment because it is listed as a sensitive species in Region 2. Within the USFS, a sensitive species is a plant or animal whose population viability is identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance and/or in habitat capability that would reduce its distribution [FSM 2670.5 (19)]. A sensitive species may require special management, so knowledge of its biology and ecology is crucial. This assessment addresses the biology of the Ottoe skipper throughout its range in Region 2. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal

Species assessments produced as part of the Species Conservation Project are designed to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations. Rather, it provides the ecological background upon which management must be based and focuses on the consequences of changes in the environment that result from management (i.e., management implications). Furthermore, it cites management recommendations proposed elsewhere and examines the success of those recommendations that have been implemented.

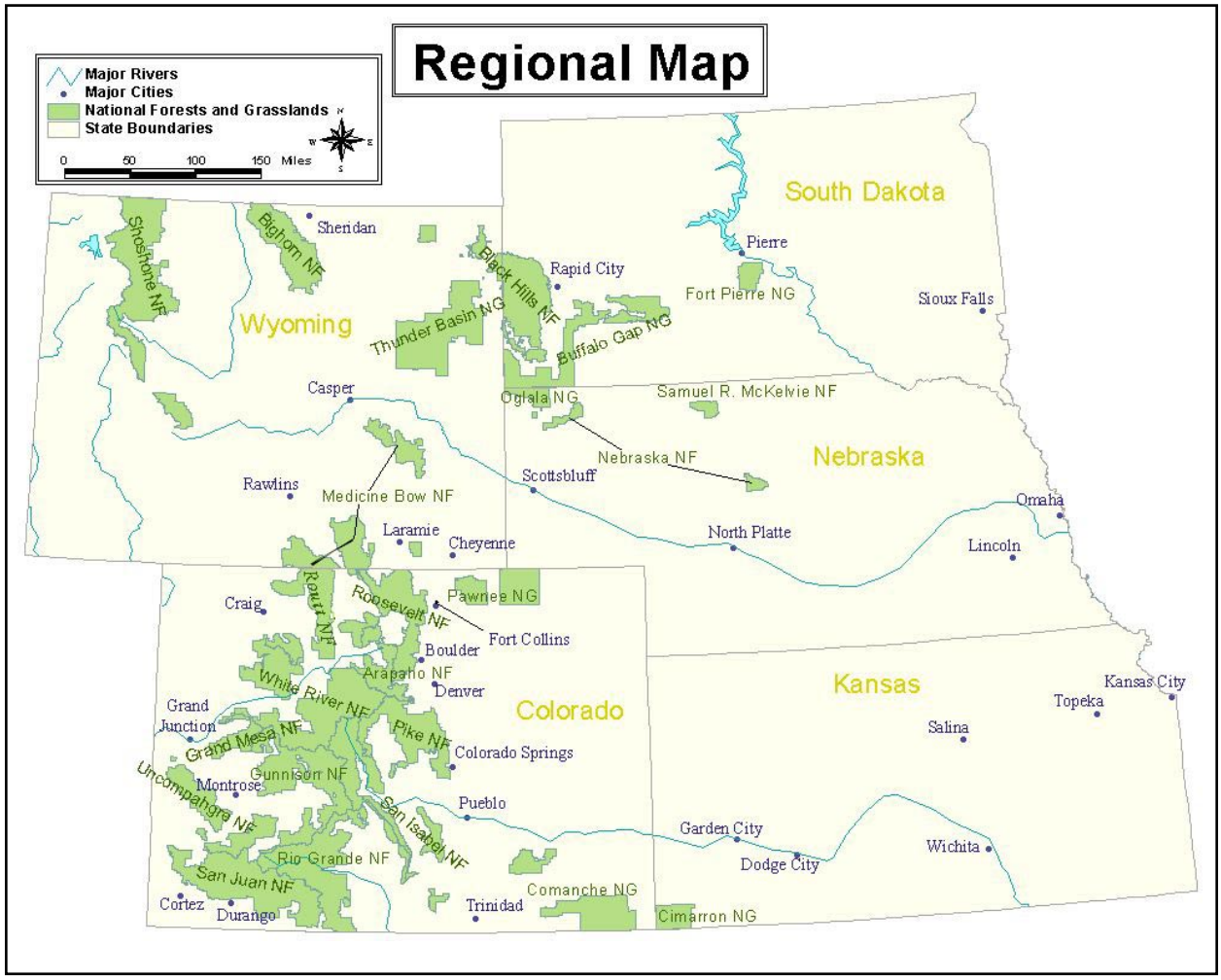

Figure 1. National Forest System lands within USDA Forest Service Region 2.

Scope

The Ottoe skipper assessment examines the biology, ecology, conservation status, and management of this species with specific reference to the geographic and ecological characteristics of the USFS Rocky Mountain Region. Although a majority of the literature on this species originates from field investigations outside the region, this document places that literature in the ecological and social context of the central Rocky Mountains. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of Ottoe skippers in the context of the current environment rather than under historical conditions. The evolutionary environment of the species is considered in conducting the synthesis, but it is placed in current context.

In producing the assessment, I reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies and butterfly experts. Not all publications on Ottoe skippers are referenced in the assessment, nor were all published materials considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. Non-refereed publications or reports were used when information was unavailable elsewhere, and these were regarded with greater skepticism. Unpublished data (e.g., Natural Heritage Program records, research reports, reports from butterfly experts) were important in estimating the geographic distribution of this species. Natural Heritage Program records were very incomplete for most of the states in Region 2, so it was necessary to supplement those records with data from other sources (e.g., published distribution maps, research reports, state experts) to get a more complete picture of the distribution and status of the Ottoe skipper in the region. These data required special attention because of the diversity of persons and methods used in collection. Often the butterfly data were only available as county records. More specific data (e.g., dates, locations, population trends) would have been helpful, and attempts were made to obtain additional documentation with some success, but tracking down and evaluating the accuracy of individual records was beyond the scope of this assessment.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct critical experiments that produce clean results in the ecological sciences. Often, we must rely on observations, inference, good thinking, and models to develop and test predictions, and to guide our understanding of ecological relationships. Confronting uncertainty, then, is not prescriptive. In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described where appropriate.

Application and Interpretation Limits

Information used to complete this assessment includes studies from across the geographical range of the Ottoe skipper. Most information should apply broadly throughout the range of the species, but certain life history parameters may vary along environmental gradients. Inferences made from this information regarding threats to the species are understood to be limited in scope (see section above) and take into account the particular conditions present in Region 2. Therefore, information regarding conservation status of this species pertains specifically to Region 2 and does not necessarily apply to other portions of its range.

Publication of Assessment on the World Wide Web

To facilitate the use of species assessments in the Species Conservation Project, they are being published on the Region 2 World Wide Web site (www.fs.fed.us/r2/projects/scp/assessments). Placing the documents on the Web makes them available to agency biologists and the public more rapidly than publishing them as reports. In addition, it facilitates their revision, which will be accomplished based on guidelines established by Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to their release on the Web. This report was reviewed through a process administered by the Society for Conservation Biology, an independent scientific organization that chose two recognized experts to provide critical input on the manuscript. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

NatureServe (2005) has determined that the Ottoe skipper is globally "vulnerable to apparently secure" and has assigned it a Global Heritage Status Rank of G3G4 (rounded status G3). This ranking was last reviewed on 11 May 2004 and has not been changed since 01 September 1998. It is based on the tendency for populations to be small and localized within the fragmented prairie landscape, their susceptibility to further habitat loss/degradation or "non-optimal" (i.e., negative impacts outweigh positive impacts) fire management programs, and low recolonization potential for locally extirpated populations. The World Conservation Union does not provide a global classification ranking for the Ottoe skipper (IUCN 2004).

The entire range for the Ottoe skipper is concentrated in the central to north-central portion of the United States, with a few populations just across the border in Manitoba, Canada (**Figure 2** and **Figure 3**). The National Heritage Status Rank for the United States

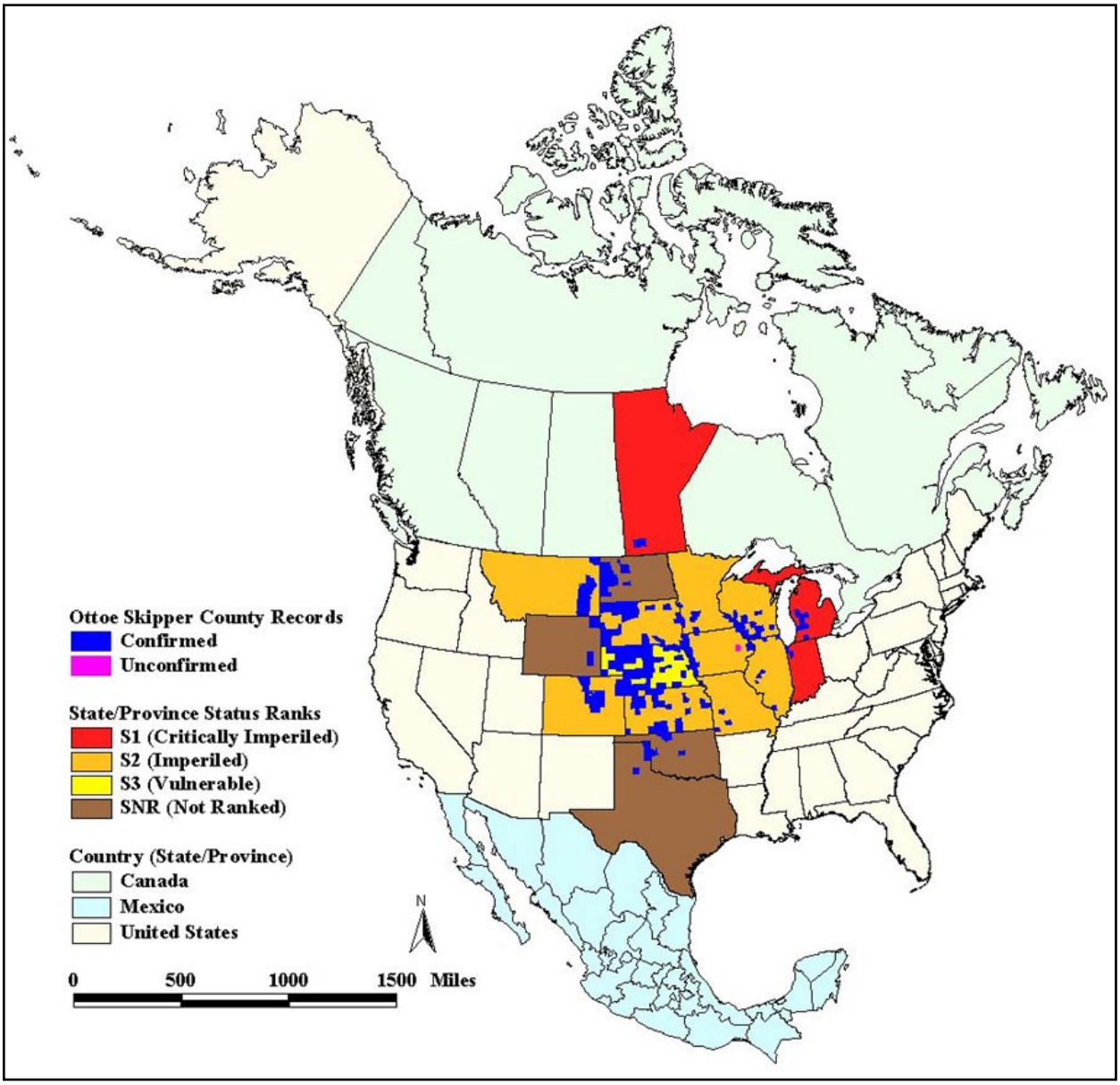

Figure 2. Natural Heritage Program state/province status ranks, and county distribution records for Ottoe skippers in North America (adapted from NatureServe 2005).

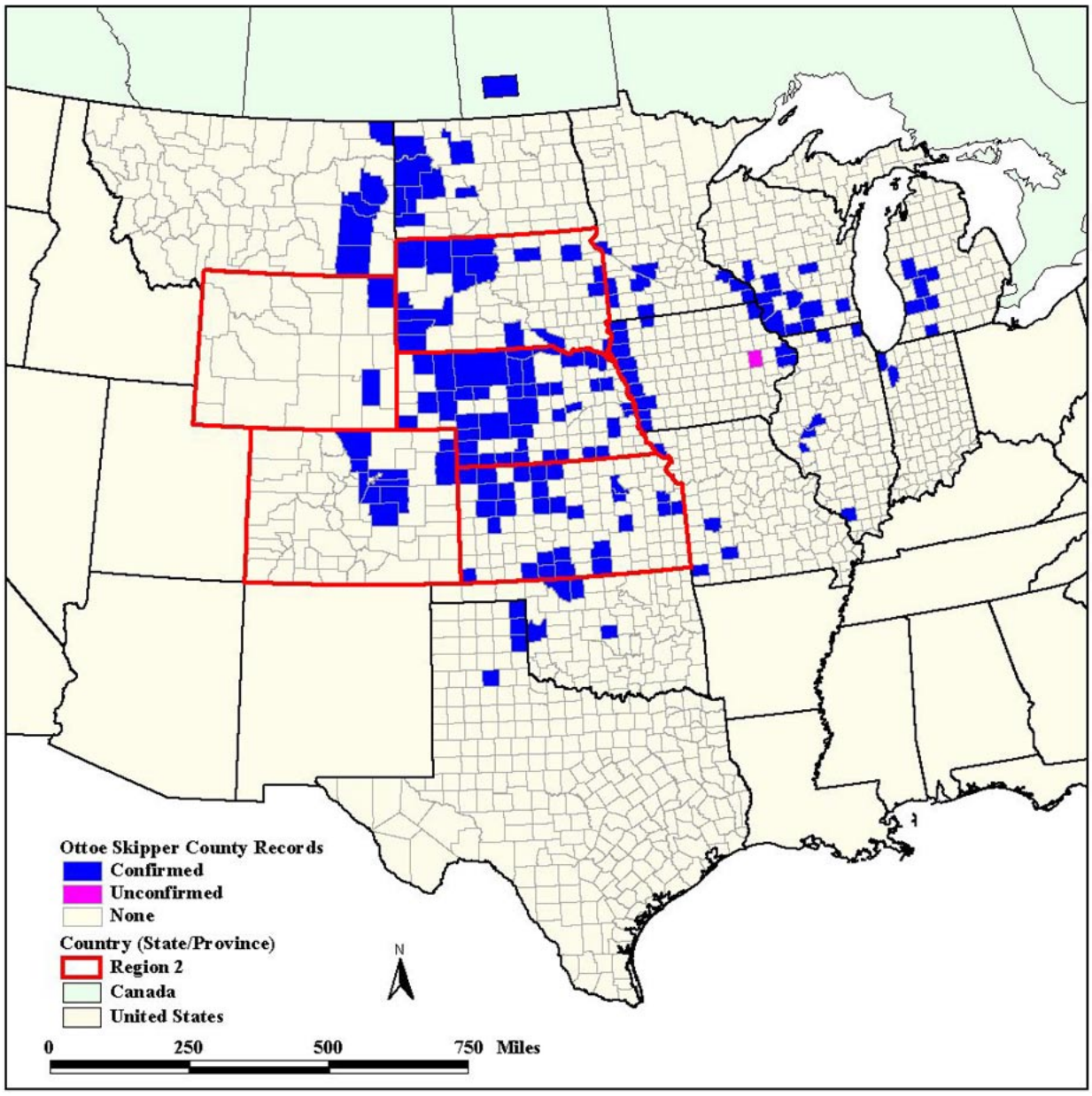

Figure 3. County distribution records for Ottoe skippers throughout their range in North America.

populations is the same as the global rank (N3N4), but for Canada it is N1 (critically imperiled). There is currently no federal protection for the Ottoe skipper in the United States under the Endangered Species Act, but it has been designated as a sensitive species within Regions 1, 2 and 9 of the USFS (USDA Forest Service 2004). The Region 2 sensitive species listing rationale states that there is a lack of abundance and trend data for the Ottoe skipper in the region, but Ottoe skipper populations tend to be small and localized, are threatened by habitat conversion, fragmentation, exotics, fire and grazing, and National Grassland units within the region could be important for Ottoe skipper conservation (USDA Forest Service 2003). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently completed an assessment of the Ottoe skipper in Canada (COSEWIC 2005). Based on the assessment it was assigned endangered status, but this designation does not confer legal protection at the national level because Canada does not have a national law analogous to the Endangered Species Act.

The Ottoe skipper has been documented from 16 states and one Canadian province. State Heritage Status Ranks (rounded to the lower rank number where mixed ranks are given) are critically imperiled (S1) in

two states (Indiana and Michigan) and one province (Manitoba), imperiled (S2) in nine states (Colorado, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, South Dakota, and Wisconsin), and vulnerable (S3) in one state (Nebraska). State ranks have not been assigned (SNR) in four states (North Dakota, Oklahoma, Texas, and Wyoming). There are relatively few Ottoe skipper records in those states, so if state ranks were assigned they would likely merit ranks of S1 or S2. However, those states are all near the periphery of the Ottoe skipper's range, and it may have never been abundant there. The Ottoe skipper is listed as state/province endangered in one state (Indiana) and one province (Manitoba), state threatened in three states (Illinois, Michigan, and Minnesota), and of special concern in two states (Iowa and Wisconsin). It does not currently have any state legal protection or special concern designation in any of the states comprising Region 2. Global, national, and state/province status ranks and legal protection status are summarized in **Table 1**. State/province status ranks and county distribution records for Ottoe skippers are illustrated in **Figure 2**.

Table 1. Natural Heritage Program Global, National, and State/Province Status Ranks, and legal protection status (Adapted from NatureServe 2005). USDA Forest Service Region 2 states are in bold print.

	Status Rank[1]	Protection Status[2]
Global	G3G4	—
USA (National)	N3N4	—
USA (State)		
Indiana	S1	E
Michigan	S1S2	T
Colorado	**S2**	**—**
Illinois	S2	T
Iowa	S2	SC
Minnesota	S2	T
South Dakota	**S2**	**—**
Wisconsin	S2	SC
Kansas	**S2S3**	**—**
Missouri	S2S3	—
Montana	S2S3	—
Nebraska	**S3**	**—**
North Dakota	SNR	—
Oklahoma	SNR	—
Texas	SNR	—
Wyoming	**SNR**	**—**
Canada (National)	N1	
Canada (Province)		—
Manitoba	S1?	E

[1]Status Rank Definitions:

G1/N1/S1 = Critically imperiled
G2/N2/S2 = Imperiled
G3/N3/S3 = Vulnerable
G4/N4/S4 = Apparently Secure
SH = Possibly extirpated
SNR = Not ranked

[2]Protection Status Definitions:

E = Endangered
T = Threatened
SC = Special Concern

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

The Ottoe skipper does not have any legal protection at the national level in the United States or in Canada. It does have legal protection in several states outside of USFS Region 2 (see **Table 1**), but it does not currently have any state legal protection or special concern designation in any of the states comprising Region 2. Listing the Ottoe skipper as a sensitive species in USFS Regions 1, 2 and 9 does not confer legal protection, but it does help to ensure that appropriate conservation/management objectives and practices are implemented on those USFS lands where it might occur.

There are no regulations or conservation/management strategies that have been developed specifically to protect Ottoe skippers; however, there are good resources available to managers. Opler (1981) and Panzer (1988) develop general guidelines for managing prairies for insect conservation, and Moffat and McPhillips (1993) provide managers with a literature review and general guidebook for managing butterflies in the northern Great Plains. More recent research papers (Panzer 1998, 2002; Swengel 1996, 1998; Swengel and Swengel 1999, 2001) also provide guidelines that can be applied to the management of prairie butterflies and invertebrates. Life history and conservation management studies of the Ottoe and Dakota (*Hesperia dacotae*) skippers in southwestern Minnesota (Dana 1989, 1991) provide the most specific conservation and management guidelines for Ottoe skippers. Swengel (2001) presents a fairly comprehensive review of literature dealing with prairie insect management issues. All of these are covered in more detail in the Conservation section of this paper.

Biology and Ecology

Systematics and general species description

Systematics

Classification and Nomenclature

Scientific Name:	*Hesperia ottoe*
Common Name:	Ottoe skipper
Class:	Insecta (Insects)
Order:	Lepidoptera (Butterflies and Moths)
Superfamily:	Hesperioidea (Skippers)
Family:	Hesperiidae (Skippers)
Subfamily:	Hesperiinae (Grass or Branded skippers)
Genus:	*Hesperia* Fabricius, 1793
Specific Name:	*ottoe* W.H. Edwards, 1866

Controversial or Unresolved Taxonomy: NONE

No subspecies of Ottoe skipper are recognized, but the form "ogallala", which is darker than the "typical" light form, has been described (Leussler 1921, Spomer personal communication 2005). For this manuscript, butterfly nomenclature follows Opler and Warren (2003) for scientific names and North American Butterfly Association (2001) for English names. Plant nomenclature follows the National Plant Data Center (USDA Natural Resources Conservation Service 2005).

General species description

The Ottoe skipper is a large, stout-bodied skipper with a wingspan ranging from 2.9 to 4.3 cm (1.14 to 1.69 inches). Females are slightly larger than the males. The upper wing surface of males is bright tawny orange with a diffuse dark brown border and a distinct black stigma (specialized scent scales) on the forewing (**Figure 4**, top left). The upper wing surface of females is brownish orange with diffuse dark markings and several yellowish white translucent spots near the center of the forewing (**Figure 4**, middle left). Both sexes have a yellow-orange lower wing surface that is unmarked in males (**Figure 4**, bottom left), but with a faint postmedian spot band on the hindwing of females. [This description was adapted from Layberry et al. (1998), Opler and Wright (1999), Marrone (2002), Brock and Kaufman (2003), NatureServe (2005).]

Ottoe skipper eggs are "gleaming white" when they are first laid, but after a couple days they become duller white or creamy yellow (**Figure 5**, top left; Dana 1991). They are almost identical to Dakota skipper eggs but about 30 percent larger (basal diameter 1.31 mm; height 1 mm; Dana 1991). The larvae are greenish brown with a dark brown head and black prothorax (Layberry et al. 1998). First, fourth, and final instar larvae are illustrated in **Figure 5**.

Adult butterflies that are similar in appearance to Ottoe skippers include the Dakota skipper and the Pawnee subspecies of the Leonard's skipper (*Hesperia leonardus pawnee*). Dakota skippers (**Figure 4**, center column) can occur at the same time and place as Ottoe skippers. They can be distinguished from Ottoes by their slightly smaller size, more grayish brown ventral wing color, and an indistinct macular band on the hindwing underside (Layberry et al. 1998). Pawnee skippers (**Figure 4**, right column) fly later in the summer (August

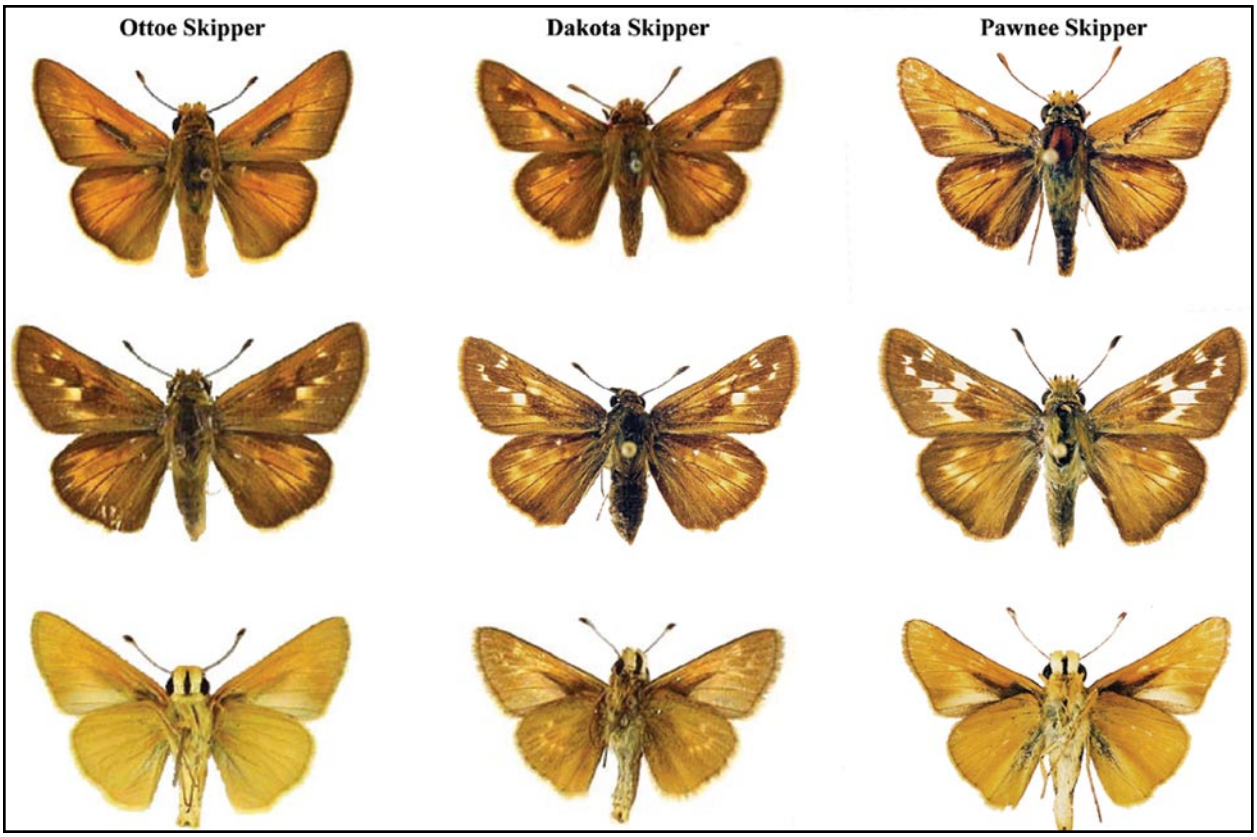

Figure 4. Figure 4. Comparison of Ottoe, Dakota, and Pawnee skippers. Male dorsal (top), female dorsal (middle), and male ventral (bottom). Ottoe skipper and male Dakota skipper photographs © Nearctic.com, Inc. 2000 (used with permission); Dakota skipper female and Pawnee skipper photographs © Gerald Selby.

– early September) and are only likely to overlap with the very end of the Ottoe flight (mid-June – July). They can be distinguished from Ottoes by several features. The center of the stigma in male Pawnee skippers is yellow, rather than black, and they have a faint row of cream-colored spots on the hindwing underside. Female Pawnee skippers have a less "faded" appearance, the translucent forewing spot is more square, and they have a row of cream-colored spots on the hindwing underside (Layberry et al. 1998).

Distribution and abundance

Global perspective

Ottoe skippers are generally restricted to upland mixed-grass and sand prairie habitats in the central to north-central plains of the United States, and just across the border in Manitoba, Canada. Their range is concentrated in a band that extends from southern Manitoba, eastern Montana, and western North Dakota, south along the high plains and foothills to central Colorado and northern Texas, and then east across South Dakota, Nebraska, and Kansas to southwestern Minnesota, western Iowa, and Missouri. Scattered populations occur further east in southeastern Minnesota, northeastern and east-central Iowa, southern Wisconsin, northern and west-central Illinois, northwestern Indiana, and southwestern Michigan (**Figure 3**). The Ottoe skipper is more widely distributed and uses a wider variety of prairie types than the Dakota skipper, but it is limited to dwindling native prairie habitat, and is highly local and uncommon to rare throughout most of its range (Dana 1991, Brock and Kaufman 2003).

Regional distribution and abundance

States comprising Region 2 of the USFS include the heart of the Ottoe skipper's range, with National Forest System lands being concentrated at the western edge of that range. There are very few documented records for Ottoe skippers on USFS lands (**Figure 6**). An overview of the distribution and abundance of Ottoe skippers in each state in Region 2, and their likely occurrence on USFS lands follows.

Kansas (S2S3): The Ottoe skipper has been documented from 28 counties in Kansas (Ely et al. 1986, Opler et al. 1995). It is not tracked by the Kansas Natural Heritage Program, so there are no Ottoe

Figure 5. Ottoe skipper egg (top left; ~1.3 mm wide), first instar larva (middle left; ~ 4 mm), fourth instar larva (top right; ~ 13 mm), and final instar larva (bottom; ~ 26 mm). Images are scaled to illustrate approximate relative sizes. Size estimates from Dana (1991; personal communication 2005). Photographs © Robert Dana (used with permission).

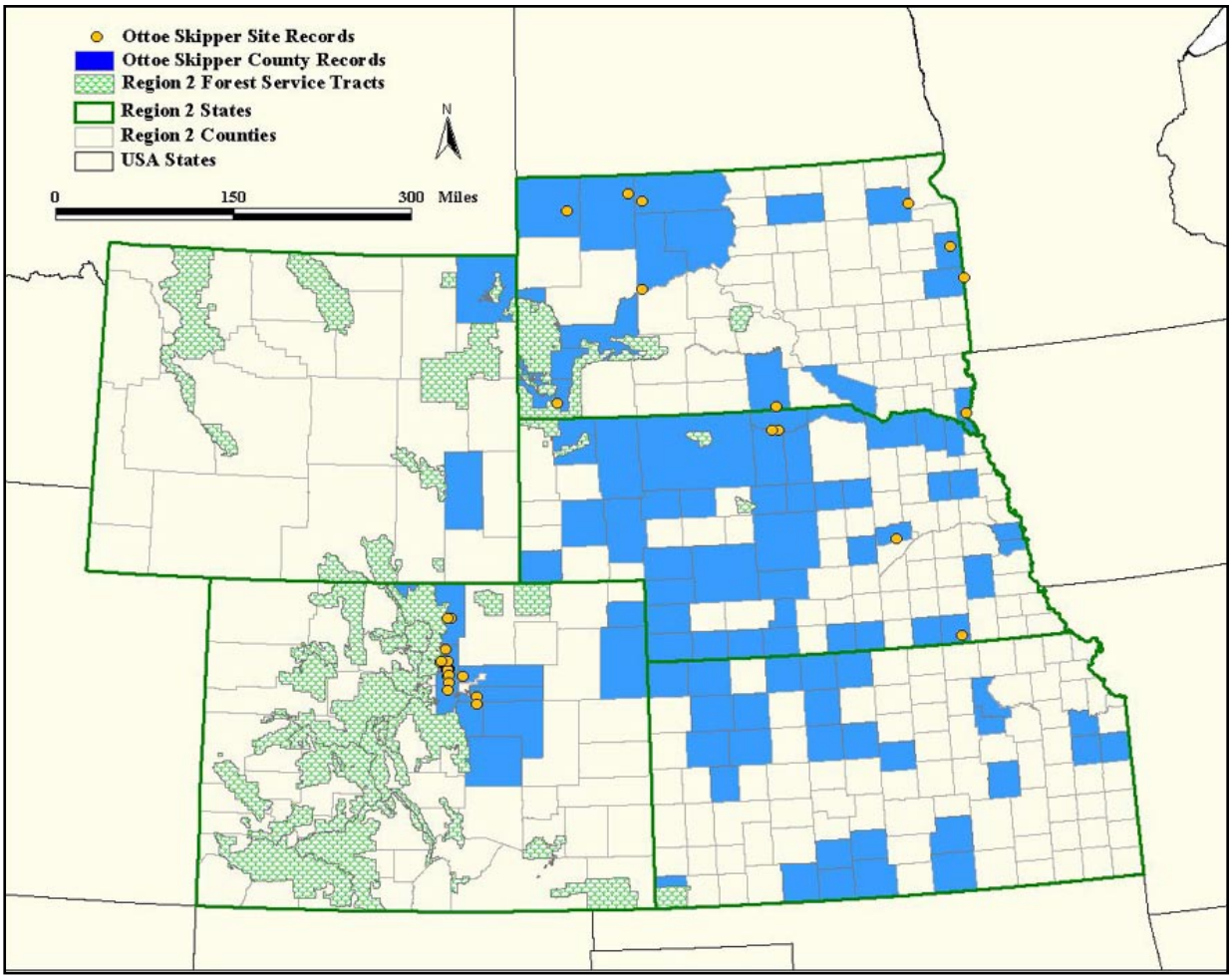

Figure 6. County distribution and Natural Heritage Program records for Ottoe skippers, and National Forest System lands within Region 2.

skipper element occurrences records, and they have not completed the State Ranking Form or Characterization Abstract (Delisle personal communication 2005). Ottoe skippers can be abundant in areas of the state with large, relatively non-degraded prairie remnants. Peak numbers in the thousands were observed during butterfly surveys conducted from 1997-1999 at Konza Prairie in the Riley and Geary County portions of the preserve (Wright et al. 2003). However, Ottoe skippers are among several Kansas butterflies experiencing contracting ranges, and they are becoming threatened or endangered in areas of the state as a result of continued loss and degradation of their habitat, and pesticide use (Wright et al. 2003).

The Cimarron National Grassland unit of the Pike/San Isabel National Forest and Cimarron/Comanche National Grassland is the only National Forest System land in Kansas, and it is located in the southwest corner of Kansas in Morton County (**Figure 6**). Ely et al. (1986) cite historic records for Ottoe skippers from this county by Field (1940), but documentation for more recent records is not given, and this county is over 100 km (62.5 mi.) south and west of the next closest county record. There are extensive areas of shortgrass prairie and scattered areas of "mixed prairie – disturbed land" mapped within the Cimarron National Grassland (U.S. Geologic Survey Great Plains GAP Landcover Web site: http://gapanalysis.nbii.gov/portal/server.pt), so it is possible that Ottoe skippers could occur there, but USFS staff are unaware of records from any units in the Pike/San Isabel National Forest and Cimarron/Comanche National Grassland (Cox personal communication 2005).

Nebraska (S3): Ottoe skippers are found in scattered colonies throughout the state of Nebraska and have been documented from 41 counties (Spomer 2004, Opler et al. 1995). They are associated with mixed- or tallgrass prairie in rolling topography, where they are usually uncommon, but can be locally common

(Spomer 2004). The Ottoe skipper has not been actively tracked by the Nebraska Natural Heritage Program, and there are only four element occurrence records in four separate counties for Nebraska (**Figure 6**).

National forest and grassland units within the Nebraska National Forest in northwestern Nebraska and southwestern South Dakota are likely the most important USFS lands in Region 2 for Ottoe skippers. In Nebraska, National Forest System lands in counties with Ottoe records include Ogalla National Grassland and Nebraska National Forest (Pine Ridge District) in Dawes County, Nebraska National Forest (Bessey District) in Blaine County, and Samuel R. McKelvie National Forest in Cherry County (**Figure 6**). In 1995, butterfly surveys focused on the tawny crescent (*Phycoides batesii*) and the regal fritillary (*Speyeria idalia*) were conducted on Nebraska National Forest units in the state of Nebraska (Fritz 1997). No Ottoe skipper observations are documented in the report, but it was noted that they should occur in the Samuel R. McKelvie National Forest. Surveys focused on potential Ottoe skipper habitat need to be done to determine if they occur on USFS lands in Nebraska, and if they do, to determine their distribution and abundance within those lands.

South Dakota (S2): Ottoe skippers have been documented from 16 counties in South Dakota (Opler et al. 1995, Marrone 2002). They are associated with relatively non-degraded mixed- to tallgrass prairie, are very local, and are uncommon to rare throughout the state. Marrone (personal communication 2005) has 22 Ottoe skipper records from 16 counties, and the South Dakota Natural Heritage Program has nine of those records from nine counties (**Figure 6**).

The Buffalo Gap National Grassland unit of the Nebraska National Forest includes parts of Custer, Fall River, and Pennington counties. Ottoe skippers have been documented from each of those counties, and the Fall River County record appears to fall within the national grassland unit, but there are no other confirmed records from USFS lands. The Fort Pierre National Grassland unit of the Nebraska National Forest occurs in central South Dakota. There are no Ottoe skipper records from that area, but extensive areas of grassland, mapped as "low, moderate and high cover grassland", occur within the unit (U.S. Geologic Survey Great Plains GAP Landcover). If those grassland areas include Ottoe skipper habitat (e.g., mixed- and tallgrass prairie), then it is possible that Ottoe skippers could occur there. The Black Hills National Forest unit in South Dakota includes parts of Custer, Fall River, Lawrence, and Pennington counties, all of which have Ottoe skipper records. This unit is dominated by forest vegetation, but scattered areas of "low, moderate and high cover grassland" are mapped throughout the area (U.S. Geologic Survey Great Plains GAP Landcover), and good examples of dry mixed-grass, mesic mixed-grass, and mesic tallgrass prairie were identified during 1996-1998 plant community inventories (Marriot et al. 1999). It is possible that Ottoe skippers could occur in those scattered prairie remnants, but it is more likely that healthy Ottoe skipper populations will be found in the more extensive prairie remnants associated with the Buffalo Gap National Grassland. Surveys focused on Ottoe skipper habitat need to be done to determine if they occur on USFS lands in South Dakota, and if they do, to determine their distribution and abundance within those lands.

Wyoming (SNR): The range of the Ottoe skipper barely extends into eastern Wyoming, and it has only been recorded from two counties in the state (Stanford and Opler 1993, Opler et al. 1995). The Wyoming Natural Heritage Program does not currently track any invertebrates, so there are no Ottoe skipper element occurrence records for the state (Beauvais personal communication 2005). The Black Hills National Forest unit in Wyoming falls entirely within Crook County, one of the counties where Ottoe skippers have been documented. This unit of the Black Hills National Forest is also dominated by forest vegetation, but it includes areas of mixed-grass prairie (U.S. Geologic Survey Great Plains GAP Landcover) that could provide habitat for Ottoe skippers. The Medicine Bow/ Routt National Forest and Thunder Basin National Grassland occur adjacent to counties with Ottoe skipper records. The Thunder Basin National Grassland is adjacent to Crook County, and the Medicine Bow National Forest has units adjacent to Platte County, Wyoming and Larimer County, Colorado. These units include significant areas of mixed-grass prairie (U.S. Geologic Survey Great Plains GAP Landcover) where Ottoe skippers could occur.

Colorado (S2): Ottoe skippers have been documented from 10 counties in Colorado (Stanford and Opler 1993, Opler et al. 1995). Two of the counties (Phillips and Yuma) are in northeastern Colorado and are contiguous with county records for Ottoe skippers in northwestern Kansas and southwestern Nebraska. The remainder of the Colorado records are western disjuncts, separated from the main Ottoe skipper range by over 200 km (125 mi.). They are associated with mixed- or tallgrass prairie along the Colorado Front Range from Colorado Springs to Fort Collins

(**Figure 6**). The Colorado Natural Heritage Program has 17 Ottoe skipper element occurrence records, all of which are from just southeast of Denver to Fort Collins (Colorado Natural Heritage Program 2005a).

All recent (since 1990) Ottoe skipper records are from western Adams, Boulder, northern Jefferson, and Larimer counties. Many of these are from surveys for the city of Boulder Open Space and Mountain Parks (Pineda and Ellingson 1998). These records are in a north/south line that runs just east of National Forest System units in the Arapaho/Roosevelt National Forest and Pawnee National Grassland. The Ottoe skipper records in Jefferson County are considerably east of the Arapaho National Forest unit, and there does not appear to be Ottoe skipper habitat between those records and USFS land (U.S. Geologic Survey Great Plains GAP Landcover), so it is unlikely that there would be Ottoe skippers in that unit. Most of the recent Ottoe skipper records and suitable prairie types occur east of the Roosevelt National Forest unit in Boulder County and come closer to the USFS unit boundaries further north in Larimer County (U.S. Geologic Survey Great Plains GAP Landcover). The northernmost Ottoe skipper records appear to be within or near the boundaries of the Roosevelt National Forest. The likelihood of Ottoe skippers occurring in this unit increases from Boulder to Larimer County, but any occurrences are likely to be at the eastern margins of the Roosevelt National Forest unit and represent the western margins of the populations.

The Pawnee National Grassland units are east of Larimer County near the northern Colorado border in Weld County. There are no documented Ottoe skipper records from this county, but it has been documented immediately to the north in Kimball County, Nebraska as recently as 1987 (Spomer personal communication 2005). There is an abundance of shortgrass prairie and some mixed-grass prairie within the boundaries of the national grassland units, and more limited amounts of tallgrass prairie between them (U.S. Geologic Survey Great Plains GAP Landcover), so it is possible that Ottoe skippers could occur there.

The Comanche National Grassland units of the Pike/San Isabel National Forest and Comanche/ Cimarron National Grassland are located in southeastern Colorado (Baca, Las Animas, and Otero counties). There are no documented Ottoe skipper records from these counties, but historic records immediately to the east of Baca County in Kansas suggest the possibility that it could occur in this area. Shortgrass prairie is the dominant vegetation in these units, but there is also some mixed-grass prairie in the southwestern corner of the Baca County unit (U.S. Geologic Survey Great Plains GAP Landcover) where Ottoe skippers could occur.

No Ottoe skippers have been documented from any of the Arapaho/Roosevelt National Forest and Pawnee National Grassland units (Lowry personal communication 2005), or from the Comanche National Grassland (Cox personal communication 2005), but this could simply be the result of inadequate attempts to document them. Suitable prairie types (especially mixed- and dry-mesic tallgrass) in the units should be surveyed to determine if Ottoe skippers are present, and if they are, to determine their distribution and abundance within those units.

Population trend

NatureServe (2005) summarizes the global status of the Ottoe skipper as "Not imminently imperiled now and certainly not demonstrably secure". This statement emphasizes that despite the apparent short-term security of Ottoe skippers based on the relatively large number of occurrences and the occurrence of locally abundant populations in areas with large high quality prairie remnants, its long-term security is uncertain. Most populations are associated with small, isolated remnants in the fragmented prairie landscape where they are highly susceptible to local extinctions. Further habitat loss and degradation, pesticide use, intensive grazing regimes, and aggressive fire management programs all place these small, isolated populations at risk, and if local extinctions occur, recolonization potential across the fragmented landscape is low.

Kansas, Nebraska, and South Dakota are at the center of the Ottoe skipper range and have most of the known records, but even in these states the long-term security of the species is uncertain. In Nebraska and Kansas, Ottoe skippers can be locally abundant in areas with large, high quality prairie remnants, but they are usually uncommon in Nebraska (Spomer 2004), and in Kansas they are among several butterflies experiencing contracting ranges and becoming threatened or endangered in areas of the state (Wright et al. 2003). In South Dakota they are considered very local, and uncommon to rare throughout the state (Marrone 2002). All recent Ottoe skipper records in Colorado are from mixed- and tallgrass prairie remnants along the Colorado Front Range. This land cover type is rare and declining due to grazing, weed invasion, and housing development. The short-term trend for the Ottoe skipper in Colorado is assumed to be declining

(Colorado Natural Heritage Program 2005b). The Ottoe skipper has only been documented from two counties in Wyoming, with the status and trends of those populations being unknown.

Ottoe skipper populations outside of Region 2 are either at the periphery of the species' range in the Great Plains, or they occur as scattered disjuncts located much further east. They tend to be even more highly localized and rare in this portion of its range. The northernmost populations occurred just across the border in a small portion of southern Manitoba, Canada (Layberry et al. 1998, COSEWIC 2005). They were documented from three sites but have not been found at two of those sites since the 1920s or at the third site since the 1980s. They were not found at those sites or other potential areas surveyed in 2002 and 2003, and the Ottoe skipper may no longer occur in Canada (COSEWIC 2005, Webster personal communication 2005). Eastern Montana populations are at the northwestern edge of the Ottoe skipper's range. Opler et al. (1995) show records from five counties. In western North Dakota, the Ottoe skipper has been documented from eight counties (Stanford and Opler 1993, Royer 2004), including populations on the Little Missouri and Blue Buttes National Grassland (USFS Region 1), McKensie District, McKensie County (Royer 2002, 2003). At the southwestern extreme of its range in northeastern Texas and northwestern Oklahoma, the Ottoe skipper has been documented from four counties each (Opler et al. 1995). There were very few data available on trends within these peripheral populations, but they tend to be small and isolated, and their long-term survival can be assumed to be uncertain.

Populations in southwestern Minnesota, western Iowa, and northwestern and southwestern Missouri make up the eastern edge of the Ottoe skipper's core range in the Great Plains (**Figure 3**). In Minnesota, the Ottoe skipper is rarer than the Dakota skipper (Dana 1991). The Natural Heritage Program has records from six counties in southwestern Minnesota, and then the next closest Minnesota populations are from three counties in the southeastern corner of the state. In Iowa, the Ottoe skipper has been documented from all nine counties along the western border of the state and possibly one additional county in northwestern Iowa. The only other Iowa records are from a single county in northeastern Iowa and two counties in east-central Iowa (Iowa Natural Heritage Program 2005, Schlicht personal communication 2005). Populations in the Loess Hills are doing quite well, but the numbers decrease with the decreasing amount of prairie towards the southern end of the Loess Hills (Selby 2003a). The long-term survival of populations in other parts of the state is less certain. The Ottoe skipper has been documented from four counties in Missouri. In northwestern Missouri, the last documented observation was a 1984 record from the southern end of the Loess Hills, and the only other recent record was from southwestern Missouri in 1996 (Koenig personal communication 2005). According to Heitzman (personal communication 2004), the northern Loess Hills populations are secure, but the southern populations are smaller, and therefore less secure.

The Ottoe skipper has records from 11 counties in southern Wisconsin, but the Wisconsin Natural Heritage Program only has records for nine counties (Wisconsin Department of Natural Resources 2005). The other county records include a 1930 record (Ebner 1970; Ferge personal communication 2005), and a 1970s record that was not confirmed with a voucher (Ferge personal communication 2005). Six of the nine Heritage records have been confirmed by Ferge (personal communication 2005), but he is uncertain if there is adequate documentation for the other three. There are six county records from northern and west-central Illinois (Opler et al. 1995). Sedman and Hess (1985) document records for the three west-central counties up through the early 1980s, but more recent documentation for those and other records was not found. The Ottoe skipper is only known to occur at one location in the northwestern part of Indiana in Lake County, and that population appears to be stable (Shuey personal communication 2004). There is a significant amount of Ottoe skipper habitat in Jasper and Newton counties, and across the border in Kankakee County, Illinois, but serious searches have not been conducted in this area and the only possible record is an unconfirmed report from Jasper County. In the 1950s, Nielsen (1958) documented the Ottoe skipper in five southwestern Michigan counties. Cuthrell (2001) stated that it was known from 17 sites in six counties, but that most of them were historic, and the only confirmed extant populations were in Allegan County. Since then, Kriegel (2002) has reconfirmed populations at four locations in three counties during surveys in 2001, and Cuthrell (personal communication 2005) discovered a new location in one of the counties in 2003.

Activity pattern and movements

Activity pattern

Ottoe skippers are univoltine (having a single generation per year) with an adult flight from about the middle of June through the end of July. The actual flight period varies somewhat across their range and can

also vary significantly from year-to-year depending on weather patterns. Their flight overlaps with the flight of the Dakota skipper where they co-occur, but Ottoe skippers emerge a little later and have a more protracted emergence for both sexes (Dana 1991). Male Ottoe skippers emerge slightly before females.

A generalized timeline summarizing the seasonal phenology for the principal stages of the Ottoe skipper life cycle is presented in **Figure 7**. Stage length data and the approximate dates for construction of buried shelters are from Dana (1991). Other date ranges for immature life stages are estimates based on the flight period and stage length data, and they should only be used as a very general guideline. The movement of larvae from aboveground to buried shelters in the fall and then back to aboveground shelters in the spring has important management implications. Larvae are extremely vulnerable to fires when they are using the aboveground shelters, so if possible, prescribed fires should be scheduled when the larvae are in buried shelters (e.g., late fall or early spring). If burning is done when the larvae are above ground, it should be assumed that there will be 100 percent mortality in the burned area, and adequate areas (e.g., 50 to 80 percent) should be left unburned to serve as recolonization sources.

Mobility and migration

Ottoe skippers do not migrate, are unable to survive in the altered landscapes (e.g., row crops, non-native pasture, developed areas) that surround the prairie remnants where they occur, and have limited dispersal capability. Therefore, if an isolated population in the fragmented prairie landscape is extirpated, it is unlikely that it will be repopulated. The entire life cycle must be completed successfully each year at each site for local populations to persist through time at those sites.

Ottoe skippers are not likely to disperse long distances between isolated prairie fragments, but they are fairly mobile and can be expected to move

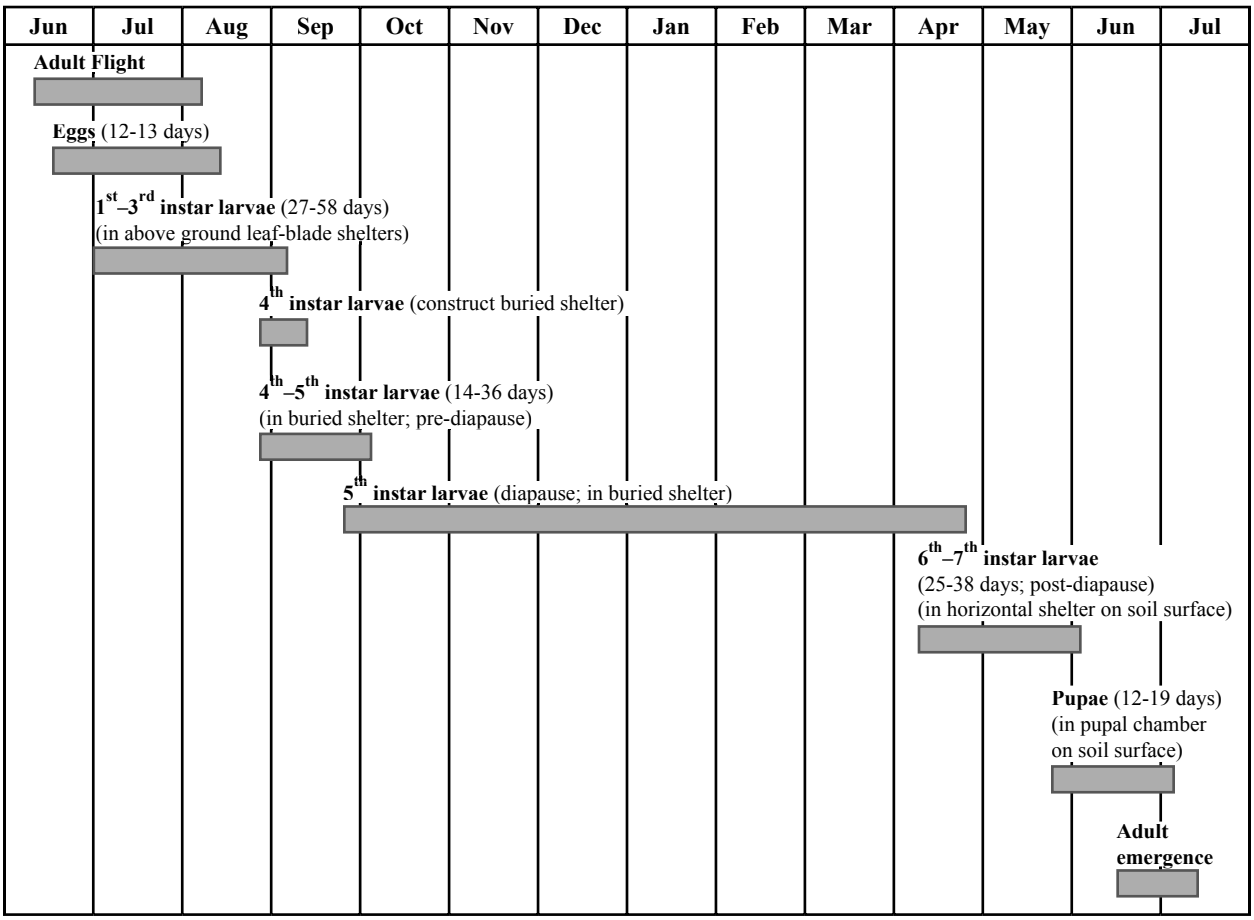

Figure 7. Ottoe skipper life history stages and their approximate seasonal phenology (adapted from Dana 1991).

throughout a prairie remnant, and even between fragments that are relatively close together. In mark-recapture studies by Dana (1991), Ottoe skippers moved throughout the 63-ha (156-acre) study area in southwestern Minnesota. Selby (1992) conducted an intensive mark-recapture study in the northern Loess Hills of western Iowa, where linear prairie ridges are separated from each other by wooded valleys. Most Ottoe skipper movements were local moves within prairie ridges (modal distance range was 0 to 200 m [0 to 656 ft.]), but there were also numerous longer moves along and between the prairie ridges (maximum distance was 1,774 m [5,280 ft.] across several valleys). These results suggest that where Ottoe skippers occur in complexes of closely associated prairie fragments, dispersal between fragments could occur, but it is likely that population recovery will take longer if it depends on recolonization between fragments. Where Ottoe skippers occur on isolated prairie fragments, recolonization will necessarily have to occur from within those fragments, and management should be planned accordingly (e.g., burning, grazing, or mowing only a portion of the fragment at any one time).

Habitat

Ottoe skipper habitat is generally described as tallgrass prairie (Opler and Malikul 1992, Opler and Wright 1999, Brock and Kaufman 2003). It is not, however, generally associated with true tallgrass prairie (e.g., mesic to wet-mesic prairie dominated by tall grasses such as big bluestem [*Andropogon gerardii*], Indiangrass [*Sorghastrum nutans*] and switchgrass [*Panicum virgatum*]) (COSEWIC 2005). A more accurate general habitat description is mixed-grass prairie (e.g., dry-mesic to mesic prairie dominated by mixed grasses such as little bluestem [*Schizachyrium scoparium*] and sideoats grama [*Bouteloua curtipendula*]), or dry-mesic tallgrass prairie (e.g., drier portions of tallgrass prairies where mixed grasses are favored over tall grasses).

Throughout most of its range in the Great Plains, Ottoe skipper habitat is relatively non-degraded native mixed- and dry-mesic tallgrass prairie associated with rolling topography or hilltops (Marrone 2002, Royer 2004, Spomer 2004). Western disjunct populations in Colorado are associated with xeric and mesic tallgrass prairie along the Front Range foothills of the Rocky Mountains between approximately 1,650 to 2,000 m (5,413 to 6,562 ft.) elevation (Pineda and Ellingson 1998, Colorado Natural Heritage Program 2005a). The northernmost populations in Canada are [or were] associated with upland mixed-grass and sand prairies, woodland clearings, and other places with native grasses (Layberry et al. 1998, COSEWIC 2005).

Ottoe skipper populations in southwestern Minnesota, western Iowa, and western Missouri are at the eastern edge of its range in the Great Plains. They are generally associated with dry to dry-mesic, native mixed- and tallgrass prairie. In southwestern Minnesota and northwestern Iowa, the prairies are associated with gravelly glacial till soils; in west-central to southwestern Iowa and northwestern Missouri, they are associated with dry loess soils of the Loess Hills Landform (Heitzman 1987, Selby 2003a). Habitat for populations in southwestern Missouri is described simply as relatively undisturbed prairie (Heitzman 1987).

The disjunct eastern populations are generally associated with sandy soils. Habitat is described as dry sand prairie and open oak barrens in Michigan (Cuthrell 2001), lakeshore low dunes and sand prairie in Indiana (Shuey personal communication 2004), and sand prairie and loess-sand hill prairie in Illinois (Irwin and Downey 1973, Sedman and Hess 1985). In Wisconsin, habitat is generally described as dry prairie (Ferge 2002). Southeastern Minnesota populations are primarily found on dry to dry-mesic prairie associated with sandy soils or limestone bluffs (Minnesota Natural Heritage Program Data 2003). In eastern Iowa, Ottoe skippers are found on dry to dry-mesic bedrock prairie associated with limestone bluffs in northeastern Iowa (sometimes referred to as hill or goat prairie), and dolomite limestone outcrop areas in east-central Iowa (sometimes referred to as glades).

Food habits

Nectar plants

The predominant nectar source for the Ottoe skipper throughout most of its range is purple coneflower (*Echinacea angustifolia*). In his study in southwest Minnesota, Dana (1991) observed Ottoe skippers taking nectar from eight plant species, with most visits occurring at three species. Purple coneflower was the predominant nectar source for both sexes, followed by hoary verbena (*Verbena stricta*) and Flodman's thistle (*Cirsium flodmanii*). Principal nectar plants for the eastern populations in Michigan include prickly pear cactus (*Opuntia humifusa*) and common milkweed (*Asclepias syriaca*) (Nielsen 1999, Cuthrell 2001).

Larval foodplants

Larval foodplants for Ottoe skippers include big bluestem, little bluestem, sideoats grama, and fall witchgrass (*Leptoloma cognatum*) (Scott 1986, Dana 1991, Opler and Malikul 1992, Opler and Wright 1999). In southwestern Minnesota, plants used by larvae for leaf-blade shelters included little bluestem (62), sideoats grama (27), big bluestem (14), and fall rosette grass (*Dichanthelium wilcoxianum*) (11); plants used for buried shelters included little bluestem (12), sideoats grama (5), and hairy grama (*Bouteloua hirsuta*) (4) (Dana 1991). The preferred species for shelters have been documented as a good indication of preferred larval food plant species (Dana 1991). However, feeding on other plant species near shelters also occurred regularly.

Breeding biology

Courtship and mating

The following description of courtship and mating of Ottoe skippers is adapted from Dana (1991). "Perching" is the primary mate-seeking behavior in male Ottoe skippers. Purple coneflowers are the preferred perching platforms, and this behavior can occur throughout the daily flight period. Mate seeking also includes some "searching" behavior. It involves wide-ranging rapid flight from coneflower to coneflower without landing, and can occur from late morning to late afternoon. Upper slopes and summits are preferred for both perching and pursuit activity. Pairing occurs throughout the day in the upper and middle slopes zones. All observed matings were with females that had probably just recently emerged (based on lack of wing wear), and would usually occur immediately after the pair landed in the vegetation.

Oviposition behavior

Dana (1991) noted that female Ottoe skippers may not begin oviposition as soon after emergence as Dakota skippers, and they may lay fewer eggs per day. He dissected a female to determine the potential fecundity of each female, and found 225 distinguishable oocytes.

Over 50 percent of the ovipositions observed by Dana (1991) were on purple coneflowers. Eggs were laid singly on the capitula, and when the larvae hatched, they dropped off the capitula, rather than crawling down. Oviposition on other substrates included potential larval food plants such as little bluestem and fall witchgrass. Eggs were laid singly on the underside of leaves, or on the upper surface of erect grass blades, and they were usually within 1 to 4 cm (2.54 to 10.16 inches) of the soil surface.

Larval stages

Hatching larvae consume all of the chorion but the base. They then proceed to construct the first shelter before further feeding. Shelters for the early larval stages (usually 1st through 3rd instars) are aboveground leaf-blade shelters. In late August to early September they construct buried shelters and move into them (usually as 4th instars). They continue feeding, and then enter diapause and overwinter in those buried shelters (usually as 4th or 5th instars). In the spring post-diapause larvae shift from buried shelters to horizontal shelters on the soil surface, and usually complete two additional stages before pupating in a pupal chamber. The information on larval stages was adapted from Dana (1991).

Demography

Genetic characteristics and concerns

Genetic isolation resulting from habitat fragmentation can lead to reduced fitness as a result of genetic drift, which can lead to decreases in heterozygosity and elevated inbreeding coefficients (Britten and Glasford 2002). Genetic studies have not been done for Ottoe skipper populations, but a study of Dakota skipper populations by Britten and Glasford (2002) provides useful insight into potential genetic issues for Ottoe skippers. Their study included Dakota skipper populations from Manitoba to northeastern South Dakota and southwestern Minnesota. The results indicated that the populations were genetically isolated from each, but that they had been more connected in recent history. Genetic variability was similar to other lepidopterans from highly fragmented habitats, but less variable than lepidopterans from more continuous habitats, and the populations had significant heterozygote deficiencies relative to Hardy-Weinberg expectations and high inbreeding coefficients. Their results suggested that each population will experience genetic drift and an erosion of genetic variability over time, and that the fairly small genetically effective population sizes would accelerate this process. It is likely that these genetic factors are also at play for the isolated Ottoe skipper populations, and maintaining or augmenting connectivity between populations could help to mitigate this.

Hybridization

There is no documentation of Ottoe skipper hybridizing with other species.

Life history characteristics

Ottoe skippers do not migrate, are unable to survive in an altered landscape, and have limited dispersal capability. Therefore, if an isolated population in a fragmented prairie landscape is extirpated, it is unlikely that it will be repopulated. The entire life cycle (**Figure 7**) must be completed successfully each year at each site for local populations to persist through time at those sites. Ottoe skippers are univoltine (having a single generation per year). Adults emerge in mid-late June and are able to mate and begin laying eggs soon after emerging. The potential fecundity per female is about 180 to 250 eggs (Dana 1991). Eggs are laid in areas with larval food plants, and when the larvae hatch they construct shelters on or near the larval host plants. Larvae are more vulnerable during the first three larval instars (late summer to early fall) and during the final instar and pupal stage (spring and early summer) when they are in aboveground shelters. They move to more protected buried shelters as fourth instars, and overwinter in those shelters as fifth instars. In control plots for burn-experiments, larval mortality was about 50 to 60 percent (Dana 1991). Additional data on the probabilities of completing each stage are not known.

Ecological influences on survival and reproduction

Severe storms can cause direct mortality of adults in flight. Prolonged periods of cool temperatures, overcast skies, and rain can limit reproduction by limiting adult activity. The larvae are afforded some protection from extreme conditions when in their buried shelters, but they are vulnerable when using aboveground shelters. Extremely harsh winters, late hard frosts following a spring thaw, severe storms, or cool damp conditions can all negatively impact the survival of this species. The impacts of extreme weather can be significant because they are often expressed over a large geographic area. Disease, parasitism, and predation can also influence survival of each stage in the life cycle, but under normal circumstances they are not considered a major threat to Ottoe skippers (Dana 1991). Extreme conditions can contribute to dramatic population fluctuations, and populations experiencing severe downward fluctuations are at high risk of local extirpation.

Social patterns and spacing

Perching behavior in male skippers has been interpreted as the defense of mating territories (McCabe 1981), but the general consensus is that the perch-chase mate-seeking behavior is not territorial (MacNeill 1964, Scott 1974, Dana 1991). Several factors support this conclusion. Perch fidelity is inversely proportional to density, with a "continuous circulation" of males among perch sites (MacNeill 1964); there are an abundance of perches (e.g., perches are not limiting); emerging females are widely dispersed and unpredictable in space; and the males move about too freely (Dana 1991). Dana (1991) suggests that the pursuits are investigative not aggressive, and that often the male-male pursuits are attempts to elicit female response. The interactions do produce a non-random (over-dispersed) distribution of perching males, but this is incidental and not the result of territorial defense (Dana 1991). In his study of Ottoe skippers in southwestern Minnesota, Dana (1991) found that upper slopes and summits were preferred for both perching and pursuit activity, and pairing occurred in the upper and middle slopes zones. Oviposition and nectaring behavior occurred throughout the same upland habitats and included areas used for perching.

Patterns of dispersal of young and adults

Adults move about freely within an area (Dana 1991, Selby 1992), and they have a limited capability for dispersal between adjacent prairie fragments (Selby 1992), but they do not migrate and are not likely to disperse long distances between isolated prairie fragments. Oviposition occurs primarily in upland habitats, often on purple coneflowers but also on or near larval food plants, and the larvae do not move far from where they hatch to establish shelters and complete their development (Dana 1991).

Factors limiting population growth

Ottoe skippers only have a single generation per year and are therefore expected to recover more slowly than species with several generations per year (Swengel 1996, Panzer 2002). Dana (1991) observed that Ottoe skippers may not begin laying eggs as soon after emergence as Dakota skippers, and they may lay fewer eggs per day. The delayed onset of egg-laying and the reduced rate at which they are laid would appear to limit population growth, but potential fecundity per female in both species is actually similar (about 180 to 250 eggs). Complete data on survival rates per life stage are not available, but in control plots for burn-experiments,

larval mortality was about 50 to 60 percent (Dana 1991). The size and quality of suitable prairie fragments is likely the most important factor limiting population size in a given area. The size and reproductive potential of populations associated with small sites are limited, and it is more likely that a catastrophic event will impact the entire population. Litter buildup can limit population growth by making it more difficult for first instar larvae to locate their first shelters, lowering nutritional quality of the grasses, and reducing flowering of nectar sources (Dana 1991). Encroachment by cool-season grasses will also limit resources for larval development. Larval development rates are proportional to temperature, so unusually cool conditions could slow growth rates and prolong exposure to mortality factors (Dana 1991). During the adult flight, prolonged periods of cool temperatures or overcast skies and rain will limit adult activity and could limit reproduction.

Community ecology

Disease, parasitism and predation

Each stage in the Ottoe skipper life cycle can be impacted by disease, parasitism, or predation. Eggs and larvae are parasitized by the larvae of various wasp species and are preyed on by various groups of insect species. Bacterial septicaemia can become a problem for some skipper species under humid conditions (MacNeill 1964), but this did not appear to be a likely mortality factor for Ottoe and Dakota skippers in the study by Dana (1991). Potential predators on adults include crab spiders, ambush bugs, robber flies, and birds, but they are not generally thought to have a significant impact on healthy butterfly populations (Dana 1991, Royer and Marrone 1992). However, conditions that favor disease agents, parasitoids, and predators could significantly increase their impact.

Competition

It might be expected that there would be competition between Ottoe skippers and other species that co-occur in time and space, and even utilize similar larval food plants and adult nectar sources (e.g., Dakota skippers). The mixed-grass species used by Ottoe skippers as larval food plants are the dominant vegetation on prairies where they occur, so it is unlikely that there would be competition at this level. However, the abundance of nectar plants is variable, and under certain circumstances there could be competition for nectar resources. During his study Dana (1991) observed population declines for Ottoe but not for Dakota skippers where they co-occurred. However, he did not observe anything suggestive of competitive suppression of Ottoes by Dakotas. The impact of competitive interactions on the dynamics of Ottoe skipper populations does not appear to be significant. However, potential competitive interactions are poorly understood and require further study.

Symbiotic and mutualistic interactions

No information on symbiotic and mutualistic interactions with Ottoe skippers was found.

Envirogram

Andrewartha and Birch (1984) define the environment of an animal as ". . . everything that might influence its chance to survive and reproduce." The important ecological relationships that affect the Ottoe skipper are depicted graphically as an envirogram in **Figure 8**. The "centrum" includes direct influences that are the proximate causes of the Ottoe skipper's condition; these are grouped into positive (e.g., resources and mates) and negative (e.g., malentities and predators) influences. The "web" includes distal causes of the Ottoe skipper's condition. They act indirectly by modifying the centrum and can be one to several steps removed from it (e.g., 1st to nth order modifiers) (Andrewartha and Birch 1984). Important resources for the Ottoe skipper are larval food plants and adult nectar sources. Adults also require an adequate moisture supply, which can come from nectar plants or wet soil (e.g., pond margins). High quality native mixed- and tallgrass prairie is required to provide these resources, and suitable soil types, rainfall amounts, grazing, and fire combine to influence the type and quality of prairie remnants. Prairie also supports species that are parasites or predators, so conditions that favor those species will have an indirect, negative impact on Ottoe skippers. Malentities include habitat loss or degradation resulting from agriculture, development, woody succession, exotic invaders, and overgrazing, and direct mortality of larvae resulting from prescribed fires, overgrazing, or extreme weather events. It is important to note that activities such as fire and grazing can have both positive and negative effects, and they must be used with caution to maximize positive impacts and minimize negative impacts.

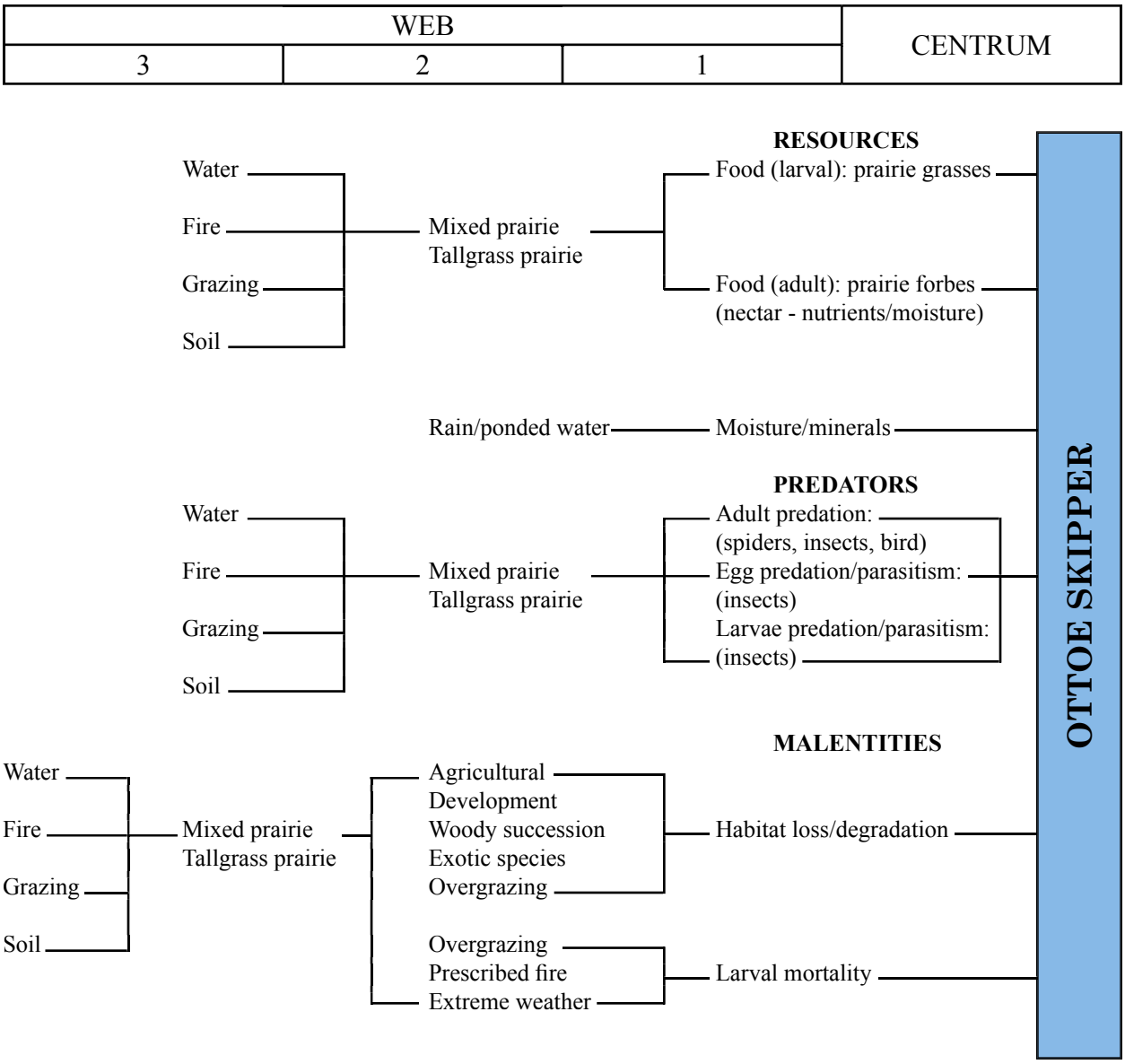

Figure 8. Envirogram for the Ottoe skipper.

CONSERVATION

Threats

Grassland conversion

Habitat loss and fragmentation are the greatest historical factors contributing to the decline and current status of the Ottoe skipper, and continued elimination or degradation of prairie habitat is the greatest future threat to this butterfly. Row crop agriculture, urban development and housing construction, road construction and maintenance, gravel mining, and wind generators are all activities that continue to threaten the elimination of remnant prairie habitats. In the absence of fire and grazing, most prairies will eventually be lost to encroachment by woody vegetation. This can include native woody species but has been exacerbated by the introduction of many aggressive exotic species that are very difficult to control. Invasive exotic species can also threaten to degrade and eventually eliminate prairie habitat.

Grazing effects

Royer (2002, 2003) recently conducted surveys for five butterfly species, including the Ottoe skipper, in the Little Missouri and Blue Buttes National Grassland, and he identified grazing as the "primary if not the sole" disturbance in the study area. He went on to note that both the Dakota and Ottoe skippers tend to be absent from grazed prairies in North Dakota. Dana (1997)

states that Dakota skipper numbers are reduced in direct proportion to grazing intensity. Light grazing may not be a threat to the long-term survival of prairie-specialist butterflies, especially if there is some contiguous ungrazed habitat, but heavy grazing is a threat (Royer and Marrone 1992, Dana 1997, Royer and Marrone 1992, Selby 2003c, 2004). Reduced availability of nectar resources is likely the primary factor, but changes to vegetative structure, removal of larval host plants, and trampling eggs and larvae may also be factors (Dana 1997, Fritz 1997).

The complete absence of grazing may also be unfavorable. There might be unique impacts of grazing on community structure (e.g., favoring mixed grasses over tall grasses) that are not replicated by other management methods (Dana 1997). Properly managed grazing (see below) could be an alternative to other forms of management (Royer and Marrone 1992).

The spatial and temporal distribution of grazing intensity can be managed by adjusting stocking rates, managing water resources to avoid concentrating activity in critical habitat areas (Royer 2002, 2003), and modifying grazing regimes (e.g., season-long vs. rotational). Bison (*Bison bison*) grazing may be preferable to European cattle (*Bos taurus*) grazing, since bison feed selectively on grasses, while cattle are more selective for forbs (Plumb and Dodd 1993). Rigorous research examining impacts of grazing on prairie-specialist butterflies has not been done, so any grazing regime should be implemented with the same caution as other large-scale natural disturbances (e.g., fire).

Exotic species

Prairie remnants survive in the context of a hostile environment. They are often surrounded by row crop agriculture and face a constant influx of eroded soil complete with annual weed seeds. Cool season exotics (e.g., smooth brome [*Bromus inermis*], Kentucky bluegrass [*Poa pratensis*]) have been introduced into many prairie pastures, and grazing practices often favor these species. Other threats include aggressive perennial species (e.g., leafy spurge [*Euphorbia esula*]) that can replace the diverse native communities with dense monocultures. Woody invasion by native and exotic species is also a threat. Prairie systems must be actively managed to maintain or enhance their quality. If succession has progressed too far, then established shrubs or trees should be removed.

Pesticides

Indiscriminant use of insecticides for pest control on rangeland or adjacent cropland can be a major direct threat to the Ottoe skipper. Royer and Marrone (1992) cite the combination of drought and grasshopper control programs along the Red River Valley in North Dakota as having serious impacts on Poweshiek skipperling (*Oarisma poweshiek*) populations. Broadcast spraying of herbicides, which usually targets dicots, can also affect Ottoe skipper populations indirectly by eliminating important nectar sources.

Prescribed burning and wildfires

NatureServe (2005) includes "non-optimal" fire management programs among the threats to Ottoe skipper populations. Dormant season burns can cause direct mortality of larvae in the litter layer (Dana 1985, 1991), and by removing the insulating litter layer, fall burns can cause indirect mortality of larvae as a result of exposure to extreme winter conditions. Improper timing of burns can also temporarily limit the availability of critical resources (e.g., larval food plants, nectar sources) immediately following the burn or as a result of altering the phenology (e.g., delayed blooming as a result of a late burn). Given these factors, it should be assumed that overly extensive (e.g., burning all or most of the Ottoe skipper habitat at one time), or excessively frequent (e.g., every one to two years) fires will have a negative effect on Ottoe skipper populations (NatureServe 2005). Fire is an essential tool for maintaining prairie habitat used by Ottoe skippers. Therefore, the interactions between positive and negative impacts of fire, and their combined impact on long-term survival, need to be understood so that appropriate plans can be developed.

Over-utilization for commercial, recreational, scientific, or educational purposes

Collecting for commercial purposes is not generally a problem for species such as the Ottoe skipper, and limited collecting for scientific documentation will not usually impact a population unless it is already severely depressed. Scientific collector permits are required in states where Ottoe skippers have legal protection, and it is usually necessary to get permission to do collecting on protected areas.

Environmental factors

Extreme weather conditions can pose a threat to prairie-specialist butterflies, such as the Ottoe

skipper, and the impact can be expressed over a large geographic area. The buried shelters used by larvae provide some protection from extreme winter weather, but once the larvae move to surface shelters, they could be susceptible to a late spring hard frost, severe storms, or cool damp conditions. Humid conditions have been associated with increased susceptibility to bacterial septicaemia in some skipper species (MacNeill 1964), but this did not appear to be a likely mortality factor for Ottoe and Dakota skippers in the study by Dana (1991). However, cool temperatures slow larval development rates, which could prolong their exposure to mortality factors (Dana 1991). During the adult flight, severe storms could cause direct adult mortality, and prolonged periods of cool temperatures, overcast skies, and rain could limit reproduction by limiting adult activity.

Disease or predation

Dana (1991) documented some parasitism and predation of Ottoe skipper eggs and larvae by various groups of wasps, ants, and other insects. He hypothesized that one possible advantage of laying eggs on the elevated capitula of purple coneflowers might be reduced susceptibility to parasitoids and predators. Mortality of larvae in his plots was approximately 50 to 60 percent. Potential predators on adults include crab spiders, ambush bugs, robber flies, and birds, but they are not generally thought to have a significant impact on healthy butterfly populations (Dana 1991, Royer and Marrone 1992). Under normal circumstances, disease and predation are not considered a major threat to Ottoe skippers, but under certain conditions (e.g., when Ottoe skipper numbers are already depressed and/or during unusually good years for disease, parasitoid or predator organisms), their impact might be greater than normal.

Conservation Status of the Ottoe Skipper in Region 2

USFS Region 2 contains the heart of the Ottoe skipper's range, and it is therefore critically important to the long-term survival of the species. Unfortunately, the Ottoe skipper is not actively tracked by most Natural Heritage Programs in the region (e.g., Kansas, Nebraska, Wyoming), so it is difficult to get an assessment of its current conservation status. In Kansas, Nebraska, and South Dakota, Ottoe skippers can be locally abundant in areas with large high quality prairie remnants, but most populations are local and uncommon to rare. The extant Colorado populations are concentrated along the Colorado Front Range in rare mixed- and tallgrass prairie remnants, and populations are assumed to be declining (Colorado Natural Heritage Program 2005b). The Ottoe skipper has only been documented from two counties in Wyoming with the status and trends of those populations being unknown.

The Ottoe skipper appears to be relatively secure in portions of Region 2, especially Kansas and Nebraska. However, many of the populations are restricted to small, isolated prairie fragments. These populations are highly susceptible to extirpation, and it can be expected that some of these populations will be lost in the future. Conservation and management practices aimed at conserving prairie ecosystems need to be implemented to mitigate these extinction probabilities and thereby help to ensure the long-term survival of the Ottoe skipper in Region 2 and throughout its range.

Potential Management of the Ottoe Skipper in Region 2

Implications and potential conservation elements

Ottoe skippers require relatively undisturbed native mixed- and tallgrass prairie, and they cannot survive in the surrounding altered landscape. They do not migrate and have limited dispersal capability, so if isolated populations are extirpated, it is unlikely that they will be repopulated. Each stage of the life cycle must be completed successfully each year at each site for local populations to persist through time at those sites. Historic loss, degradation, and fragmentation of the prairie landscape have contributed to the decline and current vulnerability of Ottoe skipper populations.

To prevent further losses, critical habitat areas (i.e., prairie ecosystems) need to be identified, protected, and managed to maintain or improve their size, quality, and connectivity. Management should be directed toward preventing encroachment by woody vegetation and exotic species, maintaining adequate nectar sources, and increasing the vigor of larval food sources. Small isolated Ottoe skipper populations are more vulnerable to events that might have been survived in the original prairie landscape, so management activities need to be designed carefully to avoid exacerbating those vulnerabilities. The timing, intensity, extent, and duration of management activities such as grazing and prescribed fires need to be adapted to ensure the availability of critical resources (e.g., nectar plants, larval food plants) when they are needed, and to mitigate any direct mortality that might result from them.

Tools and practices

Habitat management

Management for prairie invertebrates is often incidental to management focused on restoring or maintaining healthy native prairie vegetation. Prairie invertebrates such as the Ottoe skipper should benefit indirectly from the improved habitat, but it is important to make sure that they are not harmed directly by the management, or indirectly through shifts in community composition or structure. Standard habitat management methods are discussed below in the context of their impact on Ottoe skippers and other prairie-specialist butterflies.

Prescribed burning

Prescribed fire is one of the principal tools used to manage native prairies. It benefits prairie-specialist butterflies, such as the Ottoe skipper, by helping to control habitat loss to cool season exotics and woody vegetation, increasing the vigor of native species (including larval food plants), and increasing flowering rates of important nectar sources. However, to reap these benefits, these butterflies must either survive those fires, or recolonize the area from an adjacent source. Return intervals of fires must be low enough to allow for full recovery of the populations between burns as well. Negative impacts of fire can include direct mortality of larvae in the litter layer during dormant season burns (Dana 1985, 1991) and indirect mortality of larvae resulting from exposure to extreme winter conditions as a result of removing the insulating litter layer in fall burns. Indirect negative impacts also include temporarily limiting the availability of critical resources (e.g., larval food plants, nectar sources) immediately following the burn or as a result of altering the phenology (e.g., delayed blooming as a result of a late burn). Interactions between positive and negative impacts of fire, and their combined impact on long-term survival, must be understood to develop appropriate plans to manage prairies for insect conservation. The combined results from studies by Dana (1991), Panzer (1998, 2002), and the Swengels (Swengel 1996, 1998; Swengel and Swengel 1999, 2001) provide helpful guidelines for the use of prescribed fire as a management tool for Ottoe skippers.

Haying or mowing

The tradition of cutting prairie hay has helped to preserve many prairie remnants by providing an alternative to row crop agriculture, and in many cases it has also helped to maintain the quality of those prairies by preventing the accumulation of excessive litter and succession to woody species. The practice also appears to favor prairie-specialist butterflies. Swengel (1996) found that prairie specialist numbers were higher in hayed than burned prairies, and McCabe (1981) noted that Dakota skippers have survived on sites with long histories of haying. McCabe (1981) believes that for the Dakota skipper, appropriately timed mowing (e.g., after adult flight) is more compatible with the indefinite persistence of the Dakotas than burning. Ottoe skippers are likely to have a similar response.

Haying or mowing can be an effective alternative to prescribed fire, or it can be used to enhance the effectiveness of prescribed fire programs. Advantages of mowing are that it can be done when woody vegetation is already stressed (i.e.,. late summer when it is hot and dry, and when woody plants have most of their resources above ground), and it can be focused on the problem areas. Prescribed fires are usually done in the spring and fall, when woody plants are dormant and have most of their resources stored below ground. Fires tend to burn least effectively in those areas where woody vegetation problems are the worst. Even when they are successful in top-killing woody vegetation, it usually produces vigorous suckers following a burn. Late summer burns can be effective, but it is often difficult to burn hot enough in areas with established woody vegetation. Mowing and other forms of mechanical woody vegetation control can be used to enhance the effectiveness of prescribed fires by opening up areas to be burned so that fine fuels can both develop and burn more effectively.

As with any management practice, the impact on Ottoe skippers will depend on the frequency, timing, intensity, and extent of haying or mowing. If it is done too often or during the adult flight period, it will have a negative effect by eliminating nectar sources. If an area is mowed too short, it could have a negative impact on developing eggs or larvae. No matter what the timing or intensity of the mowing, there will always be species that are negatively impacted. Therefore, just as with burning, only a portion of a site (i.e., no more than one-third to one-half) should be hayed or mowed in a given year.

Grazing

Grazing by wide-ranging herds of bison and fire were likely the dominant forces that shaped the pre-settlement prairie landscape. It is therefore important to consider the role that grazing should play in managing

the remaining fragmented prairie remnants. Most current grazing is accomplished by European cattle confined to small prairie fragments that are vulnerable to invasive exotic species such as smooth brome and leafy spurge. It is drastically different from historical free-range grazing of bison herds. The complete absence of grazing may also lead to unfavorable habitat conditions, so some grazing may be needed to help maintain habitat structure (Dana 1997). Royer and Marrone (1992) suggest that properly managed grazing can be an alternative to other forms of management. Bison grazing may be preferable to European cattle grazing, since bison feed selectively on grasses, while cattle are more selective for forbs (Plumb and Dodd 1993), but this is not an option in most cases. Various grazing regimes (e.g., season-long vs. rotational) may also have significantly different impacts. Very little rigorous research examining grazing impacts on prairie butterflies has been done, so any grazing regime should be implemented with caution. Butterfly numbers are generally reduced in direct proportion to grazing intensity (Dana 1997, Selby 2003c, 2004). Therefore, as a general rule, intensity should be lighter than might be typical. Populations of Ottoe skippers and other prairie-specialist butterflies should be monitored, so the intensity, timing, and duration of grazing can be adjusted in response to observed impacts on them. As with other large-scale management practices, only a portion of a site should be grazed at any given time.

Chemical control of exotic species and woody vegetation

Selective applications of herbicides can be an effective way to control exotic species and woody vegetation. Cutting and treating stumps of woody vegetation with a systemic herbicide is an effective way to prevent suckering. Treatment is localized, so damage to the surrounding vegetation is kept to a minimum. Spot spraying of perennial exotic species might be necessary, but this should always be done as a last resort and with extreme caution to avoid damaging the surrounding vegetation. Non-persistent herbicides (e.g., glyphosphates) are preferable to more persistent herbicides (e.g., picloram), but they may not be as effective. Broadcast spraying with broadleaf herbicides is a common practice in range management, but it is not recommended for prairie systems since native forbs are killed along with the targeted exotics. In extreme cases where native vegetation is almost entirely replaced by non-natives, broadcast applications of non-persistent herbicides (e.g., glyphosphates), followed by reseeding to native vegetation might be necessary. Very late season applications of glyphosphates can be effective in killing cool-season grasses without impacting native species that might be mixed in with them.

Biological control of exotic species

Biological control provides an alternative to the use of non-selective persistent herbicides for treating aggressive perennial exotic weeds such as leafy spurge. The control agents are tested rigorously to make sure they are "safe" for native species, but it is still a good idea to thoroughly research any biological control options before approving them for use on native prairies.

Inventory and monitoring

Pollard transect surveys (Pollard et al. 1975, Pollard 1977, 1982, Pollard and Yates 1993) are the standard butterfly monitoring methodology adopted by many lepidopterists. They involve surveying fixed routes (transects) using standardized protocols (e.g., survey speed, time of day, weather), and have the advantages of being fairly simple and easily replicated. The results are relative abundance values for each species that can be used to track trends in relative abundance over time. Absolute population estimates can be useful, but they involve much more labor-intensive mark and recapture methods (Ehrlich and Davidson 1960, Brussard 1970). The "checklist" survey is an alternate methodology in which the survey route is not fixed (Royer et al. 1998). It involves an unrestricted comprehensive search and has the advantages of being fairly simple and focusing the effort in habitat for the target species. Royer et al. (1998) compared the "checklist" and "transect" methods to determine which would be the most efficacious. The number of individuals counted per unit time was significantly higher for the checklist method, but there was no significant difference between the methods for the number of species observed per unit time. However, the checklist method was better at capturing sedentary, habitat-specialist species (e.g., many lycaenids and hesperiids). They concluded that the checklist method was better for obtaining an initial site-specific butterfly species list, but that the transect method was better for long-term monitoring.

Since so little is known about the distribution and abundance of Ottoe skippers on National Forest System lands in Region 2, checklist surveys, focused in potential Ottoe skipper habitat, are needed first. Once Ottoe skipper populations are identified, then their habitat requirements and distribution can be defined more clearly, and transect surveys can be designed to monitor those populations. Current Global Positioning System

(GPS) technology makes it fairly simple to navigate defined survey routes, and to map the distribution of the butterflies and their preferred habitat areas.

Information Needs

Inventory and monitoring

There is very little information available for the occurrence and distribution of Ottoe skippers on National Forest System lands within Region 2. USFS personnel were unaware of any Ottoe skipper records from units in the region, despite the fact that many of the units are in counties where Ottoe skippers have been documented. Several USFS units are identified in this assessment as having potential for Ottoe skipper occurrences. They should be evaluated first to determine if they have Ottoe skipper habitat (e.g., mixed- and tallgrass prairie), and then areas with Ottoe skipper habitat should be surveyed. If Ottoe skippers are found, then it is important to determine their distribution and abundance, and to attempt to define their habitat requirements more precisely for that geographic area. This will make it possible to predict their potential distribution more precisely, and the actual and predicted distribution can be used to make more informed management decisions.

Grazing impacts

There is a need for rigorous research examining impacts of grazing on the Ottoe skipper and other prairie-specialist butterflies. This is especially relevant to National Forest System lands since so many of them contain grazing allotments. A study examining the impact of grazing on Dakota skippers was done in Minnesota (Selby 2003b, 2003c, 2004). The study was to examine the impacts on each of the life stages of the Dakota skipper (e.g., adults, eggs, larvae), as well as the adult stage for other concurrent prairie-specialist butterflies. Unfortunately, the study coincided with a dramatic population crash for the Dakota skipper and several of the secondary target species. Populations were too low during the study to collect data adequate to test hypotheses on the adults, much less the other stages. Similar studies are needed to examine the impact of cattle grazing on the Ottoe skipper. In Region 2 there would also be opportunities to conduct studies comparing the impacts of bison vs. cattle grazing and perhaps even interactions with prairie dogs.

Fire management impacts

General studies examining fire impacts on prairie butterflies and invertebrates (Swengel 1996, Panzer 1998, Swengel 1998, Swengel and Swengel 1999, 2001, Panzer 2002) provide general principles that can be applied to fire management. Studies of Dakota and Ottoe skippers by Dana (1991) provide more specific fire management guidelines. However, there is still a need to conduct additional research examining short- and long-term effects of prescribed burn programs on Ottoe skippers and the interaction between prescribed burning and other management options (e.g., grazing and haying).

DEFINITIONS

Capitulum – a dense headlike cluster of stalkless flowers (e.g., composite flower heads).

Chorion – outer covering of an insect egg.

Daily flight period – time period during each day when adult butterflies are active.

Diapause – a period of suspended growth and development.

Disjunct – separated; disconnected. As used here, populations that are disconnected from the main population.

Extant – populations that are still in existence; not lost, destroyed or extinct

Extirpate – to destroy completely or exterminate a population.

Glyphosphate – a general use, non-persistent systemic herbicide.

Habitat capability – the overall capacity of the habitat to support populations of the target species, including habitat components such as size, quality, fragmentation, isolation, etc.

Instar – insect stages between molts; larval stages in this paper.

Larva – immature stage between egg and pupa in insects with complete metamorphosis.

Oocyte – cell that will undergo meiosis to produce an egg.

Oviposition – laying eggs; especially in insects with an ovipositor (egg laying structure).

Picloram – a persistent systemic herbicide in the pyridine family of compounds, which is used to control woody vegetation.

Stigma – a small mark, spot or pore; specialized scent glands on the upper surface of the forewing of males in this paper.

Suckers – a secondary shoot arising from the base of a tree or shrub; multiple suckers are often produced after cutting or top-killing a tree or shrub.

Univoltine – having a single generation per year.

Wing wear – freshly emerged butterflies have little or no physical damage to their wings or the scales that give them their color. As they age, their wings show increasing signs of physical damage, and the scales are worn off causing the colors to appear more faded.

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