BEFORE THE SECRETARY OF INTERIOR

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PETITION TO LIST THE IOWA SKIPPER (*ATRYTONE AROGOS IOWA*) UNDER THE ENDANGERED SPECIES ACT

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Center for Food Safety

NOTICE OF PETITION

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PETITIONER

The **Center for Food Safety** ("CFS") is a nonprofit public interest organization whose mission centers on protecting public health and the environment by curbing the adverse impacts of industrial agriculture and food production systems on public health, the environment, and animal welfare, and by instead promoting sustainable forms of agriculture. CFS has more than one million members across the country, with offices in Portland, Oregon, San Francisco, California, and Washington, D.C. CFS is a recognized national leader on the issue of industrial agriculture and its impacts to public health and the environment, utilizing regulatory actions, citizen engagement, legislation, and, when necessary, litigation. CFS and its members are concerned about the impacts of industrial agriculture on biodiversity and its contributions to the extinction crisis. Through its Extinction Crisis program, CFS works to curb species declines and the extinction crisis by challenging the harmful inputs and practices of industrial agriculture, promoting regenerative agricultural systems that protect and preserve species and their habitat, and securing legal protections for species imperiled by the practices of industrial agriculture. CFS and its members are particularly concerned about the plight of pollinators including the Iowa skipper. CFS and its members have strong interests in the conservation of Iowa skippers that are impacted, directly and indirectly, by harmful agricultural practices. As part of its mission and member interests, CFS's multifaceted pollinator protection program actively works to reduce the adverse effects of toxic pesticides on important insect and pollinator species, such as butterflies and bees. This program utilizes scientific, policy, educational, legislative, regulatory, and grassroots campaigns to spearhead action from government agencies, policymakers, and the public, to protect food security and the environment by requiring robust analyses of these pesticides' adverse impacts and suspending or curbing their use as needed.

Submitted this 28th of March 2023

Pursuant to Section 4(b) of the Endangered Species Act (ESA), 16 U.S.C. § 1533(b); section 553(e) of the Administrative Procedure Act (APA), 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Food Safety hereby petitions the Secretary of the Interior, through the U.S. Fish and Wildlife Service (FWS or Service), to protect the Iowa skipper (*Atrytone arogos iowa*) as a threatened or endangered species.

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id.*

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EXECUTIVE SUMMARY

The Iowa skipper is a small bright-yellow orange butterfly that once ranged throughout the Midwestern U.S. and Great Plains but appears to be missing in many areas today. Where the Iowa skipper is still hanging on, it is patchily distributed in small, isolated populations, often in tiny islands of prairie habitat surrounded by a sea of inhospitable intensive row crop agriculture. Once described as one of the most abundant skipper species in Iowa, the Iowa skipper has not been seen in the state since 2009. It has also not been seen in Minnesota since 2008 and is extirpated from Illinois, where it was last seen in 1989.

The Iowa skipper is a prairie-specialist, living in tall, mixed, and short-grass prairie habitats that are among North America's most endangered habitats. The conversion of the vast majority of the Iowa skipper's habitat to cropland played a major role in past declines of this species, and the threat continues today. About 99% of tallgrass prairie has been destroyed in most central U.S. states since European settlement, most of which was converted to intensive agriculture.

Conversion to cropland continues to serve as an ongoing threat to the Iowa skipper and its habitat, especially in North Dakota, South Dakota, and Nebraska, as corn and soybean cropping has expanded westward. This continued, and in some cases accelerating, habitat conversion is driven by a combination of factors including demand for biofuels, high crop prices, government subsidies, and technological advances. The Renewable Fuel Standard in the U.S. Energy Independence and Security Act of 2007 spurred conversion to agriculture through its promotion of growing crops for biofuels, by requiring biofuels to be blended in the transportation fuel supply. This requirement has primarily been fulfilled with ethanol made from corn.

Habitat modification and degradation is also a significant and ongoing threat to the Iowa skipper. Disruption of natural disturbance regimes, such as fire suppression and the removal of native grazers, contributes to the degradation of the skipper's habitat. And attempts to manage prairies without considering the needs of individual species can itself contribute to further habitat degradation. Protection of the Iowa skipper cannot be presumed on nature preserves, as butterflies, including the skipper, are declining, and sometimes disappearing from these sites.

Pesticides are also a major driver of the past and ongoing declines of the Iowa skipper. The increasing intensification of agriculture, especially after World War II, led not only to expansion of farms but also to an emphasis on monocultures and on application of massive amounts of synthetic pesticides. Pesticides can directly harm Iowa skippers, as well as indirectly harm them through damage to their habitat. Because most of the Iowa skipper's remaining habitat is surrounded by intensive row crop agriculture, they are likely to be exposed to pesticide drift from adjacent fields. Levels of pesticide use continue to increase, putting the Iowa skipper at risk, especially with a shifting focus to crops genetically engineered to be resistant to certain pesticides and the advent of pesticide coated seeds.

The Iowa skipper is threatened by climate change, through the impacts of changing temperatures and increase in the frequency of extreme weather events. Since the Iowa skipper survives in small, isolated patches of habitat, it is unlikely to be able to shift its range and migrate to an area with more hospitable conditions. And its small, isolated populations are especially vulnerable to being wiped out by extreme weather events. Iowa skippers are also threatened by invasive, non-native plant species that outcompete their host and food plants and may be additionally threatened by the use of pesticides to manage these plants in their habitat.

Based on the best available science, the Iowa skipper is in danger of extinction and qualifies for protection under the Endangered Species Act. The U.S. Fish and Wildlife Service must act promptly to protect the Iowa skipper in order to halt and reverse its ongoing declines and disappearances throughout its range, and to plan for the species' future survival and recovery.

I. INTRODUCTION

Insects are experiencing drastic rates of decline worldwide, potentially driving 40 percent of the world's insect species to extinction in the next few decades (Sanchez-Bayo and Wyckhuys 2019, p.6; Sanchez-Bayo and Wyckhuys 2021, pp.22-23; Raven and Wagner 2021, p.3) A literature review revealed that 41% of the world's insect species are rapidly declining and a third are being threatened with extinction (Sanchez-Bayo and Wyckhuys 2019, pp.16-17). In a long-term assessment to quantify insect populations between 1989 and 2014, the biomass of insects caught fell by 75% and scientists recorded a corresponding 82% decrease in insect activity during peak periods (Hallmann et al., 2017 pg.10). Insect extinctions since the industrial era are estimated at 5-10%, with the potential for losses of half a million insect species in the coming decades (Nath et al. 2022, p.5).

Since the end of World War II, declines in insect biomass and diversity have become clear and well documented and these losses are directly related to the spread and intensification of agriculture during this period (Raven and Wagner 2021, pp.3-4). Habitat change and pollution are the primary driver of insect declines worldwide, and the intensification of agriculture over the past six decades, with its widespread use of synthetic pesticides, is a root cause of the problem (Raven and Wagner 2021, p.4; Warren et al. 2021, p.4; Sanchez-Bayo and Wyckhuys 2019, p.22).

Like other insects, butterfly and moth populations in North America and Europe show pervasive declines (Forister et al. 2021, pp.1042-44; Wepprich et al. 2019, p.7; Fox et al. 2015, p.7; Warren et al. 2021, pp.1-2; Swengel et al. 2011; Forister et al. 2011, pp.2222–2235). Fifty-three percent of butterfly and moth species are declining, and their annual rate of decline of 1.8% is higher than that for the group of insects as a whole (1%) (Sanchez-Bayo and Wyckhuys 2019, pp.16-17). And as with other insect declines, butterfly declines are primarily caused by habitat loss and degradation and pollution primarily stemming from intensive agriculture, along with climate change bringing new threats to susceptible species (Warren et al. 2021, p.4; Habel et al. 2019, p.6; Schlicht and Orwig 1998, p.83).

Insects that rely on grassland habitats are experiencing elevated rates of loss (Raven and Wagner 2021, p.4). Prairie-specialist butterflies, like the Iowa skipper (*Atrytone arogos iowa*), have experienced disproportionately large declines compared to other groups of butterflies, including those specialized to other midwestern US biomes (Swengel et al. 2011, p.328).

The Iowa skipper is a prairie-specialist butterfly considered to be an indicator of high-quality prairie habitat (Fowler and Anderson 2015, p.585). The Iowa skipper has a wide range which "is roughly coincident with the midcontinent grassland biome, from North Dakota and eastern Montana east to Illinois and south to Texas," but is patchily distributed throughout this extensive range (Minnesota Dept. of Natural Resources 2022).

Pollinator population declines in the U.S. Northern Plains have led the U.S. Fish and Wildlife Service to list the Dakota skipper (*Hesperia decotae*), Poweshiek skipperling (*Oarisma poweshiek*), and rusty patched bumblebee (*Bombus affinis*) under the Endangered Species Act, and to consider protections for several other butterfly and bumblebee species (Niemuth et al. 2021, p.2). The primary factors contributing to these declines are loss of habitat and pesticides (Niemuth et a. 2021, p.2). The Iowa skipper's range overlaps in part with the ranges of these threatened and endangered species and it suffers from many of the same threats.

As grasslands and prairies worldwide have been converted into agricultural land, they have become one of the most threatened biomes on the planet (Raven and Wagner, 2021 p.4). Tallgrass prairies in North America once extended from Manitoba to northern Texas, covering about 60 million hectares. (Raven and Wagner, 2021 p.4). About 99% of tallgrass prairie in the U.S. has been destroyed since European settlement, resulting in prairie obligate butterflies like the Iowa skipper being rare and primarily restricted to prairie reserves. (Swengel and Swengel 1993, p.9). There is a consensus that prairie skippers, like the Iowa skipper "are faring particularly poorly in their tallgrass prairie range" (Swengel 2013, p.76).

The first known specimens of Iowa skipper were captured in Iowa by Scudder (1869, p.337), who described them as one of the most abundant skippers in Iowa. But by 1998, the Iowa skipper had declined "as precipitously as Iowa prairie" and was classified as threatened and vulnerable to further losses (Schlicht and Orwig 1998, p.83-84). The Iowa skipper now appears to be missing in Iowa, or at least hanging on in very low numbers, as it has not been seen in the state since 2009 (Shepherd 2022, personal communication; Olsen 2018). The Iowa skipper has also not been found in Minnesota since 2008, despite regular butterfly surveys, and is considered extirpated in Illinois, where it has not been seen since 1989 (Dana 2017, p.4; Petersen 2020, p.8; NatureServe 2020; Illinois Dept. of Natural Resources 2015, pp.93-94).

The Iowa skipper is experiencing declines across its range, is not considered to be common or secure anywhere, and largely survives in small numbers in isolated prairie remnants (NatureServe 2020; U.S. Forest Service 2018a; U.S. Forest Service 2018b, pp.1-2; Swengel et al. 2011, p.327; Akin 2010, p.7; Schlicht et al. 2009, p.437; Holimon 2007, p.3). The Iowa skipper's survival continues to be threatened by the destruction, fragmentation, and modification of its remaining habitat, as well as by pesticides, climate change, invasive species, and its small, isolated populations, as well as the additive and synergistic effects of these threats. As such, the Iowa skipper urgently needs the protections that Endangered Species Act listing will provide. Without these protections, the Iowa skipper will continue to decline and be at risk of extinction.

II. NATURAL HISTORY

A. Taxonomy and Description

The Iowa skipper (*Atrytone arogos iowa*) is a subspecies in the Family Hesperiidae, subfamily Hesperiinae, within the Order Lepidoptera. Most authors recognize the two subspecies, *arogos* and *iowa*. (*E.g.,* Minnesota Dept. of Natural Resources 2022; NatureServe 2020; Selby 2005; Kettler and Pineda 1999; Swengel 1993). The U.S. Fish and Wildlife Service (1993, pp.2, 10) previously recognized the two subspecies and considered them separately in including the eastern subspecies *A. a. arogos* on its list of candidate species (59 Fed. Reg. 58982, 59019 (Nov. 15, 1994)).

The morphological differences between the two subspecies are subtle but they are distinct ecologically and highly disjunct (NatureServe 2020). The eastern subspecies, *Atrytone arogos arogos*, "spottily occurs in dry grasslands and sand prairies of the Atlantic and Gulf coastal plains," whereas *Atrytone arogos iowa* is found in the Great Plains and "ranges widely in prairies (usually undisturbed) from Minnesota and North Dakota south to eastern Colorado, Texas, Missouri, and only one county (Mason) in central Illinois" (Swengel 1993, p.26). Similarly, Selby (2005, p.1) describes the Iowa skipper as "a western subspecies of the Arogos skipper (*Atrytone arogos*) [that] is associated primarily with mixed- and tallgrass native prairie in the Great Plains."

The Iowa skipper is a valid taxon listed in the Integrated Taxonomic Information System (ITIS) (Guala and Döring 2022):

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Lepidoptera
Family	Hesperiidae
Genus	Atrytone
Species	Arogos
Subspecies	iowa

The taxonomy of *Atrytone arogos* is considered to be quite stable (Royer and Marrone 1992, p.2). Burns (1994, pp.276-77) describes the history of the taxonomic classification of the Iowa skipper's genus *Atrytone*, which has undergone multiple revisions. Using a review of genitalic characters, Burns (1994) revised the genus *Atrytone* and restricted it to *Atrytone arogos*. However, a recent paper suggests that *Problema* should be treated as a subgenus of *Atrytone*, adding *Problema bulenta* and *Problema byssus* to the genus *Atrytone*, in addition to *Atrytone arogos iowa* (Zhang et al. 2019, p.10, Figure 15). The authors found the genetic convergence between *Atrytone arogos iowa* and its sister genus *Problema*, was more consistent with them being congeners (Zhang et al. 2019, p.10, Figure 15). This paper did not call into question the Iowa skipper's continued placement in the genus *Atrytone*, nor its status as a valid subspecies.

Older sources, and some more recent ones, refer to this species as the Arogos skipper, or *Atrytone arogos*, but it is easy to differentiate the subspecies being referenced based on the location. It also may be referred to by the common name beardgrass skipper (Minnesota Dept. of Natural Resources 2022). Even older publications may refer to this species under the scientific names *Hesperia arogos* or *Hesperia iowa*. For clarity and consistency, we refer to the subspecies as the Iowa skipper throughout the petition, regardless of how it is referred to in the cited references.

The Hesperiidae family (skipper butterflies) are "stout-bodied, with large heads and prominent eyes, and have hooked or pointed antennae placed wide apart at their bases. The labial palpi are short, thick and hairy, giving a clumsy appearance." (Freeman 1939, p.21). Skippers often have rapid flight covering short distances, with the wing movement blurred. (Freeman 1939, p.22; Opler 1999, p.372). The common name "skippers" comes from the "characteristic jerking manner in which they fly, darting about from place to place" (Freeman 1939, p.22).

Iowa skippers are bright yellow-orange with size ranging from 1 1/8 to 1 7/16 inches (28-36 mm). (Opler 1999, p.446). From above, their wings have broad black borders and from the underside they have hindwing veins with pale scaling. (Opler 1999, p.446). The underside of the hindwings is golden yellow with pale veins (Marrone 2004, Appendix A, p.26). Iowa skipper males have wings that are buff to yellow-orange on the upper surfaces (Royer and Marrone 1992, p.3). Unlike some of its relatives, Iowa skipper males lack a stigma on its upper forewing. (Scott 2022, p.72; Royer and Marrone 1992, p.3). Females are larger and darker above than males, with a broader dark margin of the upper wing surface which diffuses into buff areas and can be so broad on the hindwings that the buff color is almost entirely obscured (Ferris and Brown 1981, p.102; Selby 2005, p.2; Royer and Marrone 1992, p.3).

Their eggs are a yellowish-cream color and develop two reddish rings, the lower one typically being faint or rarely absent (Scott 2022, p.72). Caterpillars are pale yellow-green or green cream with pale yellow-green intersegmental folds (Opler 1999, p.446). The caterpillar's head is gray-white or pale tan with four vertical orange-brown stripes (Opler 1999, p.446). The pupae are variable with a lot of differences between the sexes, ranging from yellow-cream in the palest females to smoky black on the head and thorax in males (Scott 2022, p.73). Additional descriptions of the different larval and pupa stages can be found in Scott (1992, p.148) and Heitzman (1966, pp.177-181).

The Delaware skipper (*Anatrytone logan*) is a similar-looking species, but its color is a brighter orange above and it has more distinct dark margins and dark veins (Opler 1999, p.446; Selby 2005, p.2). And "*Anatrytone logan* is a very distinct genus from *Atrytone arogos*," (Scott 1992, p.1). Scott (1992, pp.149-50) includes a table detailing the differences between *Atrytone arogos* from *Anatrytone logan* including the larval stages and behaviors.

B. Biology

The Iowa skipper is typically univoltine, producing one brood per year, in the north and western portion of their range, and bivoltine, producing two broods per year, in the southern part of their range (Lotts and Naberhaus 2022; Opler 1999, p.446; Swengel 1993, p.26). In areas where Iowa skipper have two broods, adult flight is in May/June-early July and August-September, and in areas where they have one brood adult flight is June-July (Glassberg 2001, p.270).

The Iowa skipper is univoltine in North and South Dakota, with an annual flight lasting about three weeks from late June to mid-July (Royer and Marrone 1992, p.13). It also has a single annual generation in Minnesota with the main flight occurring from late June to late July, but most records are from the first three weeks of July (Minnesota Dept. of Natural Resources 2022; Swengel 1993, p.28). Adults fly in late June and July in Colorado (NatureServe 2020).

The Iowa skipper also has a single brood in Iowa, flying from mid-June to early August, and rarely has a partial second brood that emerges in mid-September (Schlicht et al. 2007, p.60). In Nebraska records indicate that Iowa skipper may have a second brood, as records are from mid-June to late August (Dankert 2020a; Dankert 2022a). The skipper's main flight in Nebraska is from mid-June into July (Dankert 2020a). In Colorado the Iowa skipper's flight period is from late June to mid-July near the foothills, and a week or two earlier eastward on the plains (Ferris and Brown 1981, p.102).

The Iowa skipper is bivoltine in Texas (March-May, August-September) (Neck 1996, p.252). There are also two broods in Missouri, one in June and one in mid-August into September (Heitzman and Heitzman 1987, p.55). The first brood in Missouri "is most numerous" (Heitzman and Heitzman 1987, p.55). Iowa skippers were observed from June to mid-September at Wah'Koh-Tah prairie in Missouri, with the largest numbers seen from June 7-20 and July 26-August 22 (Ross 2001, pp.18-19). In 2007, Akin (2010, pp.7-8) discovered that the Iowa skipper has two broods in Arkansas, "one early in the summer (generally early June) and one towards the end (mid-August into September)," but with potential appearances as early as late May and as late as early October in some years.

Iowa skippers typically court and mate in overcast conditions, unlike most other prairie butterflies (Scott 2022, p.4; Opler 1999, p.446-47; Ferris and Brown 1981, p.102). Their mating activity is concentrated in the afternoon (Minnesota Dept. of Natural Resources 2022; Scott 2022, p.4). Males and females are typically observed nectaring in the morning and early afternoon (Minnesota Dept. of Natural Resources 2022). Feeding on flowers is the main activity for both sexes of Iowa skipper (Scott 1975, pp.27-28). "Prior to the mating period and on warm sunny afternoons adults appear quite sluggish as they just feed on flowers and do not chase" (Scott 2022, p.73). Details about the Iowa skipper's preferred nectaring flowers are included in the Habitat section below.

Iowa skippers use perching behavior to bring the sexes together for mating: "males rest at characteristic sites and investigate passing objects by flying out at them to search for females; females generally fly to these sites to mate, then they depart" (Scott 1975, p.1). Male Iowa skippers perch on low vegetation near host plants in the afternoon to watch for females (Marrone 2004a, Appendix A, p.26; Lotts and Naberhaus 2021). The males then "chas[e] insects that fly past in attempt to intercept receptive females (Minnesota Dept. of Natural Resources 2022).

Mating frequency and fecundity are not reported for Iowa skipper (Minnesota Dept. of Natural Resources 2022).

The Iowa skipper's larval foodplants are grasses, with big bluestem (*Andropogon gerardii*) documented as a main or preferred larval host (Scott 1992, p.127, 147, 178; Spencer and Simons 2006, p.59; Lotts and Naberhaus 2022; Dankert 2022a; Glassberg 2001, p.270). Other documented host plants include little bluestem (*Schizachyrium scoparius*), sideoats grama (*Bouteloua curtipendula*), and possibly panic grass (*Panicum*) (Montana Natural Heritage Program 2022; South Dakota Dept. of Game, Fish, and Parks 2014, p.275; Marrone 2004, Appendix A, p.26; Dole et al. 2004, p.131).[1]

Preference for host plants may vary in different parts of the range. In Colorado the Iowa skipper "appeared to avoid switchgrass (*Panicum virgatum switchgrass*) and Scribner's Panic grass (*Dichanthelium oligosanthes* var. *scribnerianum*), even though it was common in areas with Iowa skippers" (Scott 2022, p.72). Iowa skippers also appeared to avoid little bluestem as a host plant in Colorado (Scott 2022, p.72; Scott 1992, p.147). Host plants in Colorado are usually big bluestem, and rarely sideoats grama (Scott 2022, p.72). Big bluestem is preferred in Missouri, but they likely use other grasses like little bluestem as well (NatureServe 2020).

Female Iowa skippers lay eggs singly on the underside of host plant leaves (Lotts and Naberhaus 2022; Minnesota Dept. of Natural Resources 2022). The larvae feed on leaves and live in nests of rolled or tied leaves high on the grass (Scott 2022, p.72; NatureServe 2020). These nests can be 11.8 inches (30 cm.) or more off the ground in the grass canopy, because of the size of big bluestem (Minnesota Dept. of Natural Resources 2022). The larval stage lasts most of the year and the pupal stage is approximately two or three weeks preceding adult flight (NatureServe 2020).

[1] The federally threatened Dakota skipper also relies on grasses such as little bluestem for parts of its lifecycle (Niemuth et al. 2021, p.2).

Iowa skipper larvae overwinter in a leaf-blade shelter and complete development the following spring (Minnesota Dept. of Natural Resources 2022). The shelters are "tubular shelters made by pulling together the edges of a grass blade or by fastening together two or more blades" (Minnesota Dept. of Natural Resources 2022). They construct a series of these types of shelters as larvae (Minnesota Dept. of Natural Resources 2022).

Iowa skipper larvae undergo hibernal diapause during the winter in the fourth instar stage "in a hibernation nest consisting of two leaf blades, then a 2-3 cm pair of "stilts" as each leaf is eaten down to the midrib, then a silked-tube nest with larva inside that is closed by silk mesh at the top" (Scott 2022, p.73; Scott 1979, p.196; Heitzman 1966, p.177). Hibernal diapause is an arrested state of development, used to survive cold winter temperatures, during which the Iowa skipper larva's growth and feeding stop (Scott 1979, p.171). Heitzman (1966, pp.177-181) provides additional details about the larval stages, based on eggs reared from Lawrence, Kansas.

C. Habitat

The Iowa skipper is a prairie specialist, and its presence is considered a sign of high-quality prairie habitat (Dankert 2022a; Dole et al, 2004, p.131; Royer and Marrone 1992, p.4). Royer and Marrone (1992, p.4) called the Iowa skipper "one of the best ecosystem health barometers for both tall and short-grass prairie ecosystems in the Dakotas" because it depends on undisturbed native prairie habitat. And in Colorado, viable populations of Iowa skippers are considered indicators of a healthy and functioning foothill grasslands system (Sovell et al. 2012, p.23).

The Iowa skipper's primary habitat is mixed- and tallgrass native prairie (Selby 2005, p.1; Glassberg 2001, p.270). The skipper's habitat can vary across its range. Though strictly a prairie subspecies, the Iowa skipper's habitat can "range from short grass prairie in Colorado to mesic or dry tall grass prairie in several areas" (NatureServe 2020). Midwestern grasslands that are dominated by non-native grasses do not appear to be suitable habitat for the Iowa skipper (Minnesota Dept. of Natural Resources 2022).

In Iowa, the Iowa skipper is restricted to high-quality prairie remnants, preferring mesic to xeric sites, but it can also persist on small, unmanaged railroad prairies (Schlicht et al. 2007, p.61). It is also restricted to native prairie in Minnesota, favoring mesic or dry mesic habitat, and there is only one report of Iowa skipper from sand prairie in Minnesota (Minnesota Dept. of Natural Resources 2022). Iowa skipper was absent from wet prairie in surveys in Minnesota and Missouri, and most were found in dry, diverse prairie (Swengel 1993, p.12). In Nebraska, the Iowa skipper's habitat is native prairie with standing grass stems, either tallgrass prairie or mixed-grass prairie (Schneider et al. 2018, p.33).

In the Rocky Mountain states, the Iowa skipper is restricted to "relatively undisturbed moist, but sloping prairie meadows at up to 6200' (1900 m), dominated by tall and broadbladed grasses" (Ferris and Brown 1981, p.102). In South Dakota, the Iowa skipper "[p]refers a range of short-statured to tall-statured native grass ecosystems" (South Dakota Dept. of Game, Fish, and Parks 2014, p.275).

In a study in Oklahoma, Baum (2021, p.5) found that sites with higher average grass cover were associated with the presence of Iowa skippers. None of the other site characteristics measured (percent cover of bare ground, litter, forb, and woody) were associated with the presence or absence of Iowa skipper (Baum 2021, pp.4-5).

Larval hostplants described in the above section, predominantly big and little bluestem, are key elements of good Iowa skipper habitat. When it comes to adults nectaring, Scudder (1869, p.337) described the Iowa skipper as occurring "almost exclusively on flowers of *Echinacea angustofolia* D.C. [purple coneflower], which grew on knolls on the open prairie." While purple coneflowers appear to be an attractive, and sometimes preferred, nectar flower for Iowa skippers, Iowa skippers will utilize a variety of flowers (Minnesota Dept. of Natural Resources 2022; Heitzman and Heitzman 1987, p.55).

Scott (2014, pp.4, 24) reported on records of visits of adult butterflies to flowers and food/water sources in Colorado and explains the Iowa skipper "visits flowers of all colors, mostly purplish (and blue to pink) ones, but often yellow." Iowa skippers nectar at thistles, coneflowers, milkweeds, dogbane, vetch, ox-eye daisy, blazing star, and alfalfa (Opler 1999, p.447; Lotts and Naberhaus 2022; South Dakota Dept. of Game, Fish, and Parks 2014, p.275; Marrone 2004a, Appendix A, p.26; Royer and Marrone 1992, p.11; Scott 2014, p.24; Scott 2022, p.73).

Swengel (1993, p.27) observed Iowa skippers overwhelmingly chose purple coneflowers during surveys of Minnesota and Missouri. Heitzman and Heitzman (1987, p.55) also described pale-purple coneflower to be especially attractive to the Iowa skipper in Missouri, though it visits many other prairie flowers. In a five-year survey in South Dakota, Backlund (2009, pp.3-4) observed the Iowa skipper's nectar sources as purple coneflower, blue lettuce, and woolly vervain at Mirror Lake Game Production Area, and purple coneflower at Wind Cave National Park. In Arkansas the Iowa skipper appears to depend on blazing star (*Liatris*) as a nectar source at the end of the summer (Akin 2010, p.9).

Neck (1996, p.252) identified big bluestem and little bluestem as food plants in Texas. Howery et al. (2018, p.21) observed Iowa skipper nectaring on Baldwin's Ironweed (*Vernonia baldwinii*) in Oklahoma. During surveys in Anderson and Chase counties in Kansas, the Iowa skipper was almost always observed nectaring on pale purple coneflower or narrow-leaved purple coneflower (Busby et al. 2010, p.78; Kindscher et al. 2009, p.33). Scott (2014, p.24) and Scott (2022, p.73) provide extensive lists of flowers visited by adult Iowa skipper in Colorado, with creeping thistle (*Cirsium arvense*) noted to be a favorite.

III. RANGE AND STATUS

The Iowa skipper is "a western subspecies of the Arogos skipper (*Atrytone arogos*) [that] is associated primarily with mixed- and tallgrass native prairie in the Great Plains" (Selby 2005, p.1). Its range "is roughly coincident with the midcontinent grassland biome, from North Dakota and eastern Montana east to Illinois and south to Texas," but it is patchily distributed throughout this extensive range (Minnesota Dept. of Natural Resources 2022, *See* Figure 1). We cannot know the full extent of the Iowa skipper's historic range because records are unavailable, and the European settlement that destroyed prairie habitats spread so rapidly that "very little documentation exists of what the intact prairie ecosystem was like" (Swengel 2013, p.67). For example, the Iowa skipper is thought to have historically occurred in appropriate habitat throughout most of South Dakota (South Dakota Dept. of Game, Fish, and Parks 2014, p.275).

The maximum elevation for the Iowa skipper is 6200 feet (1900 m) (Pineda and Ellingson 1997, p.77; Ferris and Brown 1981, p.102).

The Iowa skipper's range is restricted to the United States and crosses fourteen states. Descriptions of its known range within each of those states are provided in the state-specific sections below.

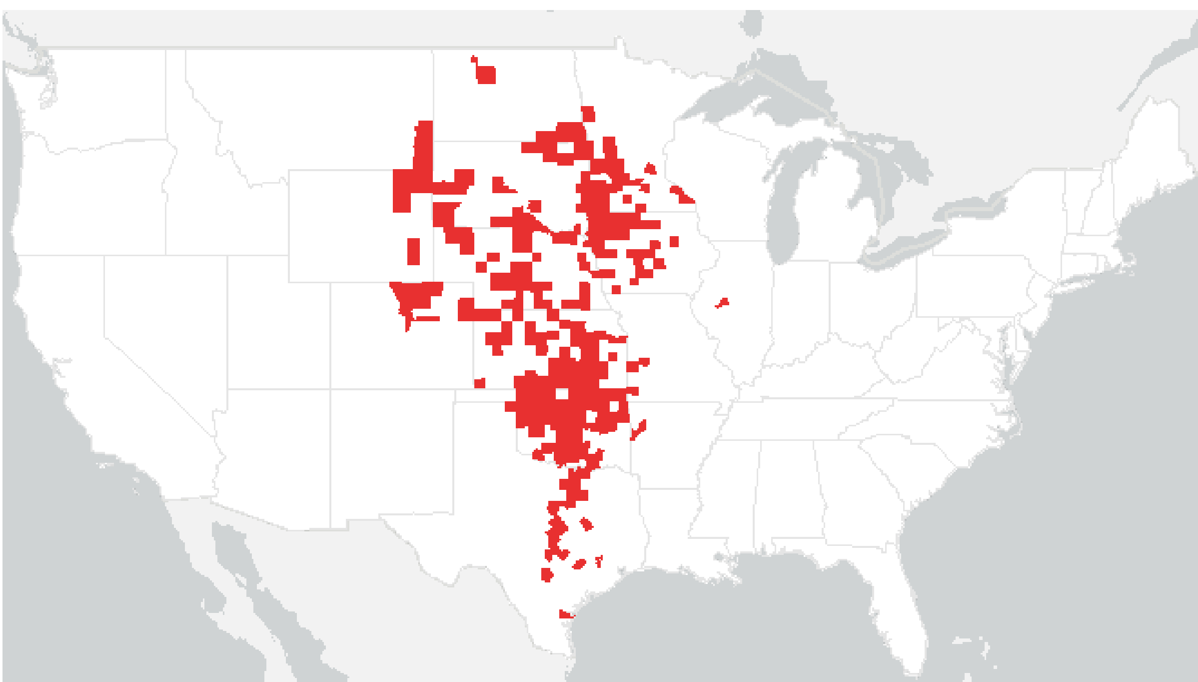

Figure 1. Map of Iowa skipper's nationwide range, showing counties with records of the Iowa skipper reported elsewhere in this petition.

The Iowa skipper is a rare species not considered to be secure or common in any part of its range and is experiencing population declines over most of its range (NatureServe 2020; Swengel et al. 2011, p.327; Akin 2010, p.7; Kindscher et al. 2009, p.34; Schlicht et al. 2009, p.437; Holimon 2007, p.3; Johnson 1972, pp.46). It is rare and sporadic in much of its range and nearly always found in low numbers, generally in isolated patches of remnant native prairie habitat (NatureServe 2020; U.S. Forest Service 2018b, pp.1-2; Royer and Marrone 1992, p.12). In its most recent NatureServe review (Feb. 21, 2020), the Iowa skipper was ranked as Imperiled (T2), which means it is "at high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors" (NatureServe 2020).

The Iowa skipper is in jeopardy throughout its range even though local abundance of the species can occasionally be high (Fowler and Anderson 2015, p.585). The Iowa skipper may have over 100 occurrences but some of these may be too small to contribute much to the species' survival (NatureServe 2020).

In 1993 the U.S. Fish and Wildlife Service reviewed the status of eight butterfly species, including the Arogos skipper (*Atrytone arogos*) across the full species' range, using recent status reports conducted in North Dakota and South Dakota along with additional data and information from other states, and decided that the Arogos skipper "does not appear to be in danger of extinction in the foreseeable future" (USFWS 1993, p.1). While at the time some of the other species reviewed may have been more imperiled, the Iowa skipper was already considered to be common in only two of the 14 states that encompass its range, while it was rare or uncommon in seven states and its status unknown in the remainder (USFWS 1993, pp.6-9). And over the last 30 years, the Iowa skipper has further declined and is no longer common anywhere in its range.

As early as 1989, Royer (1989, p.29) said the Iowa skipper might "be the skipper most in danger of elimination from North Dakota" and soon after recommended the species be listed as threatened in the state (Royer and Marrone 1992, p.16). In Iowa, the once common Iowa skipper had already declined "as precipitously as Iowa prairie" by 1998 and was classified as threatened and vulnerable to further losses (Schlicht and Orwig 1998, p.83-84). Leussler (1939, p.35) already referred to the Iowa skipper as a species that had previously been "quite common" in Nebraska, but at the time only found "where original prairie remains," and by 1972 it was classified as a rare species in the state (Johnson 1972, p.46).

The Iowa skipper was also considered to be "extremely local" in Missouri by 1987 and "found in only a few scattered prairie remnants" in the southwestern part of the state (Heitzman and Heitzman 1987, p.55). And in 1986 the Iowa skipper was described as "uncommon and local statewide" in Kansas (Ely et al. 1986, p.14).

It is increasingly apparent that the Iowa skipper is continuing to decline and disappear in much of its range and is in danger of extinction in the foreseeable future. Whereas NatureServe ranked the Iowa skipper as Vulnerable/Apparently Secure (S3S4) in 2005, in its 2020 review that ranking was elevated to Imperiled (T2) (Selby 2005; NatureServe 2000). And all states with a status ranking for Iowa skipper now rank the species as Vulnerable (S3), Imperiled (S2), or Critically Imperiled (S1) (Table 1).

Although it was considered common in Colorado and Oklahoma in the U.S. Fish and Wildlife Service's 1993 review (USFWS 1993, p.6, 8), by 2005 Colorado ranked the Iowa skipper as Imperiled (S2) and Oklahoma identified the Iowa skipper as a Species of Greatest Conservation Need by 2016, and ranked the Iowa skipper as Vulnerable (S3) (NatureServe 2020; Oklahoma Dept. of Wildlife Conservation 2016, p.31; Selby 2005, p.3 Table 1). And while the Iowa skipper had already been considered rare and endangered in Illinois, it was seen regularly at one site for at least nine years until the species disappeared in 1990 (Illinois Dept. of Natural Resources 2015, p.93). The Iowa skipper has not been in Illinois since then and it is now assumed to be extirpated in the state (Illinois Dept. of Natural Resources 2015, pp.93-94).

After determining that the Iowa skipper did not warrant sensitive species status in the U.S. Forest Service's Region 2 in 2001, the agency changed course and conferred sensitive status to the species in 2018, finding in its 2017 evaluation that more recent sources showed the species' habitat and populations had continued to decline across its range, including within Region 2 (U.S. Forest Service 2018a). The Iowa skipper is declining in all states in Forest Service Region 2 (Colorado, Kansas, Nebraska, South Dakota, Wyoming), and it "is rarely found during butterfly counts and surveys. When found, there is a low number of individuals noted" (U.S. Forest Service 2018b, pp.1-2). The Forest Service also listed the Iowa skipper as a Sensitive Species in Region 1 (northern Idaho, Montana, North Dakota, part of South Dakota) in 2011, specifically focused on its status in North Dakota (U.S. Forest Service 2011).

The Iowa skipper is listed as a state species of special concern in Iowa and Minnesota, and a species of concern in Montana, and is assumed to be extirpated in Illinois (Table 1). Nine of the thirteen states within the Iowa skipper's potential current range list the Iowa skipper as a Species of Greatest Conservation Need (SGCN) in their State Wildlife Action Plans (SWAPs) (Table 1). Of the four states that do not list the Iowa skipper as a SGCN, two of them (Montana, Wyoming) do not include any insects on their lists, and Illinois lists the species as extirpated in the state.[2]

[2] Montana Fish, Wildlife, and Parks (2015, p.122) did not consider invertebrates for inclusion in its State Wildlife Action Plan list of Species of Greatest Conservation Need, other than crayfish and mussels. The Wyoming Fish and Game Commission does not have jurisdiction over invertebrates, other than crustaceans and mollusks, so the Iowa skipper

The Iowa skipper is ranked as Imperiled in Iowa and Vulnerable in Minnesota; however, a more urgent at-risk status may be applicable in both states, as the Iowa skipper has not been seen in either state in more than ten years, despite regular butterfly surveys within their habitats (Shepherd 2022, personal communication; Petersen 2020, p.8; NatureServe 2020; Olsen 2018; Dana 2017, p.4). As Iowa skippers continue to disappear from and decline across their range, the species is increasingly at risk of extinction.

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was not considered for Species of Greatest Conservation Need status (Wyoming Game and Fish Department 2017, pp.IV-i-1 to IV-i-2).

Table 1. Iowa skipper status rankings at the federal and state levels from Selby (2005, p.3 Table 1) compared with the most recently reported rankings. Additional state classifications show where the Iowa skipper is included on each state's list of species of concern or special concern, as well as the state's list of Species of Greatest Conservation Need (SGCN) in State Wildlife Action Plans. Sources for the most recent rank and additional classifications are provided in the sections below.

State	Rank reported in Selby (2005) Report to USFWS	Most recent rank	Additional State Classifications
USA	N3N4	T2	
Arkansas	SNR	S1	SGCN
Colorado	S2	S2	SGCN
Illinois	S1	SNR	Extirpated
Iowa	S2	S2	species of special concern/SGCN
Kansas	S3	S3	SGCN
Minnesota	S3	S3	species of special concern/SGCN
Missouri	S2?	S2	SGCN
Montana	SNR	S2S3	species of concern
Nebraska	SNR	S1	SGCN
North Dakota	SU	SNR	N/A
Oklahoma	SNR	S3	SGCN
South Dakota	S2	S2	SGCN
Texas	SNR	SNR	N/A
Wyoming	SNR	SNR	N/A

S1: Critically Imperiled (At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.)

S2: Imperiled (At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.)

S3: Vulnerable (At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.)

S4: Apparently Secure (At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.)

S5: Secure (At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations, or occurrences, with little to no concern from declines or threats.)

SU: Unrankable (Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.)

SNR: Unranked (Conservation status not yet assessed.)

A. Arkansas

The Iowa skipper's range includes Arkansas (Lovely and Ettman 2013, p.184; Spencer and Simons 2006, p.59). A list of Arkansas butterflies published in 1975 did not include the Iowa skipper[3] but anticipated that the species would eventually be found in the state (Paulissen 1975, p.60). The Arkansas Valley is the only ecoregion where the Iowa skipper occurs in the state (Fowler and Anderson 2015, p.583).

The Arkansas Game and Fish Commission added the Iowa skipper to its list of Species of Greatest Conservation Need in Arkansas in its most recent Wildlife Action Plan in 2015 (Fowler and Anderson 2015, p.583-5, Appendix 2.3). It is ranked as critically imperiled in the state (S1), with an unknown population trend. (Fowler and Anderson 2015, p.583). The Iowa skipper has suffered a "tremendous loss of habitat throughout its historical range, continued threats to its few remaining habitats, and the removal of ecological factors that served to maintain tallgrass prairie habitats (e.g., fire and bison grazing)" (Fowler and Anderson 2015, p.585). Tallgrass prairie is one of the rarest community types in Arkansas, because of conversion for agriculture and urbanization (Akin 2010, p.1). Grassland dependent species like the Iowa skipper have declined due to this habitat loss, degradation, and fragmentation (Akin 2010, p.1).

The Iowa skipper is only known from two counties in Arkansas: Franklin and Sebastian counties (Lotts and Naberhaus 2021; Akin 2010, p.1). The largest tracts of remaining unplowed prairie are found in the Arkansas Valley Ecoregion, where Arkansas Natural Heritage Commission owns two prairies with high quality remnants: Cherokee Prairie and H.E. Flanagan Prairie natural areas (Akin 2010, p.1). In between these two is another high-quality prairie owned by the Nature Conservancy, called Presson-Oglesby Preserve (Akin 2010, p.1). All are within a five-mile radius (Akin 2010, p.1).

Akin (2010, p.7) conducted intensive surveys at these prairies from 2007 to 2010, with Cherokee Prairie subdivided into three sub-regions based on natural features, and found Iowa skippers at all five sites (Akin 2010, p.7). A total of 218 Iowa skippers were found over the four years at all sites combined, with yearly observations from each site ranging from zero to 53 (Akin 2010, pp.7-8, Table 5). While they appear to be relatively secure at these sites, "local extirpation with

[3] An earlier published list of butterflies of Arkansas also did not include the Iowa skipper (Freeman 1945).

subsequent colonization from segments of one or both of the other areas appears common" including following controlled burning or haying activities (Fowler and Anderson 2015, p.585).

Dr. William Baltosser returned to conduct surveys at the same prairie sites from 2015 through 2018, and found the skippers persisted through the years at all sites under varying types of management such as haying and fire (Baltosser 2019). An observation from Franklin County that appears to be from Cherokee Prairie was also reported in 2020 (Lotts and Naberhaus 2021).

The Arkansas Natural Heritage Commission (2022) has records of Iowa skippers from three sites in Franklin County, with the most recent observations in 2021 in Cherokee Prairie Natural Area (seen annually 2016-2021, and in 2008) and H.E. Flanagan Prairie Natural Area (seen annually 2016-2021, and in 2008), and in 2015 from Presson-Oglesby Prairie (also observed 2008).

Dr. William Baltosser's (2022, personal communication) major concerns for Iowa skippers in Arkansas include the "1) timing and periodicity of burning (species still active most years until the beginning of October; definitely multiple brooded in Arkansas), 2) methods used to control encroachment of woody vegetation (burning, haying, herbicides, etc.), 3) setting aside tracks of land for temporary refugia (Are such areas really suitable to serve as refugia?), 4) maintenance of floral diversity (nectar sources) and juxtaposition of these plant species later in the season."

B. Colorado

The Colorado Natural Heritage Program (2022) ranks the Iowa skipper's state status as S2, or imperiled. Although Colorado Parks and Wildlife does not have statutory authority over invertebrate species, except for mollusks, its 2015 State Wildlife Action Plan includes a list of invertebrates that are Species of Greatest Conservation Need, including the Iowa skipper (Colorado Parks and Wildlife 2015, Appendix B, p.B-2 & B-7). Boulder County also lists the Iowa skipper as a Wildlife Species of Concern (Boulder County 2013, p.2). In 2018, the U.S. Forest Service designated the Iowa skipper as a Sensitive Species in Region 2, which includes Colorado, because for 15 years prior the skipper's habitat and populations continued to decline in the region (U.S. Forest Service 2018a).

The Iowa skipper is declining in Colorado (Colorado Parks and Wildlife 2015, Appendix B, p.B-7). It is associated with xeric tallgrass habitats in Colorado, which are themselves threatened (Essington et al. 1996, p.15). In Colorado, the Iowa skipper is threatened by urban, suburban, and ex-urban development, altered fire regime, pesticide spraying and runoff, and altered native vegetation (Colorado Parks and Wildlife 2015, Appendix B, p.B-7).

The Iowa skipper has a disjunct species distribution in Colorado in relation to their overall North American distribution (Kettler and Pineda 1999, p.42). The Iowa skipper primarily occurs in Colorado's Front Range, but also occurs in the Southern

Rocky Mountains, in foothill and mountain grassland habitats (Colorado Parks and Wildlife 2015, Appendix B, p.B-7). It is also known from extreme northeastern Colorado, in five counties: Arapaho, Boulder, Jefferson, Larimer, Yuma (Kettler and Pineda 1999, p.53; Pineda and Ellingson 1997, p.77; Lotts and Naberhaus 2022). Lotts and Naberhaus (2022) also contains a record of Iowa skipper from Gilpin County, from an unknown date prior to 2005. On U.S. Forest Service lands the Iowa skipper is known from Arapaho-Roosevelt National Forest, which crosses multiple counties, and Pawnee National Grassland in Weld County and is likely to occur in Pike-San Isabel National Forest and Comanche National Grassland (USFS 2018b, p.4). Seven Colorado counties have reported records of Iowa skippers, shown in Table 2 and Figure 2, and petitioners present more detailed reports from Boulder, Larimer, and Jefferson counties below.

Table 2. Colorado counties with reports of Iowa skippers (Kettler and Pineda 1999, p.53; Pineda and Ellingson 1997, p.77; Lotts and Naberhaus 2021; USFS 2018b, p.4).

Arapahoe
Boulder
Gilpin
Jefferson
Larimer
Weld
Yuma

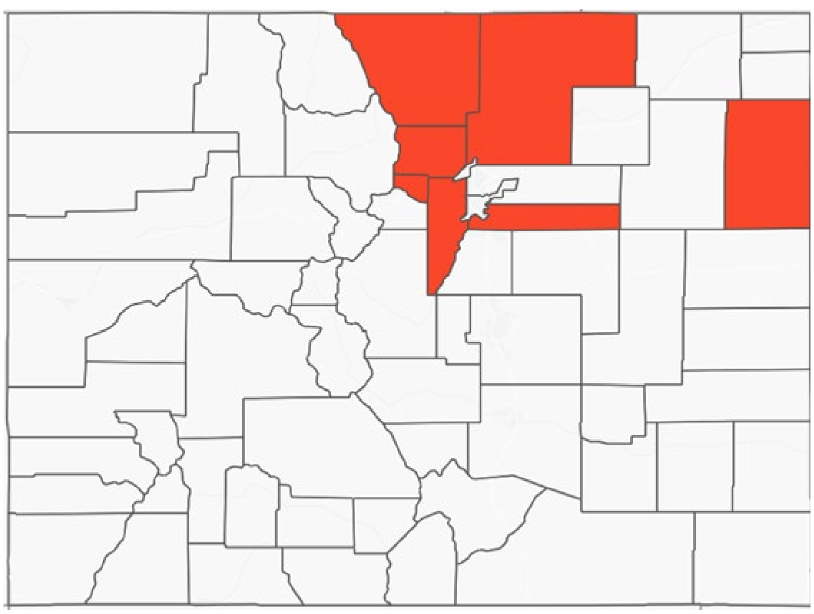

Figure 2. Map of Colorado counties with reports of Iowa skippers (Kettler and Pineda 1999, p.53; Pineda and Ellingson 1997, p.77; Lotts and Naberhaus 2021; USFS 2018b, p.4).

Boulder County

The Colorado Front Range is one of the richest butterfly regions in the country, and the butterflies of Boulder County are the best sampled within the Front Range, including within the City of Boulder's Open Space and Mountain Parks (OSMP) which contains lands within and around the city limits (Armstead 2003, pp.2-3). The Iowa skipper is one of the butterfly species of highest conservation interest on OSMP lands (Armstead 2003, p.3).

During 1996-1997 surveys in the City of Boulder's Open Space and Mountain Parks, Pineda and Ellingson (1997, p.6) reconfirmed the presence of Iowa skippers at Beech Open Space and Foothills Open Space and documented them from Mesa Trail near South Boulder Creek, and at Marshall Mesas. The Iowa skipper was observed at Foothills Trail in 1996 and 1997, Mesa Trail in 1997, and Marshall in 1997 (Pineda and Ellingson 1997, p.54).

However, Armstead (2003, pp.55, 74-77 Appendices E & F) did not observe any Iowa skippers in surveys conducted at eight sites in 2001 and three sites in 2002 on OMSP lands but noted that the Iowa skipper has been documented in the foothill grasslands of Boulder. Chu et al. (2005, p.12) also failed to observe Iowa skippers in their 2005 inventory surveys of Boulder County Parks and Open Space lands, nor were they seen in the 2002-2005 surveys of Boulder County Open Space properties conducted by the same authors, despite surveying at Heil Ranch where voucher specimens exist from 1995.[4]

Chu and Sportiello continued to report a failure to find Iowa skippers over 2004 to 2007 in butterfly surveys of Boulder County Parks and Open Space lands (Chu and Sportiello 2008a, p.27; Chu and Sportiello 2007, p.13). However, they were successful in finding Iowa skippers in Heil Valley in 2008 after seeking out maps with locations of their host plant bluestem grasses, observing skippers nectaring on bull thistle and sunflowers near bluestem grasses in July (7 individuals on 7/7 and 2 on 7/17) (Chu and Sportiello 2008b, pp.9, 13, 41). The location documented in Heil Valley, North Point, is near the location of the Iowa skipper specimen collected in 1995 (Chu and Sportiello 2008b, p.9). Chu and Sportiello (2008b, pp.9, 10) also had a likely but unconfirmed sighting of an Iowa skipper at the Southeast Buffer, near bluestem grasses.

Chu (2009, pp.8, 12, 13) failed to re-locate Iowa skippers at Heil Valley, North Point, or the Southeast Buffer in 2009, although the author posits the surveys at these sites in August may have been too late in the season for this species. Chu (2011, pp.14, 35, 37) observed a single Iowa skipper at Heil Valley-North in 2011 and found none at the Southeast Buffer. In 2018, Chu (2018, pp.27,

[4] Kettler et al. (1996, pp.21-22, 28-29) also reported the known documentation of Iowa skipper from Heil Ranch, specifically from the Red Hill and Plumely Canyon sites.

34) did not find any Iowa skippers in Boulder County Parks and Open Space lands, including Heil Valley-North and the Southeast Buffer. The next year Chu (2019, pp.22, 28, 31) again failed to observe Iowa skippers at Heil Valley-North and the Southeast Buffer, but they did find them at Heil Valley - Plumely Canyon two dates (2 individuals on 7/9, 1 on 7/13)

The Butterflies and Moths of North America website contains records of Iowa skipper observations made in Boulder County from 2012, 2018, and 2019 (Lotts and Naberhaus 2021). An observation is also recorded in inaturalist from July 7, 2019, in Boulder County. (GBIF.org 2022). There are also records of Iowa skippers ranging from 1924 to 1980 at the Boulder Foothills Potential Conservation Area (Neid et al. 2009, p.133). And records at Doudy Draw, North Boulder Grassland, and Shanahan Grassland Potential Conservation Areas in 1997 and Red Hill south of Lyons Potential Conservation Area in 1995 (Neid et al. 2009, pp.120, 147, 183, 195).

Larimer County

In Larimer County, the Iowa skipper is known from the Horsetooth Reservoir Hogbacks Site, which contains a combination of public and private lands west of Fort Collins (Kettler and Pineda 1999, p.41). The site contains big bluestem-little bluestem xeric tallgrass prairie, habitat for the Iowa skipper (Kettler and Pineda 1999, p.41). Kettler and Pineda (1999, p.45) expressed concerns about residential development and agricultural conversion that have altered the site and the continuing threat of residential development on private parcels.

There is also a 1985 record of an Iowa skipper from Colorado State University's (CSU) Foothills campus in Larimer County, which is located a few miles west of CSU's main campus (Smith et al. 2022, pp.11, 51).

Jefferson County

Essington et al. (1996, pp.7, 10-11) found Iowa skippers in xeric tallgrass prairie at the Rocky Flats Conservation Site in Jefferson County in 1994-1995 surveys. The Rocky Flats Conservation Site comprised a mix of state, private and U.S. Department of Energy land and the authors recommended protecting this land and its natural resources because it was at risk from surface mining and possible annexation and development by local municipalities (Essington et al. 1996. p.iii). The current protection status of this site is unclear to the authors of this petition, but Sovell et al. (2012, p.185) reported the most recent observation of Iowa skipper at Rocky Flats was in 1998.

The Iowa skipper is also a known, but uncommon, resident of Green Mountain in Jefferson County, with at least seven reported records (Scott 2022, Appendix 2, pp.381). Scott (2022, Appendix 2, pp.380-81) noted that most of the short-grass prairie that was just South, East, and North of the mountain has been destroyed for housing development.

Sovell et al. (2012, pp.142, 268) also reported the most recent observations of Iowa skipper at Ken Caryl Hogback Complex Potential Conservation Area (PCA) in 2010, and from Deadman Gulch PCA sometime in the 1990s.

C. Illinois

The Iowa skipper was first found in Illinois in the 1970s after having long been suspected of occurring in the state (Nyboer et al. 2006, p.37). The Iowa skipper was listed as endangered in Illinois in 1989 because it was one of the rarest butterflies in the state and was known only from one location, a nature preserve in Mason County (Nyboer et al. 2006, p.37; Illinois Dept. of Natural Resources 2015, p.92). Searches for the Iowa skipper in other parts of the state have been unsuccessful (Illinois Dept. of Natural Resources 2015, p.92; Swengel 1993).

The Iowa skipper was observed for nine years in surveys conducted between 1980 and 1989 at the singular known location, but it has not been seen there since 1989 (Illinois Dept. of Natural Resources 2015, p.93). The location was surveyed for Iowa skipper in seven years from 1990 to 2005 but the species was not observed (Illinois Dept. of Natural Resources 2015, p.93). As such, the Iowa skipper was removed from the state's list of threatened and endangered species as extirpated in 2014 (Illinois Dept. of Natural Resources 2015, pp.93-94).

D. Iowa

Scudder (1869, p.337) captured the first known specimens of Iowa skippers in Iowa and described them as "one of the most abundant Hesperians seen in Iowa." But by 1998, the Iowa skipper had declined "as precipitously as Iowa prairie" and Schlicht and Orwig (1998, p.83-84) classified the Iowa skipper as threatened and vulnerable to further losses.

The Iowa skipper is a Species of Special Concern in Iowa and listed as a Species of Greatest Conservation Need in the State Wildlife Action Plan (Iowa Admin. Code 571-77.2(3); Iowa Dept. of Natural Resources 2015, p.50). The Iowa skipper has a state status rank of S2 (Imperiled) in Iowa (Iowa Dept. of Natural Resources 2015, pp.228, 261, 358).

The Iowa skipper is now rarely, if ever, seen in the state (NatureServe 2020). And it appears that there have been no reported sightings of Iowa skipper in the state in 13 years (Shepherd 2022, personal communication; Olsen 2018). The most recent observation of the Iowa skipper reported on the Insects of Iowa website was on July 8, 2009, which was of three individuals in Dallas County (Durbin 2022). Olsen (2018, p.2 fn. 1) also noted that this 2009 sighting was the most recent in the state. In July 2018, Olsen (2018, pp.2-3) resurveyed fourteen sites in northwest Iowa with prior records of Iowa skippers, but did not find a single individual. Although it has not done targeted surveys for the Iowa skipper in recent years, the Iowa Dept. of Natural Resources performed butterfly surveys in appropriate habitat for the skipper in 2014, 2015, 2017, and 2019 and failed to find any Iowa skippers (Shepherd 2022, personal communication).

The Iowa skipper's habitat preference is for prairies and grasslands in the western half of the state (Iowa Dept. of Natural Resources 2015, p.277). Tallgrass prairie likely covered 85% of the state of Iowa prior to European settlement, but less than 0.02% of Iowa's prairie remained by 1981 (Smith 1981, p.7). Now the prairie ecosystem survives in only a few isolated pockets in Iowa and "[a]gricultural conversion and urban development continue to destroy the few remaining pockets which are not protected" (Orwig and Schlicht 1999, p.4). Habitat fragmentation and management of remaining butterfly habitat for the benefit of other species with haying, grazing, and fire also continue to make it difficult for specialist butterfly species like the Iowa skipper to survive (Schlicht and Orwig 1998, p.85, 87).

Orwig and Schlicht (1999, p.4) describe one day arriving to survey butterflies in a remnant prairie at the top of a loess bluff in Sioux City, Iowa, only to discover that the entire hilltop was gone, bulldozed and scraped clean, and sold for fill dirt. The site was known to be home to Iowa skippers and was "possibly the last site in western Iowa for [Iowa] skipper" (Orwig and Schlicht 1999, p.4). Even sites considered protected are not always safe in Iowa and elsewhere. Orwig and Schlicht (1999, pp.4-5) describe how Caylor Prairie was once a well-known site to butterfly enthusiasts for its "rich collection of northern prairie butterflies" and was a highlight of a 1980 survey of western Iowa by lepidopterists from across the country. But this did not last as Dakota skippers were not seen there again except for one individual 1992, and the populations of dusted, Iowa, and ottoe skippers also crashed at this site (Orwig and Schlicht 1999, p.6).

The last known record of an Iowa skipper in the state is from Kuehn Conservation Area in Dallas County in 2009 (Olsen 2018, pp.2 fn1, 29). The next most recent record of Iowa skippers is of two individuals at Wolter's Prairie in Osceola County in 2007 (Durbin 2022; Olsen 2018, p.28). Before that there are records of five individuals from Clay County in 2004, a record of one individual in Black Hawk County in 2003, a record of one individual from Rolling Thunder Prairie State Preserve in Warren County in 2002, and a record from Loess Hills State Forest in Monona County in 2002 (Durbin 2022; Olsen 2018, p.29).

Olsen (2018, pp.28-29) provides all records of Iowa skippers observed in Iowa since 1980, which spans 24 counties. The Insects of Iowa website contains additional, and some overlapping, records of Iowa skippers in the state (Durbin 2022). The Butterflies and Moths of North America website also contains records of the Iowa skipper from 25 counties, but all occurred prior to 2005 and specific observation dates and locations unknown (Lotts and Naberhaus 2021). In total, Iowa skippers are reported from 30 total counties, but records within the past 20 years come from only four of those counties (Table 3, Figure 3).

Table 3. Iowa counties with records of Iowa skippers. (Durbin 2022; Lotts and Naberhaus 2022). Counties with records in the past 20 years (2013-2022) are in bold.

Black Hawk	Lyon
Boone	Madison
Buena Vista	Monona
Cerro Gordo	O'Brien
Cherokee	**Osceola**
Clay	Page
Crawford	Palo Alto
Dallas	Plymouth
Dickinson	Pocahontas
Emmet	Pottawattamie
Greene	Sioux
Hancock	Story
Hardin	Union
Jasper	Warren
Kossuth	Woodbury

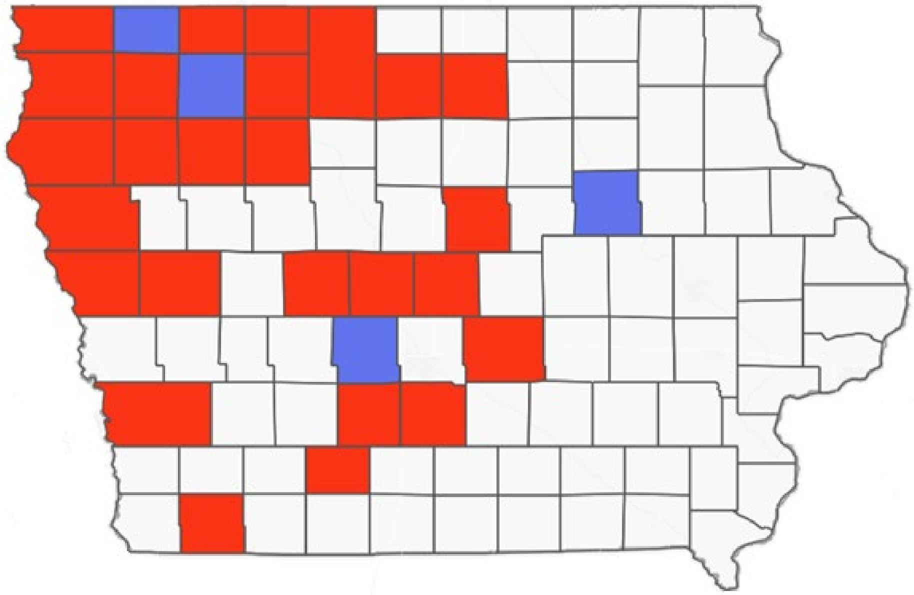

Figure 3. Map of Iowa counties with records of Iowa skippers (Durbin 2022; Lotts and Naberhaus 2022). Counties with records in the past 20 years (2013-2022) are in blue and counties with earlier records are in red.

In 1867, Scudder collected 13 females and 3 males in Denison (Crawford County) in mid-July, and 3 females near Jefferson (Greene County) on July 24 (Scudder 1869, p.337).

Orwig (1990, pp.132-33) conducted butterfly surveys in Iowa's Loess Hills from 1985-1990 (Plymouth, Woodbury, Monona, Harrison, Pottawattamie, Mills and Fremont counties) and recorded Iowa skippers in three counties, noting that the Iowa skipper is only found as far south as Pottawattamie County.

Swengel and Swengel (1993, pp.31, 89) conducted transect surveys for butterflies at 86 prairies in Illinois, Iowa, Minnesota, Missouri, and Wisconsin from 1988 to 1992, and found Iowa skippers at seven sites in Minnesota: Hole-in-the-Mountain Prairie Preserve, Ordway, Prairie Coteau, Staffanson, Bicentennial and Chippewa. The largest numbers of Iowa skipper observed were at two sites at Hole-in-the-Mountain, with 32 observed in 1990 ("new site") and five in 1991 and in 1992 ("old site") (Swengel and Swengel 1993, p.89). The other five sites had a maximum observed of only one or two individuals (Swengel and Swengel 1993, p.89).

Swengel and Swengel (1999, p.268) conducted transect surveys at 40 tallgrass prairies in Iowa, Minnesota, and North Dakota over ten years (1988-1997) for five rare prairie skippers, including the Iowa skipper, and recorded only 81 Iowa skippers at nine sites. The bulk of these, 79 Iowa skippers, were from Minnesota. They surveyed eight sites in Iowa from 1989 to 1997, within six different counties on a mix of state, local, and Nature Conservancy properties, and only found one Iowa skipper (Swengel and Swengel 1999, p.288-90 Appendices 1-2).

Farhat et al (2014, p.3) conducted biweekly butterfly surveys at marginal and conservation grassland sites in the summers of 2004-5 in Harrison County, Iowa and Washington and Douglas counties in eastern Nebraska, with 27 sites the first year and 51 sites the second. They did not observe Iowa skippers during any of these surveys (Farhat et al. 2014, pp.5-7). There is an earlier record of Iowa skipper from Mt. Talbot State Preserve in Plymouth County, but when Olsen (2013, p.4) visited in 2013 the site's prairie habitat was "overrun with five- to six-foot tall grasses that not only obscured the search for skippers, it also overwhelmed the limited number of nectar sources."

Vogel et al. (2007, pp.79-80, 87-88 Appendix B) and Vogel at al. (2010, pp.664-65, 675-76 Table 4) did not find any Iowa skippers when they conducted butterfly surveys from 2004 to 2005 on prairie remnants in the Broken Kettle Grasslands Preserve, Five Ridge Prairie, and on adjacent private lands in Plymouth County.

And as noted above, Olsen (2018, pp.2-3) conducted surveys in 2018 targeted at trying to find the Iowa skipper and the mulberry wing by surveying as many sites as possible with previous records to see if any of these sites in northwest Iowa still have populations of these target species. Fourteen of the sites surveyed had prior records of Iowa skippers. Olsen (2018, pp.2-3) did not find either species, and further noted that the total number of all butterflies seen in their surveys were "surprisingly low." Olsen (2018, p.8) theorized that the Iowa skipper and mulberry wing may be experiencing the same declines that have been recorded in Iowa with other species, including the federally threatened Dakota skipper which is extirpated in the state and the federally endangered Poweshiek skipperling which is likely extirpated in the state (last recorded in 2009). Olsen (2018, p.8) notes that in 2004 Selby wrote that Iowa skippers were absent from all but one site, and "[t]here appears to have been major widespread catastrophic declines for Iowa populations of the Poweshiek skipperling and possibly also the [Iowa] skipper."[5]

E. Kansas

The Iowa skipper has a state rank of S3, or Vulnerable, in Kansas (NatureServe 2020). The Iowa skipper is also a Species of Greatest Conservation Need included in Kansas' 2015 State Wildlife Action Plan, specifically in the Central Mixed Grass Prairie and Eastern Tallgrass Prairie Regions (Rohweder

[5] The referenced quotation is from the following report that the petition authors were unable to find: Selby, G. L. 2004. A Census and Inventory for Populations of the Dakota Skipper (*Hesperia dacotae*) and Associated Prairie Obligate Butterflies at Priority Sites I Northwest Iowa. Unpublished report, the Nature Conservancy of Iowa and Division of Parks, Recreation and Preserves, Iowa Department of Natural Resources, Des Moines, Iowa. November 5, 2004.

2015, pp.37, 152). The Iowa skipper is “uncommon and local statewide” (Ely et al. 1986, p.14).

Kansas is home to most of the remaining tallgrass prairie (~80%), including the Flint Hills region which is the largest remaining continuous expanse of native tallgrass prairie in North America, yet the Iowa skipper is still a species of conservation concern in the state (Jones et al. 2019, p.263; Sievert and Prendergast 2011, p.2; Busby et al. 2010, p.1). Kansas is home to the Tallgrass Prairie National Preserve, which encompasses about 11,0000 acres of land in the Flint Hills region, as well as the Anderson County Prairie Preserve, which is in the largest remaining block of tallgrass prairie in the Osage Cuestas physiographic province in Kansas, an area extensively converted to cultivated agriculture (Sievert and Prendergast 2011, p.2; Busby et al. 2010, p.1).

Ely et al. (1986, p.4) reported Iowa skipper specimens from 27 counties and reports from nine other counties (Douglas, Grove, Logan, Rawlins, Scott, Sheridan, Shawnee, Sumner, Johnson). The U.S. Forest Service (2018b, p.4) says the Iowa skipper is known from Cimarron National Grasslands in Morton County, Kansas, but it’s unclear when it was last seen there. Stanford and Opler (1996, p.20) also reported Iowa skippers from Cheyenne and Geary counties. Lotts and Naberhaus (2022) also contains reports of Iowa skipper from 43 counties in Kansas from sometime before 2005.

Wright et al. (2003, pp.469, 473 Table 1) found Iowa skippers on Konza Prairie Biological Station, a native tallgrass prairie preserve in Riley and Geary counties, during butterfly surveys conducted from 1997 through 1999 to establish a list of butterflies on the preserve. The petition authors were unable to find any additional information about surveys in the Iowa skipper’s habitat at Konza Prairie so the Iowa skipper’s current status there is unclear.

Busby et al. (2010, pp.iv, 77) conducted surveys for the Iowa skipper and other Species of Greatest Conservation Need on and near the Anderson County Prairie Preserve in 2008 and 2009 and two sites in Chase County in 2009. Although they did not find the Iowa skipper in 2008, they observed them at five sites in 2009: Welda Prairie Units 3 and 9, I Feel Good Prairie, Garrison Prairie, and Chase State Fishing Lake. Three of these sites were unburned hay meadows (Busby et al. 2010, p.91 Table 3). The highest number of individuals (7) observed at one site was reported from Chase State Fishing Lake (Busby et al. 2010, p.79). Busby et al. (2010, p.79) observed Iowa skippers at two units of the Anderson County Prairie Preserve in 2009 where they had not been found in 2008, despite a higher sampling effort there in 2008, and posits that this may have been a result of the reduced amount of burning in 2009 relative to 2008.

Kindscher et al. (2009, p.33) found Iowa skippers at three sites in 2009 surveys of 20 high quality prairie hay meadows in Anderson County, where they were almost always observed nectaring on pale purple coneflower.

Sievert and Prendergast (2011, p.4) conducted butterfly surveys at the Tallgrass Prairie National Preserve in Chase County in 2010 to assess the effects of fire and grazing management on the preserve. They found Iowa skippers in all four treatments, three patch-burn grazing units in Big Pasture with different timelines since the last burn, and one annually burned unit at Two Section Pasture used as the representative of traditional management for butterfly transects, with a total of 35 individuals observed across all sites (Sievert and Prendergast 2011, p.18-20 Table 1).

Additional butterfly counts at Tallgrass Prairie National Preserve were conducted annually starting in 2009 (Jones et al. 2019, p.261). Jones et al. (2019, pp.261, 263) compared the occurrence of species detected during the initial survey conducted in 2009 to species detected during the 2013 survey to evaluate trends over time and found observations of Iowa skippers declined from 61 individuals in 2009 to 10 in 2013.

More recent records of Iowa skippers in Kansas include observations in Chase County in 2014, Sedgwick County in 2018, and Douglas County in 2019 (Lotts and Naberhaus 2022). Research grade observations of the Iowa skipper were also imported in Chase County in 2017 and 2019 on inaturalist (GBIF.org 2022). In total there are records of Iowa skippers from 45 counties, but records within the last 20 years are only known from four counties (Table 4; Figure 4).

Table 4. Kansas counties with records of Iowa skippers (Lotts and Naberhaus 2022; GBIF.org 2022; Busby et al. 2010, p.79; Kindscher et al. 2009, p.78). Counties with reported observations within the past 20 years are in bold.

Anderson	Ellis	Morton
Barber	Geary	Norton
Barton	Grove	Rawlins
Butler	Greenwood	Reno
Chase	Harper	Riley
Chautauqua	Harvey	Rooks
Cheyenne	Jewell	Russell
Clark	Johnson	Scott
Clay	Kingman	**Sedgwick**
Cloud	Kiowa	Shawnee
Comanche	Lincoln	Sheridan
Cowley	Logan	Sumner
Dickinson	Lyon	Wabaunsee
Douglas	McPherson	Wilson
Elk	Morris	Woodson

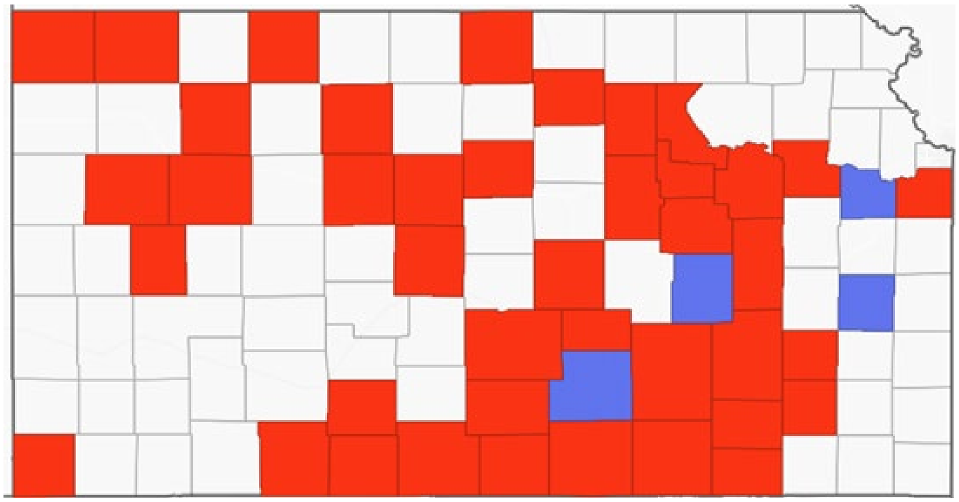

Figure 4. Map of Kansas counties with reports of Iowa skippers (Lotts and Naberhaus 2022; GBIF.org 2022; Busby et al. 2010, p.79; Kindscher et al. 2009, p.78). Counties with records in the past 20 years (2013-2022) are shown in blue.

F. Minnesota

The Iowa skipper is designated a species of special concern in Minnesota (Minnesota Admin. Rules 6134.0200(8)(C)(1)). It was first listed as a species of special concern in 1996 (Minnesota Dept. of Natural Resources 2022). In Minnesota, a species may be designated as special concern "if although the species is not endangered or threatened, it is extremely uncommon in this state, or has unique or highly specific habitat requirements and deserves careful monitoring of its status" (Minnesota Statutes § 84.0895(3)(a)(3)). The Iowa skipper is rare in Minnesota and highly vulnerable to further population decline (Minnesota Dept. of Natural Resources 2022). The Iowa skipper is also included in Minnesota's list of Species of Greatest Conservation in the state's Wildlife Action Plan, because the species is rare, its habitat is vulnerable and declining, and it suffers from habitat loss, degradation, and fragmentation (Minnesota Dept. of Natural Resources 2016, p.C13)

According to the Minnesota Department of Natural Resources (DNR), the Iowa skipper occurs in the prairie region of the state, only in native prairie remnants, with most records primarily in the southwest part of the state (Minnesota DNR 2022). Most reports are widely scattered and are of small numbers of individuals (Minnesota DNR 2022). "Small colony sizes and isolation due to past habitat loss are the primary threats facing the Iowa skipper in Minnesota. This is aggravated by continuing habitat destruction." (Minnesota Dept. of Natural Resources 2022).

Regarding the status of skippers in Minnesota in general, Jessica Petersen, an Invertebrate Ecologist with the Minnesota Biological Survey, said "[s]urvey staff annually conduct surveys for various skipper species and are consistently finding fewer populations each year" and that they "know from statewide searches of populations they seem to be following in the familiar footsteps of the two listed species," the Dakota skipper and Poweshiek skipperling (Petersen 2020).

Although about 40 colonies of Iowa skippers have been documented in Minnesota since 1970, it is unclear how many of these still survive and the species is considered rare in the state (Minnesota DNR 2022). In fact, "[a]s of 2020, the subspecies has not been seen in Minnesota since 2008 (J. Petersen, pers. comm. 2020)" (NatureServe 2020).

The Minnesota DNR conducted butterfly surveys throughout western Minnesota from 2014 to 2020 (Dana 2017; Petersen 2020) While these surveys focused on sites historically known to support the Poweshiek skipperling and Dakota skipper, many of these areas overlap with the historical range of the Iowa skipper, the timing was appropriate for observing the Iowa skipper, and the surveyors had a secondary focus on other special status species like the Iowa skipper. Across all sites and years there was not a single observation of the Iowa skipper (Dana 2017, p.4; Petersen 2020, p.8). The 2014 to 2016 surveys spanned 63 sites throughout western Minnesota, including surveying "20 of the 31 sites considered priorities for the [Iowa] skipper during the mid-late July period when adults should have been on the wing in 2014" (Dana 2017, pp.4, 6-8). From 2017 to 2020, the Minnesota DNR surveyed 31 sites for the Iowa skipper and again did not find this species (Petersen 2020, p.8).

Researchers from the Minnesota Zoo also did not observe Iowa skippers during recent extensive butterfly surveys conducted at the Hole-in-the-Mountain Prairie Preserve in Lincoln County, Minnesota, in conjunction with reintroductions of the Dakota skipper. They conducted 18 days of surveys from June 28 to July 17, 2018, and seven days of surveys between July 1 and July 13, 2020, and did not find a single Iowa skipper, despite the site having previous records of this species (Runquist et al. 2018, pp.29-34; Runquist et al. 2020, pp.8, 36 Appendix 1, Table 7).

The Iowa skipper has been recorded in 25 counties in Minnesota, but observations have not been reported from most of these counties in recent years (Table 5; Figure 5).

Table 5. Minnesota counties with records of Iowa skipper (Lotts and Naberhaus 2022; Swengel and Swengel 1993, p.89; Selby 2006, Appendix 5, Table 1). Counties with records in the last 20 years (2003-2022) are shown in bold (Selby 2006, pp.20-22).

Big Stone	**Pipestone**
Chippewa	Pope
Clay	Redwood
Douglas	Renville
Faribault	Rock
Hennepin	Sibley
Kandiyohi	Swift
Lac Qui Parle	Traverse
Le Sueur	Wabasha
Lincoln	Watonwan
Lyon	Watonwan
Murray	Winona
Nobles	

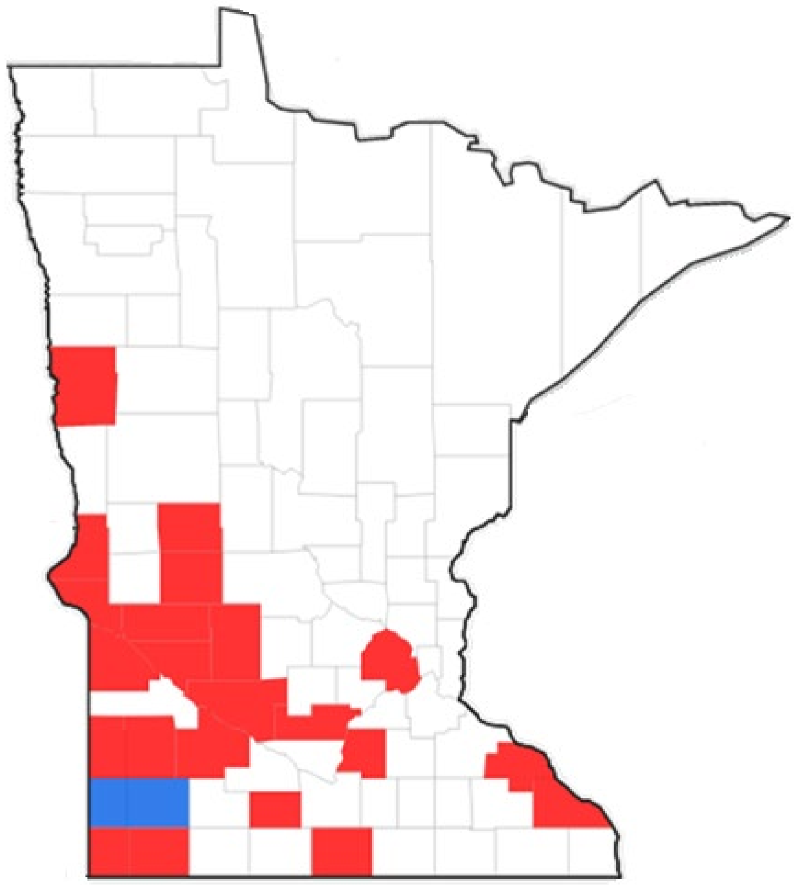

Figure 5. Map of Minnesota counties with reports of Iowa skippers (Lotts and Naberhaus 2022; Swengel and Swengel 1993, p.89; Selby 2006, Appendix 5, Table 1). Counties with records in the past 20 years (2013-2022) are shown in blue (Selby 2006, pp.20-22).

Selby and Glenn-Lewin (1989, pp.31, 43) found Iowa skippers throughout their survey areas at Prairie Coteau Scientific and Natural Area (SNA) in Pipestone County in 1988 and 1989 and noted there appeared to be good populations of Iowa skippers there. Prairie Coteau SNA is a 133-acre dry hill prairie that was first acquired in 1986 (Schlicht 2001, p.197). They found a total of 24 Iowa skippers in transect surveys in 1988 and 231 in 1989 (Selby and Glenn-Lewin 1989, pp.39-40, Tables 11, 13).

There continued to be good populations of Iowa skippers, and most other prairie-obligate butterflies, at Prairie Coteau in 1990 (Selby and Glenn-Lewin 1990, p.28). A total of 144 Iowa skippers were observed at Prairie Coteau in surveys from July 2-28, 1990 (Selby and Glenn-Lewin 1990, pp.19-20, Tables 1-3). Selby and Glenn-Lewin (1990, pp.24-26, Tables 6-9) also conducted surveys at additional locations in 1990 and found the Iowa skipper at Hole-in-the-Mountain Prairie Preserve, Blue Mound State Park, and the Chanarambie Creek Area (Wes Stevens property and Moulton Prairie - Sankey Tract) but did not find any Iowa skippers at Pipestone National Monument.

Swengel and Swengel (1993, pp.31, 89, Appendix 7) conducted transect surveys for butterflies at 86 prairies in Illinois, Iowa, Minnesota, Missouri, and Wisconsin from 1988 to 1992, and Iowa skipper was found at seven sites in Minnesota: Hole-in-the-Mountain Prairie Preserve in Lincoln County, Ordway in Pope County, Prairie Coteau in Pipestone County, Staffanson in Douglas County, Bicentennial in Clay County, and Chippewa in Chippewa and Swift counties. The highest observation counts recorded for Iowa skipper were at two sites at Hole-in-the-Mountain, with 32 observed in 1990 ("new site") and five in 1991 and in 1992 ("old site") (Swengel and Swengel 1993, p.89). The other five sites had a maximum observed of only one or two individuals (Swengel and Swengel 1993, p.89, Appendix 7).

Swengel and Swengel (1999, p.268) conducted transect surveys at 40 tallgrass prairies in Iowa, Minnesota, and North Dakota over ten years (1988-1997) for five rare prairie skippers, including the Iowa skipper, and recorded only 81 Iowa skippers at nine sites. The bulk of these, 79 Iowa skippers, were observed in Minnesota (Swengel and Swengel 1999, p.290 Appendix 2). A subset of those records (1988-1992) from Minnesota are reported in an earlier publication, discussed above, and reveal that a majority of the 79 records were reported in the first four years of the ten-year period (Swengel and Swengel 1993, p.89, Appendix 7).

Schlicht (1997a, p.4) conducted butterfly surveys in 1995-96 in six large Minnesota prairie preserves focused on areas known to have Dakota skipper, Poweshiek skipper, and regal fritillary, but all within the Iowa skipper's range. The Iowa skipper was found at four of the six prairies surveyed, with the highest numbers, 10 individuals, seen at Glacial Lakes State Park on July 12, 1995 (Schlicht 1997a, p.9). They also observed two Iowa skippers at Prairie Coteau SNA in 1996 but did not see them in 1995 (Schlicht 1997a, p.9).

In July 1997 surveys focused on the Dakota skipper, Schlicht (1997b, pp.4, 8) also found five Iowa skippers at two sites (Moulton, Christian Camp) in the Chanarambie Creek area in Murray County but did not observe any Iowa skippers in surveys in the area around Glacial Lakes State Park in Pope County.

Schlicht (2001, pp.198) conducted additional surveys at Prairie Coteau SNA in 2000 and detected only two Iowa skippers. Schlicht (2001, p.199) also compared the survey results for Iowa skipper at Prairie Coteau from 1988-90 and 1995-1996, discussed above, along with the new 2000 data and concluded the Iowa skipper has been in a precipitous decline at this site, with numbers ranging from 24 to 231 for 1988-1990 and then from 0-2 in 1995-96 and 2000. Comparisons between years were possible because Schlicht purposely used the same transects in 1995-96 and 2000 that Selby established in the 1988-1990 surveys (Schlicht 2001, p.198). To account for the differing frequency of surveys between years, Schlicht (2001, pp.198-199) compared the closest single calendar date in the flight period (July 11-15) and still found a stark contrast with numbers ranging from 9-48 Iowa skippers in 1988-1990 and 0-2 in 1995-96 and 2000. Schlicht (2001, p.199) noted that results show a tremendous among of annual variation in this population and expressed concern that regardless of whether the low population size is periodic or permanent, it puts the species at high risk for extirpation at this site.

An additional survey was conducted at Prairie Coteau in 2005 and it appeared the population has made a slight recovery, as 30 Iowa skippers were observed on July 13, 2005 (Selby 2006, pp.21-22). However, no Iowa skippers were found at Prairie Coteau in 2019 surveys conducted by the Minnesota DNR (Petersen 2020, p.11). Survey results discussed in Schlicht (2001) and those from other surveys at Prairie Coteau are compiled below in Table 6.

Table 6. Survey results from Prairie Coteau Scientific and Natural Area in Pipestone County, Minnesota.

Prairie Coteau Scientific and Natural Area			
Year	**Observed?**	**Total Observed**	**Citation**
1988	yes	24	Selby and Glenn-Lewin 1989, p.39
1989	yes	231	Selby and Glenn-Lewin 1989, pp.40-42
1990	yes	144	Selby and Glenn-Lewin 1990, pp.19-20
. . .			
1993	yes	2	Swengel and Swengel 1993, p.89 Appendix 7
. . .			
1995	no	0	Schlicht 1997a, p.9
1996	yes	2	Schlicht 1997a, p.9
. . .			
2000	yes	2	Schlicht 2001, p.198
. . .			
2005	yes	30	Selby 2006, pp.21-22
. . .			
2019	no	0	Petersen 2020, p.11

Selby (2006, pp.2-3) conducted butterfly surveys from 2003 to 2005 on public and private properties in and around Glacial Lakes State Park in Pope County for a study on the Dakota skipper and grazing impacts but with secondary target species including the Iowa skipper. They did not find Iowa skippers in any year or at any site, even though surveys were in areas where the species was previously observed (Selby 2006, pp.11-12). Selby (2006, pp.3, 11-12) notes that Skadsen (2001) observed 2 unconfirmed Iowa skippers when conducting baseline data on slightly shorter, but equivalent transects at Glacial Lakes State Park, which suggests that their numbers may have already been low in this area in 2001. Selby (2006, p.4) expressed concern that the dramatic declines of the Iowa skipper and other prairie specialist skippers in the study area may be widespread in west-Central Minnesota.[6] Results from these and additional surveys in Glacial Lakes State Park and the surrounding area are compiled below in Table 7.

In 2005, Selby (2006, pp.11-12) added additional sites outside the main project area for general status surveys based on the historic or potential occurrence of Dakota skipper and secondary targets like the Iowa skipper. They found one Iowa skipper at Sankey tract in the Chanarambie Creek area, and 30 individuals at Prairie Coteau (discussed above), but none at the other sites located at Hole-in-the-Mountain Prairie, Chippewa Prairie, and Felton Prairie (Selby 2006, pp.21-28). There are historic records of the Iowa skipper from all three sites where they were not found in 2005 and the surveys were done during the peak time for the species, so it was especially significant that none were found (Selby 2006, pp.23-28).

Schlicht et al (2009, p.437) analyzed data from butterfly surveys conducted in prairies in Minnesota (including many discussed above) spanning from 1979 to 2005 to assess trends in abundance, and found consistent declines for specialist species, including a significant skewing to negative trends (< 0.05) for the Iowa skipper.

Results from sites with multiple years of surveys, including Hole-in-the-Mountain, Glacial Lakes State Park, and Felton Prairie SNA, are presented below in Tables 7-9. While specific locations and survey effort may vary so that the survey data is not always directly comparable, they provide the best information available to assess the general trends at these sites.

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[6] Selby (2006, p.4) noted that the Iowa skipper, Dakota skipper, and Poweshiek skipperling "appear to be doing well at sites in southwestern Minnesota." However, this statement made in 2006 no longer appears to be accurate, based on recent years of surveys in western Minnesota discussed above and in Dana (2017) and Petersen (2020).

Table 7. Survey results from Glacial Lakes State Park and the surrounding area in Pope County, Minnesota.

Glacial Lakes State Park & surrounding area		
Year	**Observed?**	**Citation**
1995	yes	Schlicht 1997a, p.9
. . .		
1997	no	Schlicht 1997b, p.4
. . .		
2001	maybe - 2 unconfirmed sightings	Skadsen 2001 cited in Selby 2006, p.3
. . .		
2003	no	Selby 2006, pp.3, 13
2004	no	Selby 2006, p.3
2005	no	Selby 2006, p.3
. . .		
2014	no	Dana 2017, pp.7-9
2015	no	Dana 2017, pp.7-9
2016	no	Dana 2017, pp.7-9

Table 8. Survey results from the Hole-in-the-Mountain Prairie Preserve in Lincoln County, Minnesota.

Hole-in-the-Mountain Prairie Preserve			
Year	**Observed?**	**Maximum # Observed**	**Citation**
1990	yes	N/A	Selby and Glenn-Lewin 1990, p.24 Table 6
1990	yes	32 at new site	Swengel and Swengel 1993, p.89 Appendix 7
1991	yes	5 at old site	Swengel and Swengel 1993, p.89 Appendix 7
1992	yes	5 at old site	Swengel and Swengel 1993, p.89 Appendix 7
. . .			
2005	no	0	Selby 2006, p.23
. . .			
2017	no	0	Petersen 2020, p.4
2018	no	0	Petersen 2020, pp.5-6; Runquist et al. 2018, pp.29-34
2019	no	0	Petersen 2020, p.11
2020	no	0	Runquist et al 2020, p.36 Appendix 1 Table 7

Table 9. Survey results from Felton Prairie Scientific and Natural Area in Clay County, Minnesota.

Felton Prairie Scientific & Natural Area			
Year	**Observed?**	**Maximum # Observed**	**Citation**
1990	yes	1	Swengel and Swengel 1993, p.89, Appendix 7
1991	yes	1	Swengel and Swengel 1993, p.89, Appendix 7
. . .			
2005	no	0	Selby 2006, p.28
. . .			
2014	no	0	Dana 2017, pp.6-9
2015	no	0	Dana 2017, pp.6-9
2016	no	0	Dana 2017, pp.6-9

G. Missouri

The Iowa skipper was added to Missouri's list of Species of Greatest Conservation Need in its Comprehensive Conservation Strategy in 2020, and has a state rank of S2, or Imperiled (Missouri Dept. of Conservation 2020, pp.198, 499).[7] As early as 1987, the Iowa skipper was already considered to be "extremely local" and "found in only a few scattered prairie remnants in southwestern Missouri" (Heitzman and Heitzman 1987, p.55).

The most recent available record of the Iowa skipper in Missouri is of one individual from Wah'Koh-Tah prairie in 2021 (Missouri Dept. of Conservation 2022). The Wah'Koh-Tah prairie preserve is a tallgrass prairie remnant located in southwestern Missouri, owned by the Nature Conservancy and co-managed by the Conservancy and the Missouri Department of Conservation (Ross 2001, p.1). Two individual Iowa skippers were also observed at this prairie in 2005 (Missouri Dept. of Conservation 2022). Prior to that, the Iowa skipper was observed at this prairie in 1998 surveys (Ross 2001, pp.18-19). During the 1998 surveys, the Iowa skipper was observed from June to mid-September and was most common from June 7 to 20 and from July 26 to August 22 (Ross 2001, pp.18-19). It was also observed in Swengel's 1993 surveys at Wah'Koh-Tah prairie, with a maximum of 5 individuals seen in a single-day survey (Swengel 1993, p.90). This prairie crosses St. Clair and Cedar counties – the 2005 and 2021 observations are from St. Clair County (Missouri Dept. of Conservation 2022).

Swengel (1993, pp.31, 90) conducted transect surveys for butterflies at 86 prairies in Illinois, Iowa, Minnesota, Missouri, and Wisconsin, and found Iowa skippers at 13 sites in Missouri on public lands in 1992 and 1993: Taberville, Little Osage, Wah'Koh-Tah, Monegaw, Tzi-Sho, Clear Creek, Osage, Gay Feather, Prairie State Park, Risch, Niawathe, Diamond Grove, and Mount Vernon. The maximum number of individuals found at each site ranged from one to 20, with the largest numbers at Clear Creek (20 in 1992), Prairie State Park (12 in 1992), and Risch (10 in 1992) (Swengel 1993, p.90). They also conducted point scans of seven private hay prairies but did not observe any Iowa skippers (Swengel 1993, p.90).

Besides the 2021 record from Wah'Koh-Tah prairie, the petition authors could find no other recent records of Iowa skipper in Missouri. The most recent records prior to that are of several observations made in 2005 in Barton County (Cook, Shelton L., Mem. Meadow, Prairie State Park), Newton County (Diamond Grove Prairie), St. Clair County (Taberville Prairie Conservation Area, Wah'Koh-Tah Prairie), and Vernon County (Little Osage Prairie, Osage Prairie Conservation Area) (Missouri Dept. of Conservation 2022). However, these records are all of one or two individual skippers, whereas several of the earlier records reported larger

[7] It had not been included in Missouri's 2015 list of Species of Greatest Conservation Need (Missouri Department of Conservation 2015, p.38).

numbers (Missouri Dept. of Conservation 2022).[8] For instance, at Taberville Wildlife Area there are records of 9 individuals and 5 individuals on two days in 1982, 3 individuals on one day in 1988, 34 individuals on one day in 1991, 4 individuals on one day in 1992, and 1 individual on one day in 2005 (Missouri Dept. of Conservation 2022). Missouri Department of Conservation records from Prairie State Park start with a high observation of 42 individuals in 1980, with numbers variable but lower after that, including three dates in 1984: 2, 11, 12, and one observation in 2005 of two individuals (Missouri Dept. of Conservation 2022).[9]

H. Montana

The Iowa skipper is classified as a species of concern in Montana, with a state rank of S2S3 (Imperiled/Vulnerable), but the state says it needs more information to refine the state rank (Montana Natural Heritage Program 2021, pp.17-18). It was added to the list in 2020 because it is globally rare/threatened, and because it "is dependent on native prairies and is believed to be declining in response to loss of habitat across its range among other threats" which threaten the skipper's persistence in Montana (Montana Natural Heritage Program 2021, pp.17, 32). Occurrences are verified in Carter and Fallon counties (Montana Natural Heritage Program and Montana Fish, Wildlife and Parks 2022; Lotts and Naberhaus 2021; Stanford and Opler 1996, p.20). Their range is only known to include the southeastern portion of the state (Figure 6).

[8] While it isn't possible to say for sure that the decline in numbers observed is correlated with a decline in the population size, as factors like sampling effort, timing, and weather may play a role, it may be indicative of a decline in overall numbers of Iowa skippers in line with declines seen elsewhere in the skipper's range.

[9] The Missouri Department of Conservation has several additional records from Prairie State Park that do not contain counts for the number of individuals observed.

Figure 6. Map of Iowa skipper's known range in Montana (Montana Natural Heritage Program 2022).

Montana Fish, Wildlife, and Parks (2015, p.122) did not consider invertebrates for inclusion in its State Wildlife Action Plan list of Species of Greatest Conservation Need, other than crayfish and mussels, thus Iowa skippers were not considered for the list.

Iowa skippers are locally rare to uncommon (Montana Natural Heritage Program 2022). The petition authors are unaware of any recent records of Iowa skippers from Montana. The Montana Natural Heritage Program (2022) only has one record of Iowa skipper in the state, and it occurred more than twenty years ago. There is one record from Carter County in 1994 at about 1000-meter elevation (Montana Natural Heritage Program 2022).

I. Nebraska

The Iowa skipper has a state rank of S1, or critically imperiled, which means that it is "[a]t very high risk of extirpation in the state due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors" (Nebraska Natural Heritage Program & Game and Parks Commission 2020, pp.11, 31). It is also listed as a Tier One Species of Greatest Conservation Need in Nebraska's State Wildlife Action Plan (Nebraska Natural Heritage Program & Game and Parks Commission 2020, pp.11).

An early list of Nebraska butterflies (Leussler 1939, p.35) already referred to the Iowa skipper as a species that had previously been "quite common" but at the time only found "where original prairie remains." At the time the Iowa skipper was reported from Omaha (Douglas County), West Point (Cuming County), McCook (Red Willow County) and Oconto (Custer County) (Leussler 1939, p.35).

The full scope of the Iowa skipper's historic range in Nebraska is unknown, but there are records of the species from scattered locations across the state, except for the southern panhandle and southwestern Nebraska. (Dankert 2022a; Dankert 2020a). These records span 30 counties in Nebraska (Figure 7, Table 10).

Table 10. Nebraska counties with reports of Iowa skipper (Dankert 2022a; Dankert 2020a; Lotts and Naberhaus 2021; Stanford and Opler 1996, p.20; Dankert and Nagel 1988, p.22; Johnson 1972, pp.38-39; Leussler 1939, p.35).

Arthur	Garfield
Boyd	Gosper
Brown	Hall
Buffalo	Hooker
Cedar	Jefferson
Cuming	Kearney
Custer	Keya Paha
Dakota	Knox
Dawe	Lancaster
Dawson	Lincoln
Dodge	Red Willow
Douglas	Rock
Franklin	Sheridan
Furnas	Thayer
Gage	Webster

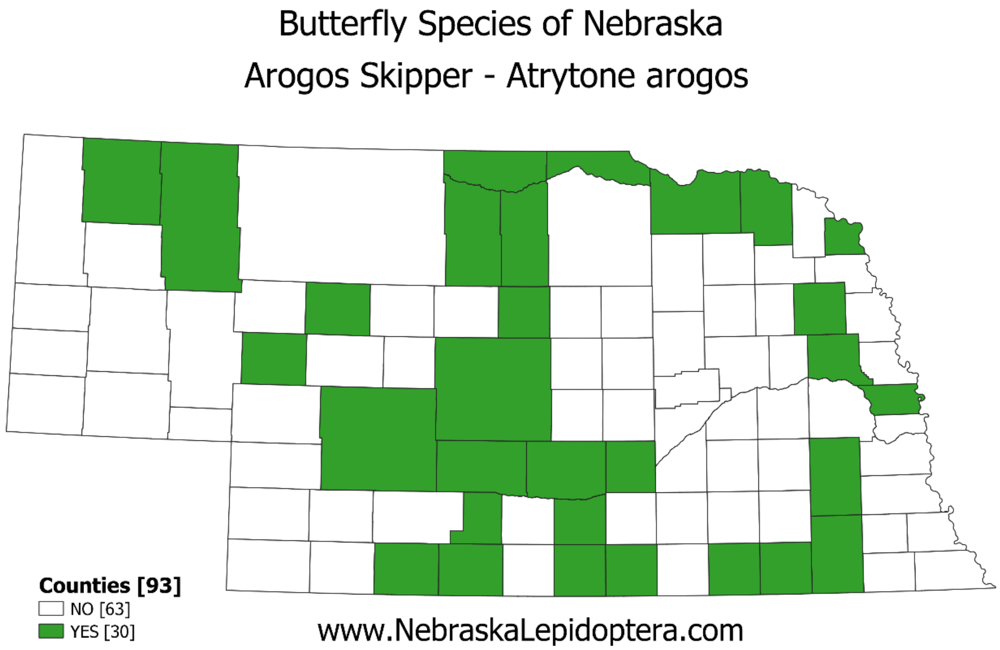

Figure 7. Map of Nebraska counties with records of Iowa skipper from Nebraska Lepidoptera website (Dankert 2022a).

The Iowa skipper is known from Rowe Sanctuary, Victoria Springs, Homestead National Monument, Niobrara Valley Preserve, Cather Prairie, Limestone Bluffs SWMA, Crane Meadows, Calamus Reservoir, and Youngsen and Macon Lakes Waterfowl Protection Areas (Dankert 2022a). The Iowa skipper is known from Samuel R. McKelvie National Forest, Halsey National Forest, and Nebraska National Forest, and likely to occur in Ogalala National Grasslands (USFS 2018b, p.4).

As elsewhere in its range, the Iowa skipper inhabits high quality prairies in Nebraska (Dankert 2022a). The Iowa skipper's presence is "cited as a biological indicator for prairie quality" (Dankert 2022a). Most recent records of the species in Nebraska are found in mixed-grass prairies, as tallgrass prairie in its original condition is "virtually non-existent" in the state (Dankert 2022, personal communication). Johnson (1972, p.42) reported that "eastern Nebraska niches for skippers such as [Iowa skipper] … seem to have disappeared." The Iowa skipper also appears to be absent from the western-most counties of Nebraska, known as the Pine Ridge habitats, based on regular research done in the area for over 100 years, but can likely still be found in the central and western portions of the state which have remaining intact grasslands (Dankert 2022, personal communication).

The Iowa skipper is one of Nebraska's rarest prairie skippers (along with the Ottoe skipper) and are infrequently reported, often unreported for years at a time from known locations (Dankert 2022a; Dankert 2020b). It has continued to decline in Nebraska since 2005, and its estimated population size is less than 500 individuals, based on expert opinion (Schneider et al. 2018, p.33). The skipper "has become increasingly difficult to locate as its prairie habitats have diminished in both numbers and quality" (Dankert 2020a). Although likely underreported in Nebraska, Iowa skippers appear to be rare in the state (Dankert 2022, personal communication).

There are few recent records of Iowa skippers in Nebraska. In 2020, Neil Dankert wrote that Iowa skippers had only been reported three times in the prior 25 years (Dankert 2020b). These included one observation in 2005 in Loup County and two observations in 2018, at Youngsen Waterfowl Protection Area in Kearney County and Macon Lakes Waterfowl Protection Area in Franklin County (Dankert 2022, personal communication). Dankert recorded two additional observations in 2020, both in Franklin County, one at Macon Lakes Waterfowl Protection Area and another in the hills southwest of Franklin (Dankert 2022, personal communication; Dankert 2020a).

Despite regular surveys, the Iowa skipper has not been observed at Niobrara Valley Preserve since 1999, a preserve in north-central Nebraska owned and managed by the Nature Conservancy (Dankert 2022, personal communication; Dankert 2022b; Dankert 2021; Dankert and Nagel 1988, p.22). However, Dankert (2022, personal communication) thinks there is a good chance Iowa skippers are still extant at Niobrara Valley Preserve.

Iowa skippers also were not found in biweekly butterfly surveys conducted at multiple marginal and conservation grassland sites in the summers of 2004-5 in Douglas County (Farhat et al. 2014, pp.3, 5-7).

J. North Dakota

Although North Dakota does not include the Iowa skipper on its list of Species of Conservation Priority and the species has no state status rank (North Dakota Game and Fish Dept. 2015), Royer and Marrone (1992, pp.12, 16) considered the Iowa skipper to already be threatened in North Dakota by 1992 and described them as being "nearly always encountered in low numbers" in the Dakotas. And in 1989 Royer said the Iowa skipper "may be the skipper most in danger of elimination from North Dakota" (Royer 1989, p.29). The Iowa skipper was also included on the list of sensitive species in the Forest Service's Region 1 in 2011, specifically in North Dakota where it is known to occur in the Dakota Prairie Grasslands (U.S. Forest Service 2011, p.4).

Lotts and Naberhaus (2022) have records of Iowa skippers from prior to 2005 in Ransom, Richland, and Ward counties, but the observation dates and locations are unknown.

Royer and Marrone (1992, p.8) reported records of Iowa skippers from two sites in Ward County (both private) and one site in Ransom County (Sheyenne National Grassland, managed as rangeland). The Iowa skipper abundance at all three sites was documented as extremely rare (Royer and Marrone 1992, p.8). Royer and Marrone (1992, pp.8, 18) reported a male Iowa skipper was collected at the Snake Road, Ward County site in 1986 but the species was not encountered in any year between then and 1991, despite an annual search. They conducted surveys at multiple sites in 14 counties in 1991 and only found one male each at the Van Sickle Pasture site in Ward County and the McLeod North site in Sheyenne National Grasslands, Ransom County (Royer and Marrone 1992, pp.8, 22-23).[10]

Orwig (1997, p.1) conducted a butterfly inventory of sites controlled by the U.S. Fish and Wildlife Service in 1997 in southeast North Dakota (Ransom, Richland, Sargent counties), but did not find any Iowa skippers. Swengel and Swengel (1999, p.268) conducted transect surveys at 40 tallgrass prairies in Iowa, Minnesota, and North Dakota over ten years (1988-1997) for five rare prairie skippers, including the Iowa skipper, and recorded 81 Iowa skippers at nine sites. In southeast North Dakota they found only a single Iowa skipper, despite surveying ten sites (eight within Sheyenne National Grassland) for four years (1994-1997) on National Forest Service, U.S. Fish and Wildlife Service, and private lands in Ransom and Richland counties (Swengel and Swengel 1999, pp.289-90 Appendices 1-2).

In 2012 surveys of insects in eastern North Dakota, Goodwin (2014, pp.485, 491) observed Iowa skippers at the Hyatt Slough Wildlife Management Area (WMA) in Dickey County and at Meszaros Slough WMA (p.491) in Sargent County. Goodwin (2014, p.392) also presented a map of North Dakota counties representing county records from their 2012 surveys and prior records (Figure 8).

[10] Royer and Marrone (1992) provide a list of these sites, along with the Iowa skipper's estimated abundance, habitat acreage, and ownership at each site in Appendix A.

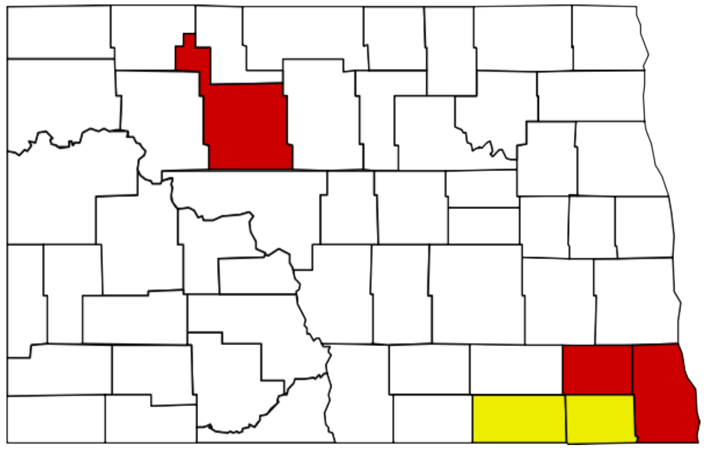

Figure 8. Map of the Iowa skipper's current range in North Dakota from Goodwin (2014, p.392). Counties highlighted in yellow (Dickey, Sargent) had Iowa skipper observations in 2011-2012 surveys, counties highlighted in red (Ransom, Richland, Ward) had previously published records, and counties not highlighted did not have Iowa skipper records (Goodwin 2014, p.392).

In a study of the influence of land use practices on the presence of Dakota skipper and other prairie-dependent butterflies, researchers from North Dakota State University (2015) conducted surveys throughout the Dakotas from 2015 to 2017, but did not observe Iowa skippers in North Dakota, despite surveying sites in Dickey, Sargent, and Richland counties.

K. Oklahoma

The Iowa skipper appears to be faring better in Oklahoma than in most of the rest of its range and it is apparently fairly common and regularly reported in the state (NatureServe 2020). However, it is still considered to be Vulnerable (S3) in the state and is listed as a Species of Greatest Conservation Need in Oklahoma's Comprehensive Wildlife Strategy (NatureServe 2020; Oklahoma Dept. of Wildlife Conservation 2016, p.31).

The ecological regions where the Iowa skipper occurs in substantial or manageable numbers in Oklahoma include: Cross Timbers (generally central one-third of OK & composed of oak woodlands & prairies), mixed-grass prairie (aka central great plains or central mixed-grass prairie – western portion of the state excluding panhandle), Ozark Region (composed of Ozark Highlands & Boston Mountains ecological regions – a portion of northeast OK), and tallgrass prairie (comprised of Flint Hills & Osage Plain ecological regions – portions of NE OK) (Oklahoma Dept. of Wildlife Conservation 2016, pp.21-22, 31)

The Iowa skipper's status varies in different regions in Oklahoma. In mixed-grass prairie region/shinnery oak shrubland the Iowa skipper is "uncommon found in the northern half of the region" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.100). In mixed-grass prairie region/blackjack oak/post oak woodlands and shrublands, the Iowa skipper is "uncommon and locally occurring in open oak woodlands with an abundance of native tallgrass vegetation" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.128).

In the tallgrass prairie region/tallgrass prairie, the Iowa skipper is "locally common in native tallgrass prairie and open oak woodlands region wide" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.152). In the tallgrass prairie region/ Post Oak and Blackjack Oak Savannah and Woodland, the Iowa skipper is "uncommon and locally occurring in oak savannahs and prairie edges region-wide" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.175). In the tallgrass prairie of the Cross Timbers Region of Oklahoma, the Iowa skipper is "locally common but restricted to larger tracts of native prairie" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.211). In the tallgrass prairie of the Ozark region the Iowa skipper is "uncommon and restricted to prairie remnants scattered throughout the region" and the trend in population size is unknown (Oklahoma Dept. of Wildlife Conservation 2016, p.304).

The Iowa skipper is reported from 51 counties in Oklahoma, shown in Table 11 and Figure 9 (Nelson and Fisher 2022, pp.3-4). The county record for Woodward County was just added in 2022 (Nelson and Fisher 2022, p.4).

Table 11. Oklahoma counties with Iowa skipper records (Nelson and Fisher 2022, pp.3-4). Counties with known records in the last 20 years (2003-2022) are in bold.

Adair	Grady	Okmulgee
Alfalfa	**Harper**	**Osage**
Atoka	Jefferson	Ottawa
Blaine	Johnston	**Pawnee**
Bryan	**Kay**	Payne
Canadian	Kingfisher	Pontotoc
Carter	Lincoln	Pottawatomie
Cherokee	Logan	Roger Mills
Cleveland	Major	Rogers
Comanche	McClain	Stephens
Craig	McIntosh	Tillman
Custer	Murray	Tulsa
Delaware	Muskogee	Wagoner
Dewey	**Noble**	Washington
Ellis	Nowata	Washita
Garfield	Okfuskee	**Woods**
Garvin	Oklahoma	**Woodward**

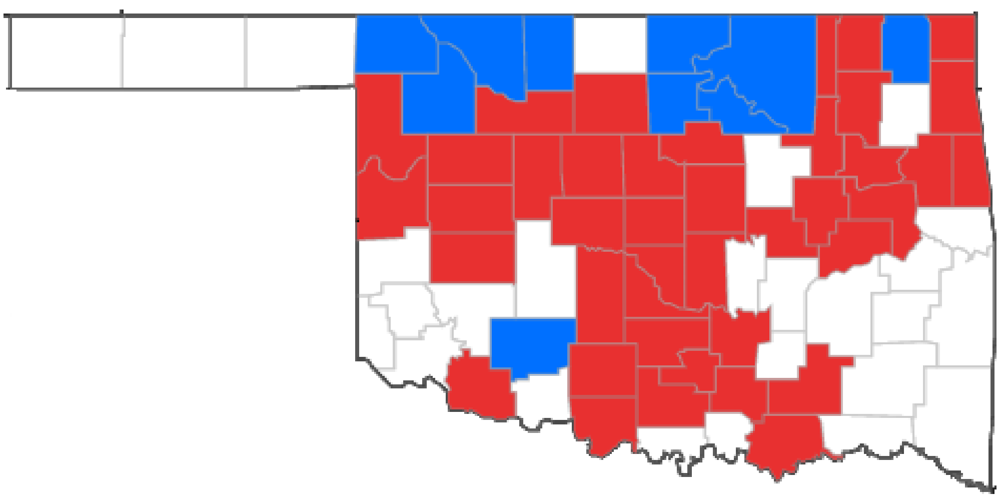

Figure 9. Map of Oklahoma counties with Iowa skipper records (Nelson and Fisher 2022, pp.3-4). Counties with records in the past 20 years (2013-2022) are shown in blue and counties with earlier records are in red.

The Iowa skipper is known from six of the Nature Conservancy's 11 Preserves in Oklahoma: Tallgrass Prairie Preserve, Keystone Ancient Forest Preserve, Pontotoc Ridge Preserve, J.T. Nickel Family Nature and Wildlife Preserve, Four Canyon Preserve, and White Oak Prairie Preserve (The Nature Conservancy 2018, p.1). NatureServe (2020) identifies strongholds for the Iowa skipper in Oklahoma as Tallgrass Prairie, Pontotoc Ridge Preserve, and the Wichita Mountains Wildlife Refuge. Dole et al. (2004, Tables 4.1, 4.3 pp.194-96, 200-203) also identified the Iowa skipper as being common at Pontotoc Ridge Preserve, meaning one or more individuals of the species could be found every visit during the species' flight period, but listed its status as rare (generally recorded once a year or less frequently) at Tallgrass Prairie Preserve.

Kondratieff et al. (2006, pp.35-41, 64) also found the Iowa skipper to be widespread and abundant in 2002 surveys at Fort Sill in Comanche County.

Howery et al. (2018, pp, 8, 21) observed several Iowa skippers incidentally at Cimarron Hills Wildlife Management Area (WMA) (Woods County) and Cimarron Bluff WMA (Harper County) when researchers were conducting inventory surveys for other taxa from 2014 to 2018.

Baum (2021, p.2) conducted butterfly surveys throughout Oklahoma from 2019 to 2021 focused on counties where Regal Fritillary were previously documented: Craig, Osage, Pawnee, Rogers, and Tulsa. In 2019, they observed a total of 16 Iowa skippers at multiple sites in Osage and Kay counties, including Tallgrass Prairie Preserve, John Dahl WMA, Hulah WMA, and at a site called Roadside 1 in Osage County (Baum 2021, pp.19-20 Table 2). In 2020, they observed a total of 38 Iowa skippers at multiple sites in Osage, Kay, and Craig counties, including: Tallgrass Prairie Preserve, Osage WMA, Kaw WMA, White Oak Prairie, Lake Pawhuska, and a site called Roadside 2 in Osage County (Baum 2021, pp.21-22 Table 3). In 2021, with more limited surveying Baum (2021, p.23 Table 4) found two Iowa skippers at one private property in Osage County.

Other relatively recent reports of Iowa skippers in Oklahoma include research-grade observations from inaturalist. The reports are from Alfalfa (2010), Comanche (2010), Noble (2021), Osage (2018, 2019, 2020), and Pawnee (2019) counties (GBIF.org 2022).

L. South Dakota

The Iowa skipper is listed as a Species of Greatest Conservation Need in South Dakota's 2014 State Wildlife Action Plan ("SWAP"), as well as the SWAP from 2006 (South Dakota Dept. of Game, Fish, and Parks 2014, p.12, Table 2-1). It is classified as state rank S2, or imperiled (South Dakota Dept. of Game, Fish, and Parks 2014, p.12, Table 2-1). The U.S. Forest Service includes the Iowa skipper on its Sensitive Species list in its Region 2, which includes South Dakota, and notes high confidence in their determination that the Iowa skipper is declining in all states in Region 2 (U.S. Forest Service 2018b, p.2).

In an earlier assessment of the conservation status of the Iowa skipper in the Dakotas, Royer and Marrone (1992, p.16) determined that the species was not threatened with extinction in South Dakota in the near future. However, the authors noted that the species' status warranted continued monitoring since the Iowa skipper "is restricted to remnant stand of bluestem grasses, which continue to decline" in South Dakota (Royer and Marrone 1992, p.16). And Royer and Marrone (1992, pp.5, 12) described the Iowa skipper as being "seldom common in any locality" and "nearly always encountered in low numbers" in the Dakotas. Marrone later described the Iowa skipper as "local and occasionally common throughout South Dakota," but potentially absent from the northwestern corner of the state (Marrone 2002, p.417; Marrone 2004a, Appendix A p.26). After four years of extensive surveys in northeast South Dakota, Skadsen (2009, p.8) suggested that the Iowa skipper may be extirpated in this part of the state.

In addition to habitat loss, Iowa skippers in South Dakota are threatened by poorly timed prescribed fire, mowing, haying, and/or grazing, and pesticides (South Dakota Dept. of Game, Fish, and Parks 2014, p.275). The U.S. Forest Service noted that the Iowa skipper's habitat trend in Region 2 is declining, especially adjacent to larger population centers such as the Black Hills foothills in South Dakota (USFS 2018b, p.2).

The Iowa skipper is thought to have historically occurred in appropriate habitat throughout most of South Dakota (South Dakota Dept. of Game, Fish, and Parks 2014, p.275). Known records of the Iowa skipper span 18 counties in South Dakota, presented in Table 12 and Figure 10 (Marrone 1994, p.239; Marrone 2002, p.417, Lotts and Naberhaus 2022; South Dakota Dept. of Game, Fish, and Parks 2014, p.275). On U.S. Forest Service land, the Iowa skipper is known from the Black Hills National Forest, Buffalo Gap National Grasslands, and Ft. Pierre National Grasslands in South Dakota but it is unclear when the species was last observed at these sites (USFS 2018b, p.4). The Iowa skipper "is most often found in level, well drained lowlands" in eastern South Dakota and "in scattered areas having more than normal supplies of soil moisture" in western South Dakota (Royer and Marrone 1992, p.12).

Table 12. South Dakota counties with records of Iowa skipper (Marrone 1994, p.239; Marrone 2002, p.417, Lotts and Naberhaus 2022).

Brookings	Lawrence
Brown	McPherson
Brule	Meade
Clay	Minnehaha
Custer	Moody
Day	Roberts
Deuel	Stanley
Fall River	Todd
Gregory	Tripp

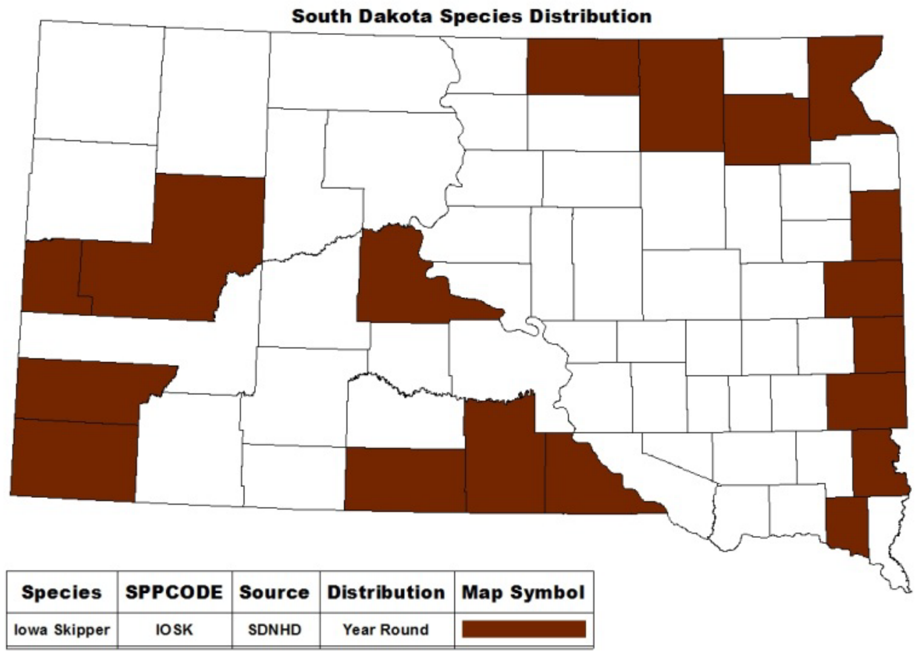

Figure 10. Map from 2014 State Wildlife Action Plan showing counties with records of Iowa skipper (South Dakota Dept. of Game, Fish, and Parks 2014, p.275).

In South Dakota, the Iowa skipper is described to be"[f]ound in relatively undisturbed prairies and grasslands such as Mirror Lake Game Production Area, Lawrence County, and South Scalp Creek Recreation Area, near Fort Randall Dam, Gregory County" (Marrone 2002, p.417; Marrone 2004a, Appendix A, p.2).

Royer and Marrone (1992, pp.6-7, 23) conducted surveys at 16 sites in 12 counties in South Dakota in 1991 and only found Iowa skippers at four sites: two individuals from East Bluedog Lake in Day County, one from West Dry Run No.3 and two from West Rosholt site in Roberts County, and 13 from South Shore Recreation Area in Gregory County. They also reported past collections of Iowa skippers from other sites: Scarlet Fawn Prairie in Day County from 1985, Crystal Springs Nature Conservancy Area in Deuel County from 1987, Crow Peak and Mirror Lake Game Production Area in Lawrence County from 1988 and 1986, respectively, Oahe Dam site in Stanley County from 1984 (Royer and Marrone 1992, pp.6-7).[11] Royer and Marrone (1992, Appendix A) estimated the Iowa skipper's abundance as common at South Shore Recreation Area, unknown at Scarlet Fawn Prairie, and rare at the other seven sites in South Dakota.

In 2004 butterfly surveys focused on documenting the presence or absence of the Iowa skipper and two other U.S Forest Service sensitive species at Badlands

[11] Royer and Marrone (1992) provide a list of these sites, along with the Iowa skipper's estimated abundance, habitat acreage, and ownership at each site in Appendix A.

National Park, Marrone (2004a, pp.2-3) failed to find any Iowa skippers, or either of the other two species. Marrone (2004b) also conducted butterfly surveys of Mount Rushmore National Memorial in 2004 to create an inventory of the site, but again did not find any Iowa skippers, despite the species being known from the Black Hills region that is home to Mount Rushmore.

Marrone (2009, p.3) conducted butterfly surveys in the northern and southern portions of the Black Hills region, in southwest South Dakota, in 2005 and 2006, respectively, to assess the presence or absence of the Iowa skipper and three other species monitored by the state's Natural Heritage Program. They observed Iowa skippers in both parts of the region, including five new locations in the northern portion and six new locations in the southern portion of the Black Hills region (Marrone 2009, p.3). Marrone (2009, pp.3-4) does not include a list of all sites where the skipper was observed but notes on documented nectar sources identify Iowa skipper observations from Mirror Lake Game Production Area and Elk Mountain campground at Wind Cave National Park.

Skadsen (2009, p.1) conducted surveys at five remnant tallgrass prairies in northeast South Dakota from 2006 to 2009 to monitor the Iowa skipper and nine other target butterfly species deemed tallgrass prairie-dependent specialists. During the four-year study the Iowa skipper "was extremely rare" as researchers only found two individuals at Scarlet Fawn Prairie in 2006 and two individuals at Hartford Beach State Park in 2007 (Skadsen 2009, pp.7-8). Skadsen (2009, p.4) did not observe Iowa skipper at the Pickerel Lake State Recreation Area in Day County during the four-year study period, but they formerly occurred at the site with the last observation in 2004. Skadsen (2009, p.8) hypothesized that they may have become extirpated from this site due to habitat degradation and the resultant loss of native forbs and grasses for larval and adult food. Skadsen (2009, p.7) also says the Iowa skipper has apparently been extirpated from Scarlet Fawn Prairie in Day County, as the only observation there was of two individuals in 2006.

Given the number of this study's surveys and the extreme rarity of observations of the Iowa skipper, including no observations in 2008 and 2009, Skadsen (2009, p.8) posits that the species "may have become extirpated in northeast South Dakota." This hypothesis appears to be supported by a more recent study of the influence of land use practices on the presence of Dakota skipper and other prairie-dependent butterflies in the Dakotas, as the authors focused their South Dakota surveys on the northeastern portion of the state and did not find any Iowa skippers during the 2015-2017 study period (North Dakota State University 2015). Further, Runquist et al (2019, pp.27-28) did not find any Iowa skippers in 2018 surveys for Dakota skippers and other butterflies at three sites in Day County and one site in Roberts County, which are counties in northeastern South Dakota with historic records of Iowa skipper.

M. Texas

There is little information available about the Iowa skipper in Texas. It is not included on Texas' list of species of greatest conservation need and it does not have a state status rank. The Iowa skipper is found in north-central Texas and the middle of central Texas (Neck 1996, p.252). It is reported to be common (one or more individuals of this species found every visit during normal flight period) in Tarrant County, Texas (Dole et al 2004, Table 4.5 pp.206-208). Stanford and Opler (1996, p.6) reported Iowa skipper presence in Waller County, Texas. The species is also reported from Dallas County, Texas in Freeman (1939, p.26).

The Butterflies and Moths of North America webpage also contains records of Iowa skippers from 20 Texas counties based on records from the U.S. Geological Survey's Northern Prairie Wildlife Research Center from sometime prior to 2005 (Lotts and Naberhaus 2022). The website contains only one more recent observation for Texas, made on June 13, 2016, in Lipscomb County (Lotts and Naberhaus 2022). A separate research-grade observation was also reported from Lipscomb County, Texas on inaturalist in 2016 (GBIF.org 2022). Records are available for Iowa skippers in 21 counties in Texas (Table 13, Figure 11).

Table 13. Texas counties with known observations of Iowa skippers (Lotts and Naberhaus 2022; GBIF.org 2022).

Bexar	Hood
Blanco	Johnson
Burnet	Lampasas
Cooke	Limestone
Coryell	Lipscomb
Dallas	Nueces
Denton	Tarrant
Erath	Travis
Fayette	Waller
Grayson	Wise
Hamilton	

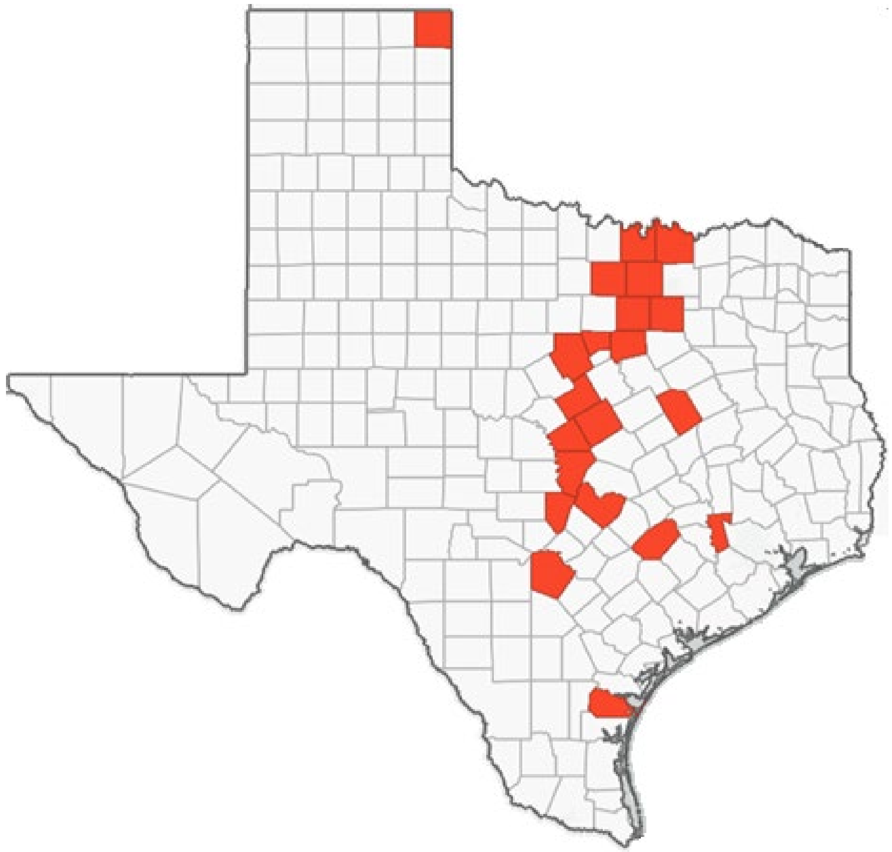

Figure 11. Map of Texas counties with records of Iowa skipper (Lotts and Naberhaus 2022; GBIF.org 2022).

N. Wyoming

There is little information available about Iowa skipper populations in Wyoming. The Wyoming Fish and Game Commission does not have jurisdiction over invertebrates, other than crustaceans and mollusks, so the Iowa skipper was not considered for Species of Greatest Conservation Need status (Wyoming Game and Fish Dept. 2017, pp.IV-i-1 to IV-i-2). The Iowa skipper's status is not ranked (SNR) in Wyoming (University of Wyoming 2022).

Lotts and Naberhaus (2022) report observations from prior to 2005 from Campbell, Crook, and Platte Counties. The exact observation dates and locations are unknown. The skipper is also reported from Platte County by Stanford and Opler (1996, p.20). It is believed to be native to Devils Tower National Monument in Crook County but was not observed during 2004 surveys (Opler and Gillette 2004, p.7). The Iowa skipper is also known from Black Hills National Forest, Medicine Bow National Forest, and Thunder Basin National Grassland, and likely to occur in Bighorn National Forest in Wyoming, but it is unclear when it was last observed at these sites (U.S. Forest Service 2018b, p.4).

IV. THREATS

There is consensus that past habitat destruction and degradation are the primary contributors to the Iowa skipper's current imperiled status. Loss of habitat to agricultural conversion, development, and mining continues to be a major threat to the species' survival in most of its range (Minnesota Dept. of Natural Resources 2022; NatureServe 2020; U.S. Forest Service 2018b, p.2; Fowler and Anderson 2015, p.585; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Sievert and Prendergast 2011, p.2; Akin 2010, p.1; Kindscher et al. 2009, p.34; Orwig 1997, pp 3-4; Royer and Marrone 1992, p.15).

However, the Iowa skipper is also threatened by a number of other factors which affect the species directly or through degradation of its habitat, including pesticides, grazing, unsuitable fire management, invasive plant species, and climate change (Dankert 2022, personal communication; NatureServe 2020; Olsen 2018, p.8; USFS 2018a; Fowler and Anderson 2015, p.585; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Sievert and Prendergast 2011, p.2; Kindscher et al. 2009, p.34; Orwig 1997, pp 3-4; Royer and Marrone 1992, p.15).

Because of the past and continuing habitat destruction and degradation, the Iowa skipper's remaining populations tend to be small and isolated in similarly small, isolated patches of native prairie habitat. This is in and of itself a threat to the Iowa skipper's survival as it makes them particularly vulnerable because they can easily be wiped out by random extreme weather events, such as a drought or an ill-timed hailstorm, pesticide drift, disease, poor habitat management, overgrazing, genetic deterioration, and other circumstances (Minnesota Dept. of Natural Resources 2022; Olsen 2018, p.8; U.S. Forest Service 2018b, p.1; Orwig and Schlicht 1999, pp.6-7). In addition, there are no regulatory mechanisms currently in place that will ensure the future survival and recovery of the Iowa skipper.

A. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Past destruction, fragmentation, and modification of habitat is a primary cause of Iowa skipper declines, and the ongoing destruction and alteration of habitat continues to be a major threat to their survival (Minnesota Dept. of Natural Resources 2022; Montana Natural Heritage Program 2021; NatureServe 2020; U.S. Forest Service 2018a; U.S. Forest Service 2018b, p.2; Fowler and Anderson 2015, p.585; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Akin 2010, p.1; Kindscher et al. 2009, p.34; Schlicht and Orwig 1998, p.83). Grasslands and prairies worldwide have been converted, primarily into agricultural land, and grassland habitats and their native biota are now one of the most threatened biomes on the planet (Raven and Wagner, 2021 p.4; Samson et al 2004, p.6).

Because of their rich, fertile soils and absence of extreme topography, "[t]emperate grasslands are among the most modified ecosystems on the planet" (Gage et al. 2016, p.107). Tallgrass, mixed, and short-grass prairies are among

North America's most endangered habitats (Samson et al 2004, p.6). Conversion to cropland is the greatest threat to temperate grasslands, which "have the highest ratio of converted to protected area of any major biome" (Stephens et al. 2008, p.1321). The Iowa skipper's native prairie habitat also continues to be lost to development, mining, and degradation (Minnesota Dept. of Natural Resources 2022; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Sievert and Prendergast 2011, p.2; Skadsen 2009, p.12; Kettler and Pineda 1999, p.54; Orwig and Schlicht 1999, p.4).

About 99% of tallgrass prairie has been destroyed in most central U.S. states since European settlement, most converted to intensive agriculture, resulting in prairie obligate butterflies like the Iowa skipper being rare and primarily restricted to prairie reserves. (Wright and Wimberly 2013, p.4138; Swengel and Swengel 1999, p.267; Howe 1994, p.692; Swengel and Swengel 1993, p.9). Tallgrass prairies in North America once extended from Manitoba to northern Texas, covering about 60 million hectares or more than 500,000 km^2 (Raven and Wagner, 2021 p.4; Sievert and Prendergast 2011, p.2). It has since been reduced by approximately 90-95% overall in North America, and closer to a 99% reduction in the United States (Raven and Wagner, 2021 p.4; Wright and Wimberly 2013, p.4138; Sievert and Prendergast 2011, p.2; Busby et al. 2010, p.1; Howe 1994, p.692).

In Iowa, prairie is thought to have covered 85% of the state prior to European settlement, but virtually all of the vast prairie landscape was gone within 70 years (Smith 1981, p.7-9). Less than 0.02% of Iowa's prairie remained by 1981 (Smith 1981, p.7). Thus, "Iowa's limitless prairie has been reduced to a few tiny islands in the midst of a vast ocean of agriculture" (Orwig and Schlicht 1999, p.6). And "[a]gricultural conversion and urban development continue to destroy the few remaining pockets which are not protected" (Orwig and Schlicht 1999, p.4). In Kansas, it is estimated that prairie covered 94% of Anderson County when European settlement began in the 1850s, but only 1.11% of the high-quality native prairie remained by 2009 (Kindscher et al. 2009, p.3). Most of the remaining tallgrass prairie is in Kansas, primarily in the Flint Hills of eastern Kansas, but this continues to be lost to development and degradation and less than 1% of the remaining tallgrass prairie is in conservation ownership (Busby et al. 2010, p.1).

At the same time that the amount of the Iowa skipper's native prairie habitat was declining, cultural practices also "eliminated most antelope and bison herds, added livestock, altered water tables, suppressed natural fire, prescribed dormant-season fire, and dissected prairie remnants with roads, railways, and other cultural barriers to fire and movements of wild or domestic ungulates" which has contributed to further destruction and degradation of the Iowa skipper's habitat (Howe 1994, p.692). The removal, or placement under direct human control, of ecological factors that helped to develop and maintain prairie habitats, such as fire set by lighting or people and ungulate grazing, has played a significant role in degrading the Iowa skipper's remaining habitat, such as by allowing for woody plant invasion (succession) (Fowler and Anderson 2015, p.585; Samson et al. 2004, p.8; Kettler and Pineda 1999, p.54; Howe 1994, p.692). Attempts to replicate these ecological factors through prescribed burns or livestock grazing, often on protected prairie sites, are not always beneficial to the Iowa skipper, and in some cases this management itself has contributed to the species' decline. This habitat management will be discussed in more detail below.

The increasing intensification of agriculture and expansion of farms into large commercial enterprises, especially after World War II, led not only to expansion of farms but also to an emphasis on monocultures and on application of massive amounts of fertilizers and synthetic pesticides (Raven and Wagner 2021, p.2). This resulted in a loss of refuges available for insects and potential corridors for dispersal. The increased usage of pesticides can directly harm Iowa skippers and also destroy their habitat, especially in areas adjacent to croplands, as discussed further below in Section IV(E)(1).

Some parts of the Iowa skipper's range historically experienced conversion of the vast majority of its prairie habitat resulting in only small, isolated patches remaining, such as in Iowa where more than 99% of its prairie habitat was destroyed. In other areas, while conversion primarily to agriculture occurred soon after European settlement and intensified in some areas after WWII, prairie habitat remained in larger amounts. However, conversion to agriculture, urbanization, or degradation from other human uses has continued and increased its pace in recent years, threatening what little prairie habitat remains for the Iowa skipper.

Although much of the tallgrass prairie in North America has been converted to cropland, shortgrass and mixed-grass prairies in the western Great Plains still contain large blocks of habitat, and potentially up to 50% of central shortgrass prairie is intact (Gage et al. 2016, pp.107). Although much of what remains tends to be less desirable land for agricultural uses, it is still under threat because of technological innovations, government incentives, and high crop prices (Gage et al. 2016, pp.107-8)

For example, Stephens et al. (2008, p.1322) described the Missouri Coteau region of North and South Dakota as "one of the most intact remaining grassland landscapes east of the Missouri River" although 56% of the region's grassland had already been converted. This region was primarily dominated by native mixed-grass prairie prior to European settlement (Stephens et al, 2008, p.1321). But this grassland continues to be threatened, and Stephens et al. (2008, p.1325) found that 36,540 hectares of native grassland was converted to cropland among the sites they monitored in this region from 1989 to 2003, which was a cumulative 5.2% loss of the existing native grassland, or a 0.4% annualized loss. Stephens et al. (2008, p.1327) predicted a future conversion rate in this region that represents a loss of at least 60,000 hectares of grassland every ten years, which is a conservative estimate in part because it does not account for evidence that loss of native grassland is increasing across the Prairie Pothole Region, which includes the Missouri Coteau region studied. Within their study area, Stephens et al. (2008, p.1326) estimated that 22% of unprotected grassland area of high biological importance was at high risk of conversion.

Similarly, grasslands in the Prairie Pothole Region (PPR; northern tier of Montana, northern and eastern North Dakota, eastern South Dakota, western Minnesota, and north-central Iowa) have continued to be converted to croplands in recent years (Alemu et al. 2020, p.2). The types of crops cultivated in this region have changed as well, with increasing emphasis on corn and soybeans (i.e., replacing alfalfa and winter wheat in parts of the region) (Alemu et al. 2020, p.2). This crop expansion in the PPR, as well as elsewhere in the U.S., is attributed to several factors, including: 1) biofuel demand driven by federal policies and subsidies; 2) high crop prices and government subsidies such as expanded crop insurance programs and other payments; 3) development of cold-tolerant soybean varieties and drought-tolerant corn varieties that allow for corn to be grown farther west and soybeans further north; and 4) other technical innovations such as more efficient equipment for planting and for moving rocks and soils (Alemu et al. 2020, p.2; Wimberly et al. 2017, pp.161-62; Stephens et al. 2008, p.1327).

The Renewable Fuel Standard (RFS) in the U.S. Energy Independence and Security Act of 2007 (EISA) spurred conversion to agriculture through its promotion of growing crops for biofuels, in the PPR as well as in other parts of the Iowa skipper's range (Lark et al. 2020, p.2; Wimberly et al. 2017, pp.161-62; Johnston 2014, p.93; Stephens et al. 2008, p.1327). The RFS requires that biofuels be blended into the transportation fuel supply at annually increasing increments (Lark et al. 2022, p.1). The mandate has primarily been fulfilled with corn grain ethanol (~87%) (Lark et al. 2022, p.1). Although the Renewable Fuel Standard technically only allows crops used for the production of renewable biofuels to be sourced from land that was cleared or cultivated prior to December 2007, in practice vast amounts of land, including native prairie, have been converted to cropland since the enactment of the EISA, with the vast majority of that planted to corn and soybeans (Lark et al. 2018, p.160; Lark et al. 2015, p.9). The RFS increased corn prices by 30% and prices of other crops by 20% and expanded U.S. corn cultivation by 2.8 million hectares in the years following the enactment of the RFS (Lark et al. 2022, p.2).

The 2014 Farm Bill included a regional Sodsaver provision which reduced the amount of federal crop insurance subsidies a farm operator could receive for crops grown on land converted from native sod or prairie, but it was limited to six states (Lark et al. 2018, p.156; Lark et al. 2015, p.9). And conversion to cropland continued even in those states. Lark et al. (2018, p.160) found a loophole in implementation of the Sodsaver provision that likely contributes to continuing conversion, in that converted prairie that is initially planted to alfalfa or other multiyear crops are exempt from the protections of the provision, and these areas can subsequently be planted to corn or other row crops without the decreased crop insurance. Lark et al. (2018, p.160) found that of the 167 hectares of prairie that they visually confirmed was converted to crop production in their study in Minnesota, as many as 39% were first planted to alfalfa or other hay.

Wright and Wimberly (2013, p.4138) found a 1.0-5.4% annual rate of the conversion of grassland to corn and soy from 2006 to 2011 across a significant portion of the US Western Corn Belt (ND, SD, NE, MN, IA), rates not seen in the Corn Belt since the 1920s and 1930s. This amounts to an estimated net loss of approximately 528,000 hectares (1.3 million acres) of grasslands from 2006 to 2011 (Wright and Wimberly 2013, p.4138). Much of this grassland conversion was concentrated in North and South Dakota as corn and soybean cropping has expanded westward, and a similar westward expansion of the Corn Belt was seen in Nebraska (Wright and Wimberly 2013, p.4135). High corn and soybean prices, driven largely by the demand for biofuel feedstocks are the driver of this recent accelerated conversion of grasslands to croplands (Wright and Wimberly 2013, p.4134).

Johnston (2014, p.82) quantified recent changes in rural land use and analyzed trends in the Dakota Prairie Pothole Region (PPR portions of North & South Dakota) from 1980 to 2012, using the USDA's Cropland Data Layer. They focused on this region because it contained large tracts of remnant native prairie and wetlands but was also experiencing rapid agricultural expansion (Johnston 2014, p.82). Statewide crop statistics showed a long-term trend of increasing area planted to corn in the Dakotas from 1980 through 2012, as well as an increase in the area planted to soybeans (Johnston 2014, p.86). Soybeans experienced a sudden upward shift in planted area in 1997 that was thought to be due to the introduction of new cold- and drought-adapted high-yielding varieties as well as increased international demand (Johnston 2014, p.86). Looking at the period of 2006 to 2012, there was a significant increase in corn and soybeans over the seven years, but the average rate of increase was nine times higher in 2010-2012 versus 2006-2010, with the total area of corn and soybean area expanding from 26.5% of the region in 2006 to 35.5% by 2012 (Johnston 2014, pp.87-88). Correspondingly, the grassland area was 9% lower in 2012 than it had been in 2006 (Johnston 2014, p.88).

Lark et al. (2015, p.2) analyzed cropland changes in the conterminous United States from 2008 to 2012, the period immediately following the passage of the Renewable Fuel Standard, tracking net and gross changes between cropland and non-cropland. The total net cropland increased by 2.98 million acres nationwide from 2008 to 2012 and the gross land conversion was about four times higher, including about 4.36 million acres of cropland that was abandoned or otherwise removed from production during the same period (Lark et al. 2015, p.3). Grasslands were the source for 77% of all new croplands, with 5.7 million acres converted, and a quarter of that land came from longstanding prairie and range-like locations (Lark et al. 2015, p.5).

The authors also analyzed the USGS's long-term land cover trends data and found 11.3% of the land recently converted to cropland had not been cultivated since at least the early 1970s (Lark et al. 2015, p.6). Corn was the primary first crop planted upon conversion to cropland and was the largest indirect contributor to change through its displacement of other crops (Lark et al. 2015, p.6). The greatest amount of conversion to cropland occurred in South Dakota and North Dakota, primarily east of the Missouri River in the Prairie Pothole Region of these states (Lark et al. 2015, p.3). Highly concentrated hotspots of cropland conversion also occurred in southern Iowa, northern Missouri, western Kansas and the panhandles of Oklahoma and Texas (Lark et al. 2015, p.4).

Lark et al. (2020, p.2) expanded upon their prior analysis to assess annual land use change through 2016, again mapping cropland expansion and abandonment throughout the U.S. They found that cropland expansion continued at a rate of over one million acres per year and supplanted high-quality habitat (Lark et al. 2020, p.3). A total of 10.09 million acres of land were converted to crop production throughout the U.S. from 2008 to 2016 (Lark et al. 2020, p.3). As with their previous findings, the hotspots of expansion were concentrated in the Prairie Pothole Region of North and South Dakota, the Dissected Till Plains of Iowa and Missouri, and the High Plains portions of Kansas, Oklahoma, and Texas (Lark et al. 2020, p.3). The greatest rates of cropland abandonment happened outside of the Iowa skipper's range, along the mid-Atlantic coast, Gulf Coast, and Pacific Northwest (Lark et al. 2020, p.3).

Grasslands accounted for 88% of the land converted to crop production and the highest rates of natural landcover lost relative to its remaining area in the western Corn Belt and western Plains (Lark et al. 2020, p.3). Longstanding habitat sites were the source of 2.8 million acres (28%) of new cropland, and 2.3 million acres of that were unimproved grasslands (Lark et al. 2020, p.4). The authors also found disproportionate impacts to wildlife from this habitat conversion, specifically looking at milkweed densities, a key plant for the monarch butterfly, and breeding duck habitat, including a loss of 8.5% of the estimated common milkweed stems across the Midwest and a loss of 2.8% of the area in the Prairie Pothole Region available for duck nesting from 2008 to 2016 (Lark et al. 2020, p.4). Prior to conversion to cropland, milkweed stem densities and available duck nesting opportunities had been higher on the habitat that was converted, compared to habitat that was not converted (Lark et al. 2020, p.4).

Wimberly et al. (2017, pp.162, 167) assessed grassland conversion and other land use decisions, using a mail survey to farm operators in the Prairie Pothole Region of North and South Dakota and found that 40% of respondents had converted at least some grassland to cropland between 2004 and 2014. The majority of those respondents reported that they grew corn and soybeans on the converted grasslands (Wimberly et al. 2017, p.167). The total acreage of converted grassland was equivalent to 5.1% of the surveyed farm acreage, including a substantial amount of native grassland conversion (1% of surveyed farm acreage) (Wimberly et al. 2017, p.169). Conversion of native grassland was highest in the western portion of the PPR in South Dakota, and it appears that lower acreages of Conservation

Reserve Program grassland available to convert to cropland in South Dakota may be shifting conversion pressure to native grasslands (Wimberly et al. 2017, pp.169-170).

Focusing specifically on Minnesota, Lark et al. (2018, p.157) screened about one-third of the estimated remaining native prairie in the state and, through inspection of the sites with aerial photographs, confirmed that 167 hectares of prairie were converted to cropland between 2008 and 2012, or 0.51% of the total prairie investigated. The average annual rate of conversion of prairie to cropland over this time period was 0.13%, which is more than four times higher than the rate of conversion found for the 1993-2008 period (0.03%) (Lark et al. 2018, p.157). The authors noted that the accelerated conversion rate in the more recent time period coincided with increasing prices for cropland and dramatic rises in prices of crops, and that most of the converted land was planted with corn and soybeans (Lark et al. 2018, p.158-59). They note that developed or built-up land may also indirectly pose a significant threat to grasslands and prairies by displacing existing croplands, resulting in an elevated demand for new croplands in other locations (Lark et al. 2018, p.159). Especially concerning was that more than 80% of the prairie to cropland conversion occurred in recently established conservation priority zones (Lark et al. 2018, p.157).

Alemu et al. (2020) analyzed land use change using the USDA Crop Data Layer for the U.S. portion of the Prairie Pothole Region (PPR), which includes large areas of North and South Dakota, Minnesota, and Iowa, and a small portion of northeastern Montana. They found a significant net decrease of the grass/pasture cover type between 2006 and 2018, which accounts for more than a quarter of grass/pasture in the U.S.-PPR (Alemu et al. 2020, p.7). Over same period there was a significant net increase in the cultivation of corn and soybeans, both individually and combined, with net increases of 23.5% of corn and soybean coverage combined (Alemu et al. 2020, p.7). North Dakota and South Dakota were the main hotspots for the increasing corn and soybean cover (Alemu et al. 2020, p.8). When looking just at the North Dakota portion of the PPR, Alemu et al. (2020, p.11) also found a significant decrease in their grass/pasture cover class of approximately 30% between 2008 and 2017. Net corn and soybean coverage significantly increased from 1998 to 2007 (11%) and from 2008 to 2017 (17%) (Alemu et al. 2020, p.11).

In addition to the direct effects of continuing habitat loss on the Iowa skipper, habitat loss also further fragments and isolates remnant native grasslands, which contributes to a disruption of the periodic disturbances or processes that are considered necessary for the persistence of prairies and makes it increasingly difficult for the potential movement of Iowa skippers between local populations.

Habitat Modification/Degradation

Modification and degradation of habitat is also a significant and ongoing threat to the Iowa skipper, especially in light of the Iowa skipper's status as a prairie-specialist species dependent on high-quality prairie habitat. Not only has much of this degradation gone unabated, but it has accelerated in recent decades (Alstad et al. 2016, pp.1-3). Human uses, such as haying and livestock grazing, degrade native prairies and can be harmful to the Iowa skipper. Additionally, prairies have been degraded by the disruption of their natural disturbance regimes, primarily through removal of native grazers and fire suppression (Fowler and Anderson 2015, p.585; Vogel et al, 2010, p.663; Vogel et al. 2007, p.78; Samson et al. 2004, p.8; Schlicht and Orwig 1998, p.83; Swengel 1996, p.77). Remnant prairie sites must be managed to prevent becoming overgrown with the invasion of woody species (succession) and accumulation of plant litter (Minnesota Dept. of Natural Resources 2022; Baltosser 2019; Swengel 1996, p.77, Swengel et al. 2011, p.327).

Attempts to manage native prairie habitats, for restoration or maintenance, have included reintroducing disturbances to mimic historical ecological processes, such as fire and grazing (Minnesota Dept. of Natural Resources 2022; Vogel et al. 2007, p.79).[12] But the management of remnant prairie habitats itself may be contributing to declines of butterflies and the Iowa skipper specifically. In an unfortunate trend, it is clear that protection of the Iowa skipper cannot be presumed on preserves, as butterflies, including Iowa skippers, have been declining and sometimes disappearing from nature preserves (NatureServe 2020; Swengel et al. 2011, p.327, 332; Orwig and Schlicht 1999, p.6). And in some cases, the butterfly declines appear to be more extreme on protected areas than on nearby privately-owned habitat (Orwig and Schlicht 1999, p.6). Orwig and Schlicht (1999, p.6) noted "a growing concern among Midwestern lepidopterists that current management practices, particularly fire management, have accelerated the loss of butterfly species" (Orwig and Schlicht 1999, p.6).

In Iowa, Orwig and Schlicht (1999, pp.4-5) describe how Caylor Prairie was once a well-known site to butterfly enthusiasts for its "rich collection of northern prairie butterflies" and was a highlight of a 1980 survey of western Iowa by lepidopterists from across the country. But this did not last as Dakota skippers were not seen there again except for one individual 1992, and the populations of dusted, Iowa, and ottoe skippers also crashed at this site (Orwig and Schlicht 1999, p.6). Swengel et al. (2011) saw a pattern that with initiation of conservation action in sites across four states, the change in management approach (primarily burning) affected specialist butterflies negatively.

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[12] Pesticides may also be used as a management technique to control invasive plants and slow succession in prairies, but this usage also threatens the Iowa skipper as such spraying may kill or otherwise harm Iowa skippers at any life stage, as well as destroy their habitat (*See* Section IV(E)(1)).

In some cases, sites are being managed with haying, grazing, and fire for the benefit of other species, like plants and cattle, which continues to make it difficult for specialist butterfly species like the Iowa skipper to survive (Schlicht and Orwig 1998, p.85, 87). This has created selection pressures since European settlement with haying and grazing management, and more recently large-scale fire management has impacted the ability of some butterflies to survive (Schlicht and Orwig 1998, p.87).

Fire is considered a particularly important component of disturbance regimes in grassland ecosystems, including tallgrass prairie (Moranz et al. 2012, p.2720; Vogel et al. 2010, p.663). However, the use of fire as a management technique in prairies can be a significant threat to the Iowa skipper, likely dependent on the seasonal timing, size, and frequency of fires, as it can lead to the loss of host plants, removal of nectar sources, and the destruction of larvae (NatureServe 2020; Jones et al. 2019, p.260; Schneider et al. 2018, p.33; Olsen 2018, p.8; U.S. Forest Service 2018b, p.2; South Dakota Department of Game, Fish, and Parks 2014, p.275; Moranz et al. 2012, p.2720; Schlicht et al. 2007, p.61; Orwig and Schlicht 1999, p.6; Swengel 1996, p.79). Frequent use of fire is considered a threat to the Iowa skipper (NatureServe 2020; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Kindscher et al. 2009, p.34). Wildfires or prescribed burns that occur in large blocks may result in extirpation of local populations, as the Iowa skipper does not readily recolonize after habitats are disturbed by fire unless another occupied habitat is nearby (U.S. Forest Service 2018b, p.2). The Iowa skipper's larvae are vulnerable to fire at any season because they live in nests high in the grass and hibernate and pupate there (Minnesota Dept. of Natural Resources 2022; NatureServe 2020; Schlicht 2001, p.197). In listing the Poweshiek skipperling as endangered, the U.S. Fish and Wildlife Service (2014, p.63723) acknowledged that the species is exposed to fires during its larval stages because they overwinter as larvae on the host plants and do not burrow into the soil surface.

It appears that highly specialist butterfly species, including the Iowa skipper, may not respond well to frequent and/or intensive prairie management. Swengel et al. (2011, p.335) noted that "prairie-specialist butterflies have significantly more negative responses than non-specialists to fire, the dominant process used to manage tallgrass prairie preserves." But it appears that prairie specialist butterflies may be compatible with unintensive agricultural land uses, such as infrequent haying and light grazing (Swengel 2013, p.71; Swengel et al. 2011, p.337). Iowa skippers generally appear to be favored by idling, grazing, and haying, and negatively impacted by fire (Schlicht 2001, p.199). While the impacts of idling, grazing, and haying may appear relatively better than fire, their effects are also highly variable and likely depend on intensity, frequency, timing, and other factors (Jones et al. 2019, p.260; South Dakota Dept. of Game, Fish, and Parks 2014, p.275; Moranz et al. 2012, p.2720; Vogel et al. 2007, pp.85-86; Selby 2006, p.2; Swengel and Swengel 1993, p.13). And even with the group of prairie specialist butterflies there are varying effects on different species dependent on life history factors such as larval requirements, or timing of flight periods (Skadsen 2009, p.11). Predictably, severe overgrazing negatively impacts most adult prairie butterflies, but there is likely more variability in responses of different species to less intense levels of grazing (Selby 2006, p.2). As with fire, Iowa skipper larvae are at risk of being destroyed by grazing and fall haying because they live in leaf shelters above ground (Minnesota Dept. of Natural Resources 2022; Skadsen 2009, p.11; Skadsen 2008, p.8).

Swengel (1996) surveyed butterflies in tallgrass prairies and open savannas in Illinois, Iowa, Minnesota, Missouri, North Dakota, and Wisconsin from 1987-95 and found that prairie-specialist butterfly species like the Iowa skipper were present in significantly higher numbers in sites with less frequent and/or less intrusive management. For example, specialists did better with single occasional wildfires than regular burning and mechanical cutting was better than grazing (Swengel 1996, p.82).

In Missouri and the western Upper Midwest, Swengel (1998, p.79) found a lower number of Iowa skippers in the burned category. In Missouri, Swengel (1998, p.79) found higher numbers of Iowa skippers in sites with haying, and grazing and haying; however, in the western Upper Midwest the Iowa skipper was virtually absent in the sample of farm haying.

In surveys in Missouri, Swengel and Swengel (1993, p.13) found the Iowa skipper "appeared averse both to recent haying and fire, but much more so to fire than to haying, since it had higher numbers and recovered more quickly in hay than fire prairies." And in transect surveys at 40 tallgrass prairies in Iowa, Minnesota, and North Dakota over ten years (1988-1997) for five rare prairie skippers, including the Iowa skipper, Swengel and Swengel (1999, p.268) noted that "[Iowa] skipper rates were significantly higher in dry units in large sites with management by idling rather than burning.

In Kansas, Busby et al. (2010, p.79) found mixed effects of fire, finding the largest number of Iowa skippers at a site that was recently burned but had no haying or grazing, whereas they did not observe any in nearby prairie that was not burned, grazed, or hayed. But in hay meadows they did not find Iowa skippers in recently burned hay meadows from 2008-2009 but observed them at three of eleven unburned hay meadows in 2009 (Busby et al. 2010, p.79). They also did not find clear evidence either way as to the effects of haying, but their observations did point to the negative effects of intense grazing on Iowa skipper habitat (Busby et al. 2010, p.79).

While it appears clear that frequent fire is incompatible with the Iowa skipper, longer intervals between fires may allow for some preservation of prairie-specialist butterflies like the Iowa skipper. In Plymouth County, Iowa, Vogel (2010, p.668) reported a positive correlation between total butterfly richness and abundance and between prairie-specialist butterfly richness and abundance and the time since a site was burned. Swengel (1996, p.73) found prairie-specialists, including Iowa skipper, suffered the most negative effects from fire compared to mechanical cutting and grazing, with the effects persisting for approximately five years post-fire. And there is evidence that fire return intervals of two years or less can severely impact butterflies, with units left unburned for 6 to 8 years offering the best habitat for grassland butterflies (NatureServe 2020; Vogel et al. 2010, p.668; Swengel and Swengel 1998).

Because of the important historic role of herbivory by bison and other ungulates on the ecological dynamics of prairies, livestock grazing is often considered as a management tool in an attempt to mimic the historic role of disturbance from these native species (Hanberry et al. 2021, p.222; Samson et al. 2004, p.8). But different species have varying responses to livestock grazing, and these responses also vary depending on factors such as intensity and frequency of grazing (Hanberry et al. 2021, p.222). And livestock are not a clearly equivalent replacement for native herbivores. For example, bison historically moved nomadically in response to vegetation changes associated with rainfall and fire, which allowed for a time lag between periods of bison herbivory at a particular site which may have ranged from one to eight years, providing a natural rest period that is not typical with livestock grazing and leading to a natural habitat mosaic of short, mid, and tall seral stages (Samson et al. 2004, p.8). And cattle also impact prairies differently from bison, as cattle feed more selectively on forbs and bison feed selectively on grasses (Plumb and Dodd 1993, pp.635, 640).

Numerous authors reporting on the Iowa skipper throughout its range identify grazing or overgrazing as one of the threats to the species' survival (U.S. Forest Service 2018a; U.S. Forest Service 2018b, p.2; South Dakota Department of Game, Fish, and Parks 2014, p.275l; Sievert and Prendergast 2011, p.2; Busby et al. 2010, p.79; Schlicht and Orwig 1998, p.83; Orwig 1997, pp.3-4; Samson and Knopf 1994, p.418; Royer and Marrone 1992, pp.15-16). Royer and Marrone (1992, p.16) identified overgrazing as a significant threat to the Iowa skipper in North and South Dakota, and "perhaps the major one." The authors reported that the McLeod North site in Sheyenne National Grassland, one of the few known sites for Iowa skipper in North Dakota, was already severely overgrazed by domestic livestock under lease arrangement with the U.S. Forest Service (Royer and Marrone 1992, p.15). And Busby et al.'s (2010, p.79) research in Kansas points to the negative effects of intense grazing on Iowa skipper habitat. They found narrow-leaved purple coneflower, an important species for adult nectaring, blooming abundantly in burned, ungrazed prairie but across the fence did not observe flowering ramets of this species in recently burned and grazed tallgrass prairie (Busby et al. 2010, pp.79-80)

Pharmaceuticals used to treat cattle may also harm Iowa skippers when cattle grazing occurs in their habitats. Livestock are often treated with parasiticides in order to proect them from parasites like lice, ticks, and blowflies, as well as internal worms (Sánchez-Bayo 2021, pp.8.) For example, Peterson et al. (2019, pp.3,

5) found moxidectin, a parasiticide used with cattle, to be extremely toxic to painted lady butterfly larvae. It induced 100% mortality at the highest exposure concentration in testing, and larvae in all exposure treatments were smaller and many had impaired development, including delayed pupation or complete failure to pupate, depending on the treatment level (Peterson et al. 2019, p.3). The U.S. Fish and Wildlife Service considered ivermectin, another pharmaceutical used to treat parasites in cattle, to be a potential threat to the threatened Dakota skipper and endangered Poweshiek skipperling, and noted that sites with grazing are particularly vulnerable to ivermectin use (USFWS 2014, p.63738).

More research focused specifically on the Iowa skipper is needed to fully assess the impacts of different management techniques on this species, and to understand the proper management of native prairies needed to maintain and recover this species. In the meantime, management suggestions for the Iowa skipper include subdividing sites with units burned in rotations to leave enough larval habitat unburned to assure the population can survive and recolonize the burned areas between burns, which may be difficult, if not impossible, for small sites (Minnesota Dept. of Natural Resources 2022; Baltosser 2019). A similar strategy is recommended for other management techniques such as haying or mowing Iowa skipper habitat[13] (Skadsen 2009, p.11). Swengel et al. (2011, p.337) recommends establishing "permanent non-fire refugia located in core areas for butterfly population and managed with alternative less lethal managements" including rotational haying for Iowa skippers. They also suggest that, because sites are often preserved because they already contain prairie-specialist butterflies, conservation philosophy should change to include the concept of conserving not only sites but also their historic, pre-conservation, management history, which may include a regime of unintensive haying or light grazing that helped to maintain the site's flora and fauna (Swengel et al. 2011, p.337).

B. Overutilization

Overutilization does not appear to be a clear threat to the Iowa skipper. However, given its rarity, the Iowa skipper may be valued by collectors, and because in many places the Iowa skipper lives in small, isolated populations, any amount of collection may be detrimental to their survival.

C. Disease or Predation

Flower spiders (*Misumena* spp.) and ambush bugs (*Phymata* spp.) commonly inhabit the blooms of the Iowa skipper's known nectar sources and may prey on the skipper (Royer and Marrone 1992, p.14). Royer and Marrone (1992, p.14) reported that no diseases or parasites specific to the Iowa skipper are known. It does not

[13] Skadsen (2009, p.11) found that fall haying may be beneficial to a butterfly species like the federally threatened Dakota skipper, but harmful to other prairie butterflies like the Iowa skipper, hence the need to find a balanced management strategy.

appear that disease and predation are current threats to the species' survival, but the species is highly susceptible to disease given their small populations.

D. Inadequacy of Existing Regulatory Mechanisms

There are no existing regulatory mechanisms that adequately protect the Iowa skipper. Although the species has federal and state special status designations in parts of its range, none of these provide for the long-term protection and recovery of the Iowa skipper, because while some of these designations require consideration of impacts to the Iowa skipper, they do not require that harm to the skipper be avoided. They also do not provide funding or other commitments to recover the Iowa skipper.

In addition, the Fish and Wildlife Service cannot rely on voluntary measures to deny listing of species. Voluntary and unenforceable conservation efforts are per se insufficient as "regulatory mechanisms" under 16 U.S.C. 1533(a)(1)(d):

> [T]he Secretary may not rely on plans for future actions to reduce threats and protect a species as a basis for deciding that listing is not currently warranted . . . . For the same reason that the Secretary may not rely on future actions, he should not be able to rely on unenforceable efforts. Absent some method of enforcing compliance, protection of a species can never be assured. Voluntary actions, like those planned in the future, are necessarily speculative . . . . Therefore, voluntary or future conservation efforts by a state should be given no weight in the listing decision (*Oregon Natural Resources Council v. Daley*, 6 F. Supp.2d 1139, 1154-155 (D. Or. 1998).

The Iowa skipper is a classified as a Forest Service Sensitive Species in the U.S. Forest Service's Region 1, specifically in North Dakota where it is known to occur in Dakota Prairie Grasslands (U.S. Forest Service 2011, p.4). It was also added to the list of Forest Service Sensitive Species in Region 2 in 2018, after sources from the 15 years prior showed that Iowa skipper habitat and populations continued to decline in the region and across its range (U.S. Forest Service 2018a). The listing covers all states within the Forest Service's Region 2, which includes Colorado, Kansas, Nebraska, South Dakota, and Wyoming (U.S. Forest Service 2018). But these designations provide little protection for the Iowa skipper on Forest Service lands in these states because they only require the Forest Service to consider impacts to sensitive species and do not prevent the agency from taking actions that would harm the Iowa skipper.

The Iowa skipper is listed as a species of special concern in Minnesota (Minnesota Admin. Rules 6134.0200(8)(C)(1)). However, Minnesota's protections only apply to species designated as threatened and endangered: "species of special concern are not protected by Minnesota Statutes, section 84.0895 or rules adopted under that section" (Minnesota Admin. Rules 6134.0150), so the listing does not provide any protection in fact. However, "[i]nformation about known occurrences is taken into account as part of the state environmental review process to help avoid negative impacts" (Minnesota Dept. of Natural Resources 2022).

The Iowa skipper is also listed as a special concern species in Iowa, but "no special protection is afforded under this rule" (Iowa Admin. Code 571-77.2(3); Iowa Admin. Code 571-77.1(481B)). Similarly, the Iowa skipper's designation as a species of concern in Montana does not provide any protections for the species as "[d]esignation as a Montana Animal Species of Concern or Potential Animal Species of Concern is not a statutory or regulatory classification" (Montana Natural Heritage Program 2021, p.1).

And these state special status designations do not appear so far to have helped the plight of the Iowa skipper. For example, the Iowa skipper was designated a species of special concern in Minnesota in 1996, but since that time the species has only further declined, and it has not been seen in the state since 2008.

As discussed above, nine states within the Iowa skipper's range list it as a Species of Greatest Conservation Need. While potentially focusing some attention and funding towards research and management for this species, this designation does not in and of itself provide any protections for the Iowa skipper or guarantee any work will be done to preserve or recover the species, as this designation does not provide a regulatory status for the species.

Although many of the remaining populations of Iowa skippers occur on county, state, or Nature Conservancy lands, this is no guarantee of preservation or recovery of these species at these sites. As discussed above, these sites are not necessarily managed in a way that preserves the Iowa skipper and declines and/or disappearances of populations of Iowa skipper have been documented on these "protected" lands.

The federal Conservation Reserve Program (CRP) protects some grassland habitat but does not provide any protections for the Iowa skipper and its native prairie habitat because CRP only provides payments for land that has been taken out of agricultural production (Wimberly et al. 2017, p.172).

The Iowa skipper may derive some protection in areas where its range overlaps with that of the Dakota skipper, which is listed as threatened under the Endangered Species Act and uses similar habitats to the Iowa skipper. However, this overlap only occurs in a portion of the Iowa skipper's range in Minnesota, North Dakota, and South Dakota. And it is also unclear if the ideal prairie management techniques for Dakota skippers are equally applicable to the long-term preservation and recovery of Iowa skippers. Vogel et al. (2007, pp.79, 86) studied the effects of restoration on butterfly communities in Iowa and found that butterfly species have a diversity of responses to different restoration practices, so they could not recommend a single type of management that would benefit all species or even one that would benefit all habitat-specialist butterfly species. And Skadsen (2009, p.11) found that fall haying may be beneficial to a butterfly species like the federally threatened Dakota skipper, but harmful to other prairie butterflies like the Iowa skipper, thus efforts focused solely on recovering the Dakota skipper may in fact be harmful to the Iowa skipper's survival.

E. Other Natural or Manmade Factors

1. Pesticides

As discussed above, the extent and intensity of agricultural land-use has drastically increased in the last century. Modern industrial agriculture is associated with high inputs of pesticides to increase overall yield of crops and protect agricultural production from pests. Relentless anthropogenic inputs of agrochemicals have unavoidable side effects like decreased crop diversity, loss of soil fertility, habitat destruction and loss of species.

Along with habitat loss and degradation, discussed above, pesticides are a major driver of the past and ongoing declines of the Iowa skipper. The Iowa skipper persisted in low numbers, but above today's near-extinction levels, long after the vast majority of prairie had been converted to farmland, a process largely completed in Iowa by 1900 (Smith 1981, p.7). As late as 1967, for instance, Royer and Marrone (1992, p.2) reported that the Iowa skipper was "locally common in the southern part of the Black Hills," with similar reports from other states such as Minnesota (*See* Section III(F)). In fact, all known tallgrass prairie butterflies survived on many prairie remnants up through the mid-20th century (Schlicht 2001, p.197). The advent and rapid growth of intensive pesticide use after World War II is a major factor in bringing the Iowa skipper and other prairie-specialist butterflies even closer to the brink of extinction.

About one billion pounds of pesticides are used in the U.S. each year, accounting for about one-fifth of the pesticide use worldwide (Atwood and Jones 2017, pp.9-10). The agricultural sector accounts for approximately 90 percent of the pesticide use in the U.S. (Atwood and Paisley-Jones 2017, p.11). Herbicides constitute the majority of pesticide use in the U.S. agricultural sector, accounting for 62% of pesticides applied in 2012 (based on pounds of active ingredient), followed by fumigants, fungicides, and insecticides (Atwood and Paisley-Jones 2017, pp.11-12). Intensive farming practices, dominated by pesticide use, in areas which served as valuable habitat for insect species have further pushed species towards rapid decline. Indiscriminate and relentless use of pesticides puts non-target organisms at significant risk.

Although pesticides are generally intended as a tool to control pests, diseases, and weeds in agricultural systems, they can also have toxic impacts to non-target insects and other organisms, which may include direct mortality or a variety of sublethal effects (Serrão et al. 2022, p.2; Tooker and Pearsons 2021, p.50; Sánchez-Bayo 2021, p.1; Niemuth et al. 2021, p.2). Sublethal effects are any effects to individuals that survive pesticide exposure, and can affect a wide range of a non-target insect's physiology, including nervous, muscular, integumentary, respiratory, digestive, excretory, reproductive, circulatory, and exocrine systems (Serräo et al. 2022, p.2). They can also alter behavior, mobility, feeding, orientation, feeding, and reproduction, all of which can change an insect population's dynamics (Serräo et al. 2022, p.2). Pesticides impact pollinator behavior, such as hypo- or hyper-activity, and involuntary movements or tremors that impede walking, flying, and feeding (Serräo et al. 2022, p.4). Pesticides affect immunity for insects through various mechanisms, with most evidence coming from insecticides, and can also impair grooming behaviors which make insects more susceptible to disease (Sánchez-Bayo 2021, pp.7-8; James and Xu 2012). Even low levels of pesticides make bees less immune to biological infection and parasites (Serräo et al. 2022, pp.3-4; Sánchez-Bayo 2021, pp.7-8).

In addition, pesticides can indirectly harm non-target organisms through impacts to habitats and to ecological interactions (Sargent et al. 2023, 3p.1; Tooker and Pearsons 2021, pp.50-53; Sánchez-Bayo 2021; Uhl and Brühl 2019, p.2361). These pesticide impacts are particularly problematic for species like the Iowa skipper, whose habitat is often intermingled with agricultural lands (Niemuth et al. 2021, p.2).

Current pesticide regulations in the U.S. are not sufficiently protective of non-target organisms and broader ecological interactions, in part because the science required to discover many of the negative impacts of pesticides takes significantly longer than what is mandated under current regulations (Sargent et al. 2023, p.1). For example, when the herbicide glyphosate was introduced, it was thought to be harmless to non-plant organisms because of its mode of action, but now it is known to harm other organisms, such as by impeding animal gut microbial growth (Sargent et al. 2023, pp.1-2).

Agricultural intensification and the associated application of toxic pesticides are major drivers of butterfly declines. An estimated 70% of butterfly species (comprising Papilionidae and Hesperiidae families) occur in or adjacent to arable land, exposing them to enormous quantities of the myriad toxic pesticides applied in agriculture (Mulé et al. 2017, p.2). Pesticide exposure of flower-visiting insects at environmentally realistic levels can cause relevant population-level adverse effects (Uhl and Brühl 2019, p.2355).

Butterfly communities have less diversity and richness in habitats surrounded by or occurring within agricultural fields that are sprayed with pesticides (Habel et al. 2019, p.5). Chemical pollution, including pesticides, is considered to be one of the main drivers of butterfly declines in Europe (Warren et al. 2021, p.4). Brittain et al. (2010, p.113) found fewer butterflies and bumblebees in intensively managed systems with high pesticide application rates as compared to less intensively managed systems that had fewer pesticide applications, when looking at the regional scale. At the field scale, they found negative impacts to wild bee species richness did not show up until after two or three pesticide applications (Brittain et al. 2010, p.111). Braak et al. (2018, pp.8-11) reviewed eight studies looking at butterfly responses across a range of spatial and temporal scales and found all reported a similar trend of increased pesticide levels leading to reductions in butterfly abundance or species richness.

While there are no specific studies directly examining the effects of pesticides on Iowa skippers, we can look to studies of other insects and butterflies to assess the potential risks posed. There is also little research available on the effects of pesticides on butterflies specifically, despite the likely risks (Warren et al. 2021, p.4; Braak et al. 2018, p.3; Mulé et al. 2017, p.91; Gilburn et al. 2015, p.2). Thus, this petition also includes some information regarding effects of pesticides on other insect species that can be extrapolated to assess the risks to Iowa skippers. Most research on the effects of pesticides on non-target insects has focused on the European honeybee (Braak et al. 2018, p.4; Pisa et al. 2015, p.68). In the Environmental Protection Agency's (EPA) review of new pesticides or registration review of already registered pesticides, the agency uses testing on honeybees as a surrogate for all terrestrial invertebrates, thus honeybees are a common focus of pesticide research in the U.S.

Butterfly populations, both larvae and adults, are at risk of direct and indirect exposure to single and multiple pesticide applications (Hoang et al. 2011, pp.997–1005). Butterflies are exposed to pesticides through the nectar they ingest and through direct contact or from contaminated non-crop plants and habitats, including pollen, contact with leaves or flowers, and soil (Serräo et al. 2022, p.3; Main et al. 2020, p.7; Gilburn et al. 2015, p.2). Like the threatened Dakota skipper, the Iowa skipper may be impacted "directly by pesticides by foliar application, and indirectly by exposure to contaminated seed, plant tissue, and soil; as well as consuming contaminated plant tissue" (USFWS 2018).

Given the susceptibility of butterflies in all their life stages to pesticides presently in use, pesticides are considered a major factor in the population declines and fluctuations of butterflies. Pesticides can have lethal and sublethal direct effects on pollinators, as well as indirect effects such as through removal of habitat and ecosystem disruption (Serräo et al. 2022, pp.2-4; Sargent et al. 2023, p.1; Niemuth et al. 2021, p.2; Tooker and Pearsons 2021, p.50; Uhl and Brühl 2019, p.2361; Mulé et al. 2017, p.2; Longley and Sotherton 1997, pp.2-3). Butterfly populations can suffer severe impacts even with low sublethal doses of pesticides (Pisa et al. 2015, p.78). Sublethal effects of pesticides can severely impact butterfly fitness and population recruitment, thus impacting population size (Braak et al. 2018, p.27).

Although most studies focus on the toxicity and risks caused by exposure to a single pesticide, in reality butterflies and other non-target organisms are likely to be exposed to multiple pesticides, which can have additive or synergistic effects (Sánchez-Bayo 2021, pp.14-15; Main et al. 2020, p.7; Peterson et al. 2019, p.2; Mulé et al. 2017, p.2). While the Environmental Protection Agency's (EPA) regulatory review of pesticides and the bulk of the research focuses on individual active ingredients in pesticide products, these products also contain "inert ingredients," which include things like solvents, emulsifiers, surfactants, spray adjuvants, clay, and propellants, that are included for reasons other the pesticidal activity (Atwood and Paisley-Jones 2017, p.22). EPA does not register surfactants or spray adjuvants even though some of them have widespread use and hundreds of pounds may be used yearly, thus the full extent of the negative impacts of pesticide spraying on non-target organisms is difficult to discern (Mullin et al. 2016, pp.5-6). Butterflies and other non-target organisms may be harmed by these "inert ingredients," either on their own, or through additive or synergistic effects in combination with other ingredients, pesticides, and/or environmental factors, but there a large knowledge gaps about these effects (Zaller and Brühl 2019, p.6; Berger et al. 2018, p.2; USFWS 2018, p.46; Stark et al. 2012, p.27). In some cases, the surfactants in pesticide products may be even more toxic than the active ingredient itself (Van Hoesel et al. 2017, pp.8-9). Stark et al. (2012, p.27) posited that impacts they observed in an evaluation of three herbicides on pupal development of the Behr's metalmark butterfly were not due to the active ingredients alone but instead may have been due to an inert ingredient or combination of inert ingredients in the product formulations.

While neonicotinoids, discussed further below, have received a lot of attention in recent years for their association with honeybee declines and effects on wild pollinators and because they are the most widely used insecticides in the world, there are a number of other pesticides that wild pollinators are exposed to in agricultural areas (Main et al. 2020, p.2). Main et al. (2020, pp.2, 6-7) analyzed tissues from wild bees and butterflies collected on conservation areas adjacent to agricultural fields in Missouri and found that wild pollinators are exposed to, and are potentially bioaccumulating, a wide variety of pesticides, including insecticides, fungicides, and herbicides. The authors hypothesized that wild pollinators collected on Conservation Areas would be buffered against most pesticides, but instead they found that they may be exposed to a wide variety of pesticides (Main et al. 2020, p.6). When looking specifically at butterfly, moth, and caterpillar samples, Main et al. (2020, p.5) found pesticides in the majority of samples (56%), with herbicides in 35%, insecticides in 30%, and fungicides in 17% of samples. Samples contained as many as five pesticides (Main et al. 2020, p.5). Metolachlor, an herbicide, was the most frequently detected pesticide (Main et al. 2020, p.5). The greatest number of detected pesticides and highest concentrations were found in adult butterfly and moth tissues when compared to caterpillars (Main et al. 2020, p.5). This study provided evidence of pesticide exposure to wild pollinators at concentrations that may result in sublethal effects or cause chronic impacts through accumulation (Main et al. 2020, p.6).

In a country-wide field study in Germany, Brühl et al. (2021, p.2) measured pesticide residues in flying insects collected from 21 nature conservation areas embedded in agricultural landscapes, where declines in insect biomass had been observed. They detected 47 common agricultural pesticides: 13 herbicides, 28 fungicides and 6 insecticides (Brühl et al. 2021, p.2). Insects on average were contaminated with 16.7 pesticides (Brühl et al. 2021, p.2). Brühl et al. (2021, pp.5-6) conducted an analysis to look for correlations with landscape variables at different scales and found the only significant variable impacting the number of pesticide residues was the proportion of agricultural production area within a 2000-meter vicinity of the insect sampling location, as a higher proportion of agricultural land was related to a higher number of residues measured.

In a study to test the toxicity of agrichemicals used in row crops and in cattle feed yards to Painted Lady butterflies, Peterson et al. (2019, pp.5-6) examined the species' larvae and found that the pesticides pyraclostrobin (fungicide), clothianidin (insecticide), and permethrin (insecticide) all delayed development.

Pollinators can be exposed to pesticides through several different mechanisms, including through drift from adjacent crop fields and direct foraging in adjacent crop fields (Niemuth et al. 2021, p.7; Braak et al. 2018, p.16; Longley and Sotherton 1997, p.4). Spray drift is considered one of the main sources of exposure of non-target butterflies to pesticides (Braak et al. 2018, p.16). Exposure can be especially significant for non-target species with aerial spraying (Longley and Sotherton 1997, p.4). Routes of exposure may differ depending on pollinator life history and include interactions with soil, floral resources (e.g., pollen, flowers) or contact with leafy material (Kopit and Pitts-Singer 2018, pp.499–510). Butterfly families face variable risks of exposure to pesticides, with the extent of exposure dependent on factors like morphological features, mobility, behavioral and distributional features of the organism, and pesticides' persistence and availability to susceptible life stages of the organisms (Longley and Sotherton 1997, pp.5-6).

Exposure to insecticide spray drift in habitat downwind of row crop fields is expected to occur up to 300 meters from those fields; however, drift distances of pesticides vary widely, with reports ranging from 1 m to 2000 m (Hall et al. 2021, p.139; Goebel et al. 2022, pp.2). Goebel et al. (2022, p.5) detected chlorpyrifos at all distances from the field edge (up to 400 m) in prairies adjacent to soybean fields. Studies in Minnesota prairies show that pesticides regularly drift from agricultural fields to nearby natural areas, including sites where the Iowa skipper has been observed (Goebel et al. 2022; Runquist et al. 2021, pp.27-28; Runquist et al. 2020, p.28; Runquist et al. 2018, p.21). Because the amounts and types of pesticides detected can vary from year to year (or even within a season) it is important to have repeated sampling in order to fully assess the pesticide exposures in a particular natural area (Runquist et al. 2021, pp.27-28; Runquist et al. 2020, p.28; Runquist et al. 2018, p.21).

Because Iowa skippers often live in native prairie habitat fragments that are adjacent to, and sometimes surrounded by, agricultural fields, they and their habitats may be harmed by pesticide drift from those fields, especially from pesticides applied via aerial spraying (Pisa et al. 2015, p.77). Pisa et al. (2015, p.77) summarized studies that reported losses or declines of butterfly populations living in habitat adjacent to intensively sprayed agricultural fields, likely caused by pesticide drift.

And since Iowa skipper larvae nest and hibernate high in the grass for the vast majority of the year, and do not burrow in the soil, they are at high risk of exposure to pesticides drifting from nearby fields (*See* Section II(B) above). The U.S. Fish and Wildlife Service (2014, p.63723) noted in listing the Poweshiek skipperling as endangered that this species is likely more vulnerable to pesticides because they do not burrow into the soil surface during their larval stages, in contrast to other butterflies like the Dakota skipper. In a study of tallgrass prairie wildlife exposure to spray drift from commonly used soybean insecticides in the Midwestern US, Goebel et al. (2022, pp.5-6) found higher levels of target insecticides in passive samplers placed at mid-canopy compared to ground level, regardless of distance from field edge. Iowa skippers are often found in native prairie remnants with nearby agricultural fields and are not very mobile, thus pesticide drift from those fields is a likely major source of exposure for this species, as well as pesticides used in the prairie remnants to control non-native plants and broad scale aerial spraying for pests like mosquitos and grasshoppers. Iowa skippers are most likely to be exposed in the larval stage since it lasts most of the year, as larvae overwinter and complete development the following spring (*See* Section II(B) above).

And pesticides are recognized as past and continuing threats to the Iowa skipper and its habitat (Royer and Marrone 1992, p.15; USFS 2018b, p.2; Colorado Parks and Wildlife 2015, Appendix B, p.B-7; Olsen 2018, p.8; South Dakota Department of Game, Fish, and Parks 2014, p.275; Schlicht and Orwig 1998, p.82; Backlund 2009, p.12). In a review of the status of the Iowa skipper in North and South Dakota, Royer and Marrone (1992, p.15) identified herbicides and insecticides as a threat to large areas of remaining Iowa skipper habitat in these two states. The primary use of those pesticides was to control leafy spurge, Canada thistle, and grasshoppers, and at one site in North Dakota helicopter spraying of pesticides to control leafy spurge resulted in a loss of broadleaf prairie plants, including favored nectar sources of the Iowa skipper (Royer and Marrone 1992, p.15).

a) Herbicides

The vast majority of herbicides are used in agricultural landscapes, which often surround Iowa skipper habitat, and thus are likely to impact Iowa skippers through drift from those adjacent fields. However, herbicides may also be used as a habitat management tool for invasive plant control within natural areas (Russell and Schultz 2009, p.53). Herbicides can persist in the environment for long periods, with half-lives usually exceeding a month but for some lasting over a year (Sánchez-Bayo 2021, p.3).

While the intent of herbicides may be to target particular plant species, they can also kill or otherwise harm non-target plants, such as by impairing the nutrient quality of these plants, which may indirectly affect butterflies by impacting the growth and development of feeding larvae (Russell and Schultz 2009, pp.54, 60-61). When herbicides kill plants in the native habitat of an insect like the Iowa skipper, they impact their survival and reproduction by removing important nectaring sources, host plants for larvae, shelter, and overwintering sites (Sánchez-Bayo 2021, p.3). And herbicides can also have direct lethal effects of non-target insects, as well as sublethal effects, such as altered fecundity and hormone production and reduced pupal weight (Russell and Schultz 2009, pp.54, 57-61). For example, the herbicide glyphosate can impair the growth of important resident microbes in the hindgut of bumblebees and other animals, and interfere with bumblebee thermoregulatory function, impacting colony size and queen production (Sargent et al. 2023, p.2).

Herbicide use has increased greatly since the advent of genetically engineered crops that are engineered to be resistant to certain herbicides (i.e., glyphosate, dicamba, 2,4-D) in the 1990s, with an estimated increase in herbicide use of 527 million pounds between 1996 to 2011 (Benbrook 2012, p.3). Most of this increase is attributable to glyphosate-resistant crops, with a nine-fold increase in agricultural use of glyphosate from 1995 to 2014 (Figure 12; Benbrook 2016, p.5 Table 1; Benbrook 2012, p.3). EPA (2017a, p.12 Table 3.2) reported a 34% increase of overall herbicide use on U.S. farms from 2005 to 2012.

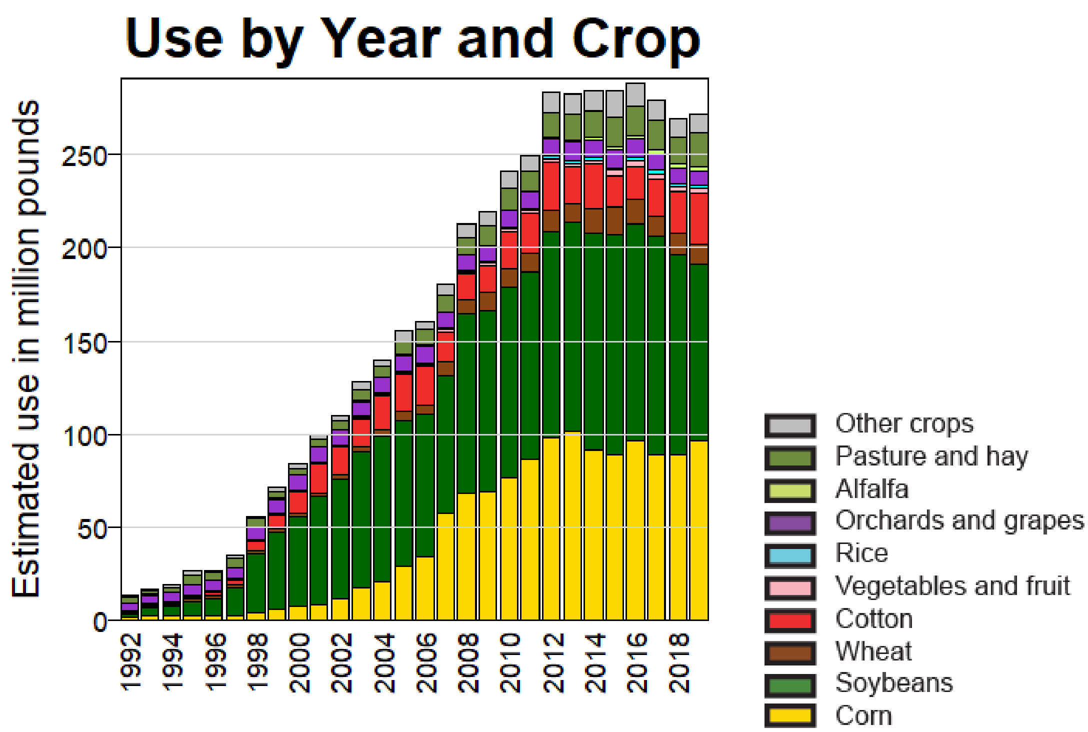

Figure 12. Estimated glyphosate use by year and crop for 1992-2019 (U.S. Geological Survey 2019a).

The widespread adoption of genetically engineered herbicide resistant (HR) crops has led not only to an overall increase in the quantity of herbicides sprayed, but also a change in the timing of herbicide applications. Before this technology, herbicides were primarily sprayed on fields early in the season, prior to crop plant emergence, in order to avoid harm to the crop plants themselves; but because the HR crops are protected from this herbicide damage, spraying can occur throughout the growing season. The use of herbicides post crop emergence has led to more herbicide drift harming non-target species than the early season herbicide use that occurred before this technology was available. Glyphosate, dicamba and 2,4-D, which are now mainly used post-emergence on HR crops, are the three herbicides responsible for more drift damage than any others (Association of American Pesticide Control Officials (AAPCO) 1999, pp.11-19; AAPCO 2005, p.4). All three are used extensively throughout the Iowa skipper's range (Figures 13-15) and thus are likely to cause damage to the Iowa skipper's habitat, threatening its ability to sustain populations of this species.

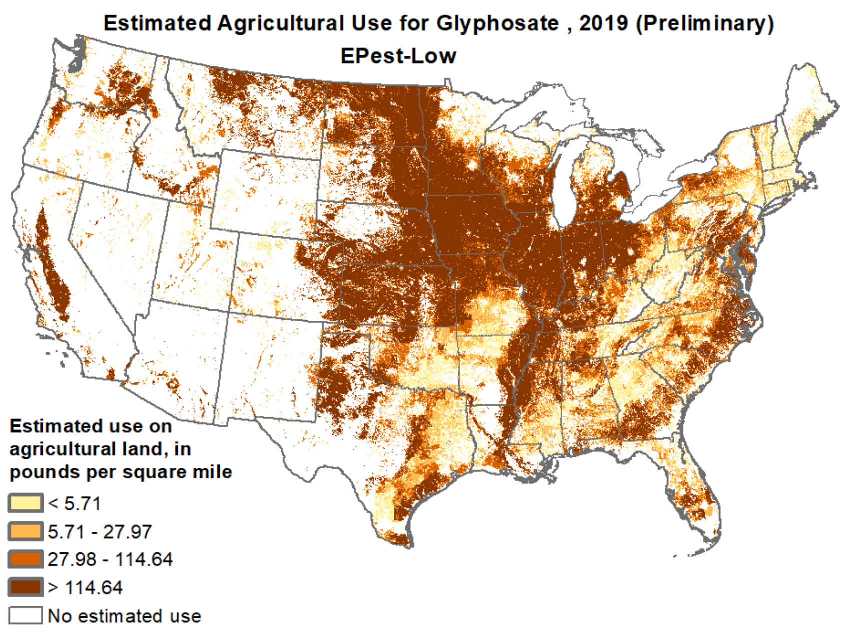

Figure 13. Estimated glyphosate use on agricultural land in 2019 (U.S. Geological Survey 2019a).

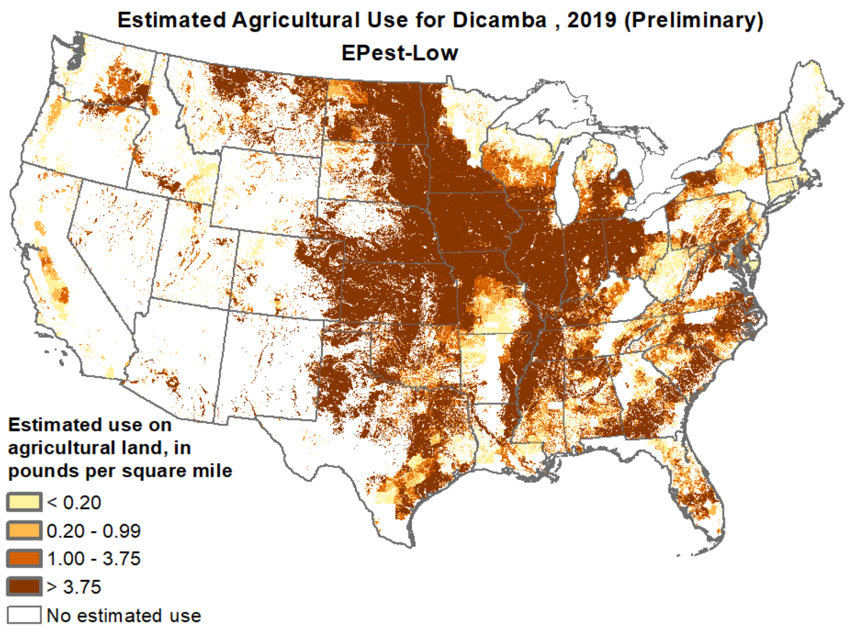

Figure 14. Estimated dicamba use on agricultural land in 2019 (U.S. Geological Survey 2019b).

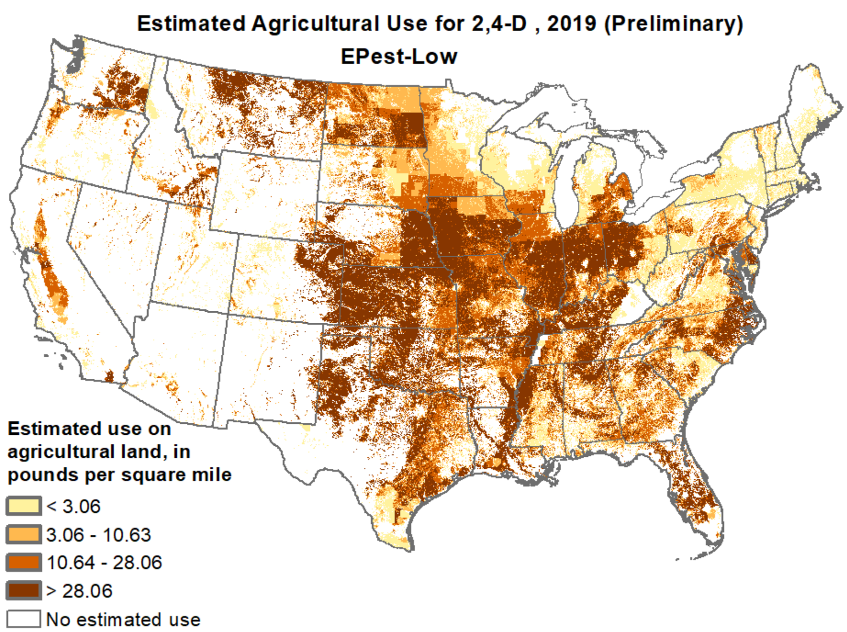

Figure 15. Estimated 2,4-D use on agricultural land in 2019 (U.S. Geological Survey 2019c).

The newer HR crops allow for resistance to multiple broad-spectrum herbicides, including HR soybeans and cotton that confer resistance to three herbicides (Vulchi et al. 2022, pp.5-6), and approvals are being sought for at least one HR corn variety that would be resistant to five herbicides, including dicamba

(85 Fed. Reg. 37254 (May 8, 2020)). This development is likely to result in further use of herbicides and their resulting impacts on non-target species like the Iowa skipper.

The increase in post-emergence use of herbicides on HR crops reduces floral and other plant resources for butterflies. It is well-established, across a range of herbicides and plants, that drift-level doses of herbicides reduce flowering, delay flowering, reduce seed production, and/or otherwise adversely affect flowering plants (Boutin et al. 2014, pp.87-88; Carpenter et al. 2020, pp.1247, 1253). Carpenter et al. (2020, pp.1245, 1253-54) tested the impacts on flowering on five different herbicides at realistic drift-level doses on nine wild plant species and found all tested herbicides negatively impacted total flower production of at least one species. All nine wild plant species were impacted by at least one herbicide, with glyphosate having the most adverse effects on the total number of flowers produced (Carpenter et al. 2020, p.1253). Strandberg et al. (2021, p.9) showed drift-level doses of glyphosate reduce the cumulative number of flowers produced by red clover (*Trifolium pratense*) and birdsfoot trefoil (*Lotus corniculatus*). Similarly, drift-level doses of glyphosate reduced floral density and substantially delayed flowering of tansy (*Tanacetum vulgare*), and co-exposure to nitrogen fertilizer further exacerbated the delay in flowering (Dupont et al. 2018).

When herbicides cause reductions in floral diversity, butterfly and bee populations are indirectly harmed through the decrease in their available resources (Sánchez-Bayo 2021, p.5). Herbicide use has been linked to butterfly declines in the UK, and to monarch declines in the US through a massive decline in their milkweed host plant that corresponded with the increased spraying of the herbicide glyphosate along with planting glyphosate-tolerant corn and soybeans (Sánchez-Bayo 2021, p.5). The herbicide dicamba has also caused a reduction in biomass of thistles, which in turn affected larvae of painted lady butterflies, which grew smaller as they were forced to feed on young plants (Sánchez-Bayo 2021, p.5).

Glyphosate has been implicated in the near-eradication of milkweed, a major factor in the quarter-century decline in the eastern monarch butterfly population and exemplifies the threat herbicides can pose to insects via impacts on their host plants (USFWS 2020, pp.36-37, 106-107; Sánchez-Bayo 2021, p.5). Glyphosate is a broad-spectrum herbicide that kills broadleaf and grass family plants alike. Just 62 grams/ha (equivalent to 0.055 lbs/acre) of glyphosate is sufficient to reduce aboveground biomass of big bluestem, the main or preferred larval host for the Iowa skipper, by 25% (Boutin et al. 2012, p.85 Table 2). This amount of glyphosate could easily drift into prairie habitat hundreds of feet beyond a treated agricultural field, as it represents just 1/10th to 1/20th of typical agricultural application rate. Intensive use of glyphosate occurs throughout much of the Iowa skipper's range (Figure 13).

Dicamba is an extremely potent, highly volatile herbicide that has a propensity to drift long distances, sometimes for miles (EPA 2021a, p.21). Since the widespread introduction of dicamba-resistant soybeans and cotton in 2017, dicamba has drifted rampantly each year to cause widespread damage to non-resistant soybeans, fruits, vegetables, trees and natural areas throughout the Midwest, Mid-South and Plains states (EPA 2021a, pp.16-28). By 2021, dicamba-resistant soybeans comprised two-thirds, and dicamba-resistant cotton three-fourths, of total acres planted to the respective crops in the U.S. (EPA 2021a, p.4), leading to an enormous increase in dicamba use in recent years (Figure 16). With this high level of dicamba use, there have been unprecedented reports of crop damage, including tens of thousands of episodes affecting millions of acres (EPA 2020, pp.29-32).

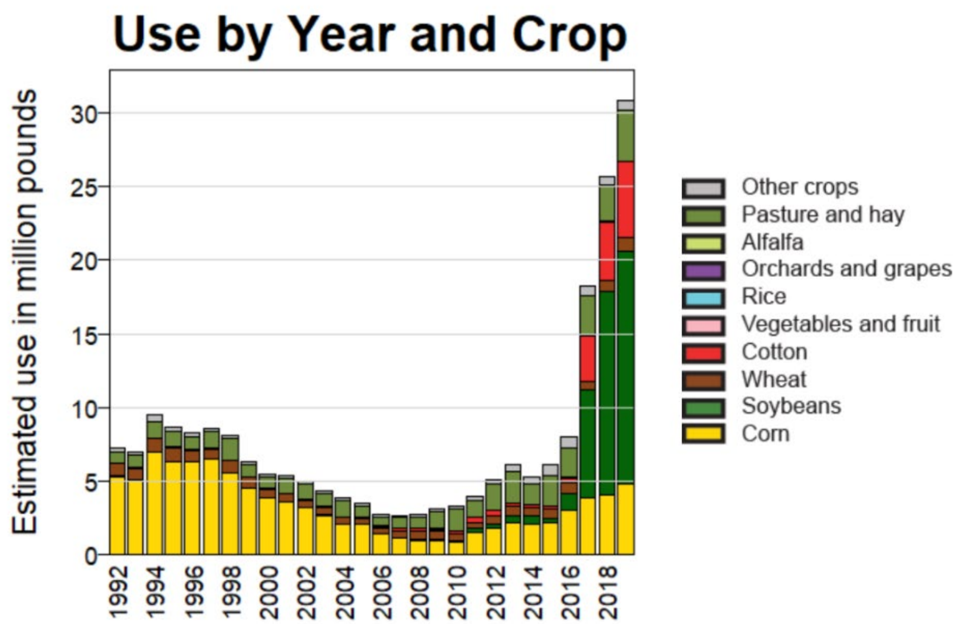

Figure 16. Estimated dicamba use by year and crop for 1992-2019 (U.S. Geological Survey 2019b).

The unprecedented crop damage caused by dicamba–tens of thousands of episodes affecting millions of acres–cannot fail to also cause serious harm to non-crop plants in natural areas, particularly given dicamba's propensity to volatilize and drift, sometimes for miles (EPA 2021a, pp.21, 29-32). This drift and harm are likely in much of the Iowa skipper's habitat, given the skipper is often restricted to small prairie remnants within an agricultural landscape, and the overlap between many of the areas of the most intense dicamba use and the Iowa skipper's range (Figure 14).

Controlled field experiments involving alfalfa and common bonoset demonstrate that drift-level doses of dicamba (about 1% of the application rate) delay the onset of flowering and reduce the number of flowers produced; moreover, affected plants were less often visited by pollinators (Bohnenblust et al. 2016, p.144). And pollinators visited these dicamba-affected plants less often (Bohnenblust et al. 2016, p.144). Bohnenblust et al. (2013, p.587) applied sublethal, drift-level applications of dicamba to three plant species and measured the growth and survival of larvae of two butterfly species. They found significant negative indirect effects on painted lady butterfly (*Vanessa cardui*) larvae, specifically on larval and pupal mass (Bohnenblust et al. 2013, p.590).

And real-world experience shows that dicamba drift threatens tens of millions of acres of wild and ornamental plants, putting at risk the pollinators and other insects that depend on them (Knuffman et al. 2020). In areas hard-hit by dicamba drift, including states from Arkansas to the Dakotas, beekeepers attributed steep declines in honey production to dicamba's adverse effects on the flowering plants that are essential to honeybees (Bennett 2017, Gross 2019).

Russell and Schultz (2009, pp.57-59) examined the effects of two herbicides (fluazifop-p-butyl, sethoxydim) on two species of butterflies (*Icaricia icarioides blackmorei*, *Pieris rapae*) and found reductions in survival (21-32%), as well as reductions in wing size and pupal weights, for *P. rapae*. Low pupal weights correlate with low survivorship, reduced fecundity, and reproductive success (Russell and Schultz 2009, p.60). They also found impacts to development time in *I. icarioides blackmorei* (Russell and Schultz 2009, p.58).

Stark et al. (2012) examined impacts of three herbicides on the Behr's metalmark butterfly, used as a proxy for the federally endangered Lange's metalmark butterfly. They exposed first instars of Behr's metalmark butterfly to recommended field rates of triclopyr, sethoxydim, and imazapyr, and found that all three herbicides reduced the number of adults that emerged from pupation by 24 to 36 percent (Stark et al. 2012, p.26). Because the active ingredients in the three herbicides evaluated have different modes of action, Stark et al. (2012, p.27) hypothesized that the observed impacts on pupal development may have been linked to inert ingredients or to indirect effects on the food plant quality.

As mentioned above, Royer and Marrone (1992, p.15) identified the use of herbicides, primarily to control leafy spurge and Canada thistle, as threats to large areas of remaining Iowa skipper habitat in North and South Dakota. And at one site in North Dakota, they found that efforts to control leafy spurge by helicopter spraying reduced broadleaf prairie plants, including the skipper's favored nectar sources (Royer and Marrone 1992, p.15). The disappearance of federally threatened Dakota skippers in North Dakota appears to be correlated with the use of chemical weed control methods (USFWS 2014, p.63737). The major herbicides used to control leafy spurge include picloram, 2,4-D, dicamba, and glyphosate (Lym 1998, pp.368-369). Picloram and 2,4-D, those most frequently use for leafy spurge control in North Dakota (Lym 1998, p.371), are broadleaf herbicides that specialize in killing flowering plants, with picloram having substantial persistence and hence residual activity.

The U.S. Forest Service also identified herbicide use as a threat to the Iowa skipper's larval host plants and nectar sources in the Forest Service's Region 2, which covers five states in the skipper's range: Colorado, Kansas, Nebraska, South

Dakota, and Wyoming (U.S. Forest Service 2018b, p.2). And as of the late 1990s, herbicide use on private lands for weed and brush control was regarded as the most significant threat to skipper species at the Hole-in-the-Mountain complex in Minnesota, a site that was at least historically home to the Iowa skipper, as well as the threatened Dakota skipper and endangered Poweshiek skipperling (Dana 1997, p.5; USFWS 2014, p.63737). The Iowa skipper was last reported at the Hole-in-the-Mountain Prairie Preserve in 1992 (*See* Table 8).

b) Insecticides

Insecticides are likely the most concerning types of pesticides for wild bees and butterflies, based on past studies of toxicity (Main et al. 2020, p.6-7). Insecticides are the most obvious direct threats to Iowa skippers and other insects, as they are intended to harm insects such as through interference of the nervous system. Because many lepidoptera species, primarily moths but also some butterfly species, are considered pests that are the target of insecticide use, there is even more cause for concern about the harms of insecticides to non-target butterfly species (Braak et al. 2018, p.3; Pisa et al. 2015, p.78). Insecticides are also the class of pesticides most commonly studied in butterflies (Braak et al. 2018, p.4).

A shift in recent years towards using insecticide treated seeds as a preventative measure against pests, especially in large-acreage crops like corn and soybeans, has led to insecticides being applied on more acres of crops than at any time in history, increasing the potential for harm to non-target species (Tooker and Pearsons 2021, p.50).

Non-target insects may be exposed to insecticides at the time of application, or by coming into contact with contaminated media like soil, sediment, plants, and water, or indirectly as insecticides move through trophic connections in food webs (Tooker and Pearsons 2021, p.50).

Insecticide exposure for 'at risk' butterfly species in the north central United States, like the Dakota skipper, Poweshiek skipperling, and regal fritillary, is likely given the spatial-temporal overlap of these species use of habitat in close proximity to agricultural crops and patterns of insecticide use on those crops (Hall et al. 2021, p.139). The Iowa skipper's range and habitats overlap with some of the 'at-risk' butterfly species discussed in Hall et al. (2021, p.138-9), and in some cases, as with the Dakota skipper, they may utilize the same types of larval host plants. In the north-central U.S., 8-20% and 6-30% of corn and soybean fields are treated with foliar or soil-applied insecticides, and nearly 100% of corn and 50% of soybean fields use neonicotinoid coated seeds (discussed further below) (Hall et al. 2021, p.139). These insecticides are most often applied during the growing season of crops, increasing the likelihood of exposure for butterfly species in the north central U.S. because this is the same time of year when these species are typically most active (Hall et al. 2021, p.139).

Wepprich et al. (2019, p.2-3, 7, 15) assessed the rate of change of butterfly abundance and population trends for butterflies using data from 21 years (1996-2016) of systemic monitoring in Ohio and found a cumulative reduction in butterfly abundance of 33%, with a decline in total abundance of about 2% per year, with even common species experiencing declines. Although the study wasn't designed to test the specific role of insecticides in these declines, such as the role of the rapid increase in the use of neonicotinoids after 2004, the authors acknowledged their results would be consistent with widespread exposure to insecticides because declines included common and generalist species that would normally be expected to be able to exploit agricultural or human-altered landscapes (Wepprich et al. (2019, p.15).

Mulé et al. (2017) conducted a systematic review examining the effects of insecticides on four butterfly families, which included the Iowa skipper's family Hesperiidae. Because of the limited research available on the effects of insecticides on butterflies, Mulé et al. (2017, p.3) found only seven studies that were helpful in answering their questions. However, they found a trend with all studies showing negative effects of insecticides on all species for both larval and adult stages, with a generally larger negative effects on larvae than adults (Mulé et al. 2017, p.4). These effects included reduced survival rate, feeding interruption, and alteration of oviposition behavior (Mulé et al. 2017, p.4).

Main et al. (2020, p.7) frequently detected synthetic pyrethroid bifenthrin, an insecticide highly toxic to pollinators, in tissue samples of butterflies and bees collected in conservation areas adjacent to agricultural lands. Bifenthrin has been found to cause mortality in bumblebee workers, to significantly reduce fecundity and development in honeybees (Main et al. 2020, p.7). While there is no data on the effects of bifenthrin on butterflies, studies of the toxicity of other pyrethroids found sublethal effects from exposure to butterflies, such as delays in larval development, inhibition to feeding, and smaller pupae and adults (Main et al. 2020, p.7).

There are a wide range of uses for and types of insecticides that may be used within the Iowa skipper's range. Below are several detailed examples of the specific widespread uses of insecticides and how they can harm the Iowa skipper and other butterflies and insects.

(1) Neonicotinoids

Neonicotinoids are a class of insecticide chemically similar to nicotine, and represent a worldwide threat to biodiversity, ecosystems, and ecosystem services (Chagnon et al. 2015; Pisa et al. 2015). They are relatively new, widely used systemic insecticides designed to kill insects which damage crops, but which in reality, are harmful to many nontarget species (Pisa et al. 2015, p.69; Warren et al. 2021, p.4). Neonicotinoids have been implicated in the declines of bees, insectivorous birds, and other organisms (Warren et al. 2021, p.4).

Since their introduction in the 1990s, neonicotinoids have become the most widely used class of insecticides worldwide and act by disrupting the central nervous system of insects, which results in paralysis and death (Braak et al. 2018, p.5; Simon-Delso et al. 2015, p.7; Bonmatin et al. 2015, p.36; Douglas and Tooker 2015, p.A). Although neonicotinoids can be applied in a variety of ways, such as foliar sprays, root drenches to the soil, or as trunk injections to trees, they are most commonly (~60% of applications) applied as seed or soil treatments (Bonmatin et al. 2015, p.36).

The most common application method for neonicotinoids is as seed coatings (Douglas and Tooker 2015, p.E). Because of inadequate regulation of coated seeds, the total quantity of neonicotinoids used for seed coatings in the U.S. is unknown. It is believed neonicotinoid coated seeds are used on hundreds of millions of acres in the U.S., including on nearly all non-organic corn and the majority of soy. There was a rapid increase in neonicotinoid use in the U.S. between 2003 and 2011, at the same time that seeds coated with neonicotinoids were introduced in field crops, which led to a large-scale shift towards preemptive insecticide use, with 34-44% of soybean and 79-100% of corn acreage treated with neonicotinoids in 2011 (Douglas and Tooker 2015, pp.D-F) .

Neonicotinoids are systemic, which means that when a plant takes up neonicotinoid molecules, they and their metabolites circulate throughout all plant tissues, which allows for protection from sap-feeding insects (Bonmatin et al. 2015, p.36; Simon-Delso at al. 2015, p.7). But this also means non-target insects may be exposed to lethal or sublethal doses of neonicotinoids through consumption of plant tissue, as happens with Iowa skipper larvae, as well as through nectaring at a plant's flowers, which is done by Iowa skipper adults (Tooker and Pearsons 2021, p.51; Gilburn al. 2015, p.2). Bumblebees can obtain ingest harmful doses just from feeding on flowers in field margins (Warren et al. 2021, p.4).

The chemical characteristics of neonicotinoids make it simple for them to contaminate unintended locations, such as nearby natural habitats, organic farms, and aquatic habitats (Tooker and Pearsons 2021, p.51). Neonicotinoids are persistent in the environment and can leach into the soils and water courses, as well as into field margins where butterflies may feed and forage (Warren et al. 2021, p.4; Simon-Delso at al. 2015, p.7). They can also persist for long periods of time in plant tissues, for months or even years (Gilburn et al. 2015, p.3). During a 5-year moratorium on the use of three neonicotinoids European Union, they were still found in high concentrations in new plantings, indicating that the residues were highly persistent in the soil and residues could diffuse in the environment and contaminate crops or other plants (Serrão et al. 2022, p.2). The combination of neonicotinoids' persistence and solubility in water, leads to the potential for neonicotinoids to accumulate in the environment at field-realistic levels of use (Bonmatin et al. 2015, pp.40, 42, 60).

Neonicotinoid treated seeds can contaminate farmland habitats and vegetation on field margins in two ways (Gilburn et al. 2015, p.2). First, dust produced during drilling of treated seeds can contain high concentrations of neonicotinoids, which drifts onto surrounding et vegetation (Gilburn al. 2015, p.2). Second, neonicotinoids are water soluble and persist in soil for long periods, with half lives in soil that can be more than 1000 days, resulting in a high potential for repeat exposure to some pesticides within and across butterfly stages (Braak et al. 2018, p.27-28; Gilburn al. 2015, p.2; Simon-Delso at al. 2015, p.7). Levels of neonicotinoids on field margin plants near fields planted with treated seeds can be high enough to cause mortality in herbivorous insects feeding on this vegetation (Gilburn al. 2015, p.3).

Global exposure of neonicotinoids to pollinators is widespread. Mitchell et al. (2017, p.1) found at least one type of neonicotinoid in 75% of honey samples tested from around the world, with the highest proportion (86%) of samples containing at least one type of neonicotinoid from North America. Two or more neonicotinoids were found in 45% of samples worldwide, and 10% of samples contained four or five (Mitchell et al. 2017, p.1).

The environmental consequences of neonicotinoids are severe, impacting insects, invertebrates, aquatic invertebrates, birds, and sometimes mammals (Tooker and Pearsons 2021, entire; Douglas and Tooker 2015, p.B). The greatest harm has come to bees and other pollinators, which have undergone dramatic declines in population numbers since these chemicals first started being used on agricultural crops.

Neonicotinoids have very high toxicity for insects (Pisa et al. 2015, p.69). And there is enough information available to conclude that field-realistic exposure to neonicotinoids likely results in lethal and sublethal impacts to a wide variety of non-target insects and are thus likely to have large scale biological and ecological impacts on non-target insects (Pisa et al. 2015, pp.69, 92). Even at lower-level exposure, neonicotinoids have sublethal effects on insects, which include reductions in growth and reproduction, weakened immunity to parasites and viral diseases, impaired learning and foraging behavior, as well as increased mortality in the first and subsequent generations (Mitchell et al. 2017, p.2; Pisa et al. 2015, pp.69, 78, 92). Butterfly populations can suffer severe impacts even from low sublethal doses of neonicotinoids (Pisa et al. 2015, p.78).

Studies on the effects of neonicotinoids on honeybees and bumblebees have found a range of sublethal effects, such as impaired navigation, reduced colony growth and queen production, and impaired immunity (Sánchez-Bayo 2021, pp.7-8; Gilburn et al. 2015, p.2). The neonicotinoid imidacloprid impairs coordination of flight muscles for pollinators, including partial and total loss of flight during foraging (Serräo et al. 2022, p.4). And oral exposure to the neonicotinoid thiamethoxam causes lack of orientation and navigation, which impairs bees' ability to return to their hive (Serräo et al. 2022, p.4). Exposure to thiamethoxam can also cause malformations of pollinator larvae (Serräo et al. 2022, p.4).

The European Union (EU) severely restricted the use of treated seeds containing three neonicotinoids in 2013 (clothianidin, thiamethoxam, imidacloprid) because of their likely role in colony collapse disorder for honeybees (Braak et al. 2018, p.5; European Commission 2023; Serräo et al. 2022, p.2). And in 2018, a report by the European Food Safety Authority provided further evidence that most uses of these three neonicotinoid pesticides represent a risk to wild bumblebees, solitary bees, and honeybees (European Food Safety Authority 2018). In response, the EU went a step further and approved a ban on all uses of these three neonicotinoids outside of closed greenhouses (European Commission 2023). The European Commission (2023) further withdrew the approval of the neonicotinoid thiacloprid in 2020 based on a risk assessment conducted in consideration of a potential renewal. In contrast, in the Unites States, the EPA continues to allow the use of neonicotinoids, including clothianidin, thiamethoxam, and imidacloprid, and appears ready to renew their approvals of these toxic pesticides in ongoing registration review processes (85 Fed. Reg. 5953, February 3, 2020).

In an analysis conducted in the UK, populations of widespread butterfly species commonly found in agricultural areas declined by 58% between 2000 and 2009 (Gilburn et al. 2015, pp.6-7). Populations of widespread butterflies exhibited a significant increase from 1985 to 1998, the years before neonicotinoid use began in relevant amounts[14], as compared to highly significant declines seen from 1999 to 2012, a time period with extensive and increasing use of neonicotinoids (Gilburn et al. 2015, p.5). This included three species of skipper butterflies which exhibited some of the most significant declines (35-67%) from 2000 to 2009 (Gilburn et al. 2015, p.7). This steady decline was correlated with the increasing use of neonicotinoid pesticides within the same period (Gilburn et al. 2015, pp.6-7) Their modelling revealed a strong negative association of the butterfly population index with the previous year's usage of neonicotinoids (Gilburn et al. 2015, p.5). Levels of neonicotinoids found in field-edge plants was at a level sufficient to kill insects (Gilburn et al. 2015, p.3). Major declines of populations of widespread butterflies were also observed in the Netherlands where neonicotinoids are also widely used, but, in contrast, declines of generalist butterflies were not seen in Scotland where neonicotinoid use was lower than in England (Gilburn et al. 2015, p.8).

Forister et al. (2016, p.2, 4) examined dramatic declines in butterfly fauna of lowland California seen since the late 1990s and found a negative association between butterfly populations and increasing neonicotinoid use even after

[14] Neonicotinoids were introduced to the UK in 1994 and use first exceeded 100,000 hectares for the first time in 1999 and did not decline from that level in later years (Gilburn et al. 2015, p.5).

correcting for changes in land use and climate conditions. The association was especially severe for smaller-bodied species Forister et al. (2016, p.4).

In an experimental study, Whitehorn et al. (2018, pp.3, 7) found that field-realistic, sub-lethal exposures of the neonicotinoid imidacloprid negatively impacted the development of the cabbage white butterfly (*Pieris brassicae*). Both the length of time for pupation and the size of adult butterflies were significantly reduced, compared to the controls, at all exposure levels (Whitehorn et al. 2018, p.7). This result indicates that exposure to imidacloprid may compromise adult fitness because in lepidoptera larger individuals have greater reproductive success, flight ability, and endurance (Whitehorn et al. 2018, p.7). And it provides support for the hypothesis from Gilburn et al. (2015) and Forester et al. (2016), discussed above, that recent declines in farmland butterflies may be due to the increase in neonicotinoid use (Whitehorn et al. 2018, p.7).

(2) Grasshopper Control

From the late 19th to mid-20th century, efforts to control outbreaks of grasshoppers in rangeland initially involved deployment of poisoned baits containing arsenical and copper compounds, which were succeeded by organic hydrocarbon, organophosphate and carbamate insecticides (Dakhel et al. 2020, p.4). Subsequently, broadcast spraying of insecticides became more commonly used for this purpose, accompanied by lethal impacts to butterflies (Cochrane and Delphey 2002, p.32).

The USDA's Animal and Plant Health Inspection Service (APHIS) played a major role in this effort beginning in 1972, and in 1987 established a formal program for control of grasshoppers and Mormon crickets in 17 western states, including nine in the Iowa skipper's range[15] (Dakhel et al. 2020, p.4). The total rangeland area treated in this program has risen from 4.8 to 13.8 to 20 million acres in 1972/73, 1979 and 1985/86, respectively (EPA 2003, p.165 Fig. 13), with 1.3 million gallons of insecticides sprayed on 20 million acres of western rangeland during grasshopper outbreaks from 1986 to 1988 (Hastings et al. 2014, p.858). These insecticides threaten large areas of Iowa skipper habitat. Royer and Marrone (1992, p.15) identified insecticides to control grasshoppers as threats in large areas of the remaining Iowa skipper habitat in North and South Dakota. The area treated by APHIS varies greatly from year to year depending on grasshopper population cycles and program funding (APHIS 2002, Fig. 1-1, p.112; APHIS 2019, Fig. 3-1, p.80). The acreage of rangeland and other potential Iowa skipper habitat that is

[15] The 17 states, including nine with Iowa skipper habitat (bolded), are: Arizona, California, **Colorado,** Idaho, **Kansas, Montana, Nebraska,** Nevada, New Mexico, **North Dakota, Oklahoma**, Oregon, **South Dakota, Texas**, Utah, Washington, and **Wyoming** (APHIS 2002, p.21).

sprayed with insecticides by private actors outside the APHIS program is unknown.[16]

APHIS renewed its grasshopper control program in 2002 and 2019, and it is ongoing (APHIS 2002, 2019). For this program, APHIS uses the insecticides carbaryl, malathion and diflubenzuron, and a fourth, chlorantraniliprole, is under consideration (APHIS 2019, Table 3-1, p.25). More detail is provided below about carbaryl, malathion and diflubenzuron, the three insecticides most used for grasshopper control in the past and at present. All three insecticides also have additional uses which may lead to additional exposures for the Iowa skipper.

Carbaryl

Carbaryl is a carbamate insecticide that kills insects by disrupting their nervous systems, and is classified as highly toxic to honeybees, EPA's surrogate species for terrestrial invertebrates. EPA estimates that acute exposure of adult bees to carbaryl via the oral route is up to 3,504 times higher than the Agency's "Level of Concern" (LOC) for non-listed species, which for honeybees is 0.4 x LD_{50} (40% of the single dose that kills 50% of honeybees) (EPA 2021b, p.5, 11-13 Table 1-2). While EPA estimates that spraying any amount of carbaryl above 0.0013 lbs/acre would kill adult bees, it permits spraying of up to 1.5 lbs/acre – over 1,000-fold more – twice a season, in pasture and rangeland settings (EPA 2021b, p.5, pp.30-31 Table A1). Even the top rate of 0.5 lb./acre used by APHIS for grasshopper control is roughly 380 times higher than the bee kill threshold rate of 0.0013 lbs/acre (APHIS 2019, p.35 Table 3-1). EPA's analysis is supported by 83 reports of carbaryl adversely affecting bees in the Agency's Incident Data System, including incidents in which hundreds to thousands of bees and 1 to 1,000 colonies were adversely affected (EPA 2021b, p.17).

Bees of three species were killed at rates of 69%, 78% and 85% from one day's exposure to 48-hour old residues of a carbaryl formulation on alfalfa foliage (Johansen 1972, p.393 Table 1). Carbaryl is also recognized as being moderately to highly toxic to a wide range of beneficial arthropods that prey on or parasitize pests, including lace bugs, big eyed bugs, lady beetles, carabid ground beetles, hymenopterous parasitoids, predacious mites and spiders (EPA 2003, p.159). The insecticide's widespread harm to non-target species is further demonstrated by EPA's recent determination that carbaryl is "likely to adversely affect" 137 of 161 species of threatened or endangered terrestrial invertebrates (EPA 2021c, Exec. Summary p.4 Table 1). This total includes two species of moth and 35 species of butterflies; of the butterflies, including the Pawnee Montane skipper, Laguna Mountains skipper, Carson Wandering skipper, Dakota skipper and the Poweshiek skipperling (EPA 2021c, Appendix 4-1). Carbaryl may also negatively impact plants in the Iowa skipper's habitat. EPA determined that carbaryl is "likely to adversely

[16] APHIS (2019, p.35) says that the use rates the agency proposed in their 2019 Final EIS for grasshopper suppression are lower than the rates used by private landowners.

affect" 912 of 950 threatened and endangered plant species in its recent biological evaluation (EPA 2021c, Exec. Summary p.4 Table 1).

Like the problematic herbicides glyphosate and dicamba, discussed above, carbaryl is volatile and drift-prone, such that "vapor phase and particulate transport may carry the compound far from the area of application" (EPA 2003, p.9). For instance, researchers measured drift of aerially applied carbaryl at 80 and 550 meters (262 and 1,804 feet) downwind of an application site in Tulare County, CA (Majewski and Capel 1995, p.32 Table 2.2). Like other pesticides, carbaryl is detected in fog at higher concentrations than found in rain or surface waters, and according to EPA "may represent a significant, though generally overlooked, route of exposure" (EPA 2003, p.9). For instance, carbaryl was detected in California for water at concentrations ranging from 0.69 to 4 ug/liter (Schomburg et al. 1991, p.157 Table II).

Given carbaryl's volatility and drift-prone nature, EPA estimates acute risks to honeybees at over 1,000 feet from a sprayed field when 9 lbs/acre are applied, and at a distance of 33 feet when the extremely low rate of 0.0466 lbs/acre is used (EPA 2021b, p.19).[17] Thus, application at up to 0.5 lbs/acre by APHIS or 1.5 lbs/acre by others to control grasshoppers in grassland habitat would very likely result in sufficient drift to harm terrestrial invertebrates such as the Iowa skipper hundreds of feet from a sprayed field. This is particularly true of aerial applications that APHIS mainly relies upon (APHIS 2019, p.84), which entail longer-distance drift than ground applications. Such drift would likely have adverse impacts on Iowa skippers even in unsprayed areas when the applicator is utilizing the reduced agent area treatment (RAAT) method for grasshopper control, in which alternating swaths of a field are treated (Dakhel et al. 2020, p.4), because for carbaryl the skipped swath width for aerial applications is typically just 100 feet (APHIS 2019, pp.34-35).

Malathion

Malathion is an organophosphate insecticide that kills insects on contact or systemically by interfering with transmission of neural impulses (EPA 2017b, Exec. Summary p.2). It is highly to very highly toxic to many species of beneficial insects (EPA 2009, p.52). EPA references malathion toxicity data for 145 species of terrestrial invertebrates representing 23 different taxonomic orders, including Hymenoptera (bees and wasps) and Lepidoptera (moths and butterflies) (EPA 2017b, pp.2-180 to 2-181). Based on this dataset, malathion kills invertebrates at application rates as low as 0.00012 lbs/acre (EPA 2017b, p.2-192).

According to EPA, the most sensitive mortality endpoint in organismal units is an acute contact LD50 for honeybee adults of 0.156 μg/bee, equivalent to 1.22 μg/g body weight (EPA 2017b, p.2-187). However, malathion contact LD50 values for

[17] EPA does not specify whether these drift distances pertain to ground or aerial applications.

larval stages (3rd and 5th instars) of the long-tailed skipper (*Proteus urbanus*) are four- to five-fold lower, 0.26 and 0.30 µg/g body weight, respectively, than this honeybee endpoint (Salvato 2001, p.13 Table 4). At the 5th instar stage, the long-tailed skipper was 21 to 27 times more sensitive to malathion than two other butterfly species, while the adults of all three species were less sensitive than their larvae (Salvato 2001, p.13 Table 4). Thus, at least one skipper is considerably more sensitive to malathion, especially at the larval stage, than EPA's Biological Evaluation would suggest.

Malathion is particularly likely to impact non-target insects "when use sites are not a specifically targeted agricultural field or residential/commercial site," but rather "application in ground fogs *designed to drift* and impact flying mosquitoes (adulticide use) or application to large tracts of rangeland to combat grasshopper" (EPA 2005a, p.4, emphasis added). For ground or aerial application to pasture or rangeland, malathion can be applied at up to 0.92 lbs/acre (EPA 2017b, pp.1-24 to 1-26 Table 1-5), which is over 7,600 times greater than the lowest rate (0.00012 lb/acre, as noted above) found to kill terrestrial invertebrates.

With a short 7-day minimum retreatment interval and no label limit on the number of applications per year, malathion could be applied repeatedly with accumulation of residues on foliage and pollen, posing potential hazards to pollinators. APHIS applies from 0.25 to 0.62 lbs/acre of malathion in its grasshopper control program (APHIS 2019, p.35 Table 3-1), from 2,000 to over 5,100 times this same mortality threshold. Thus, it is not surprising to learn that "all or large numbers of [terrestrial invertebrate] individuals exposed to [malathion] will die across most uses and habitat types," although mosquito adulticide use would leave some survivors to suffer "sublethal effects to growth, reproduction, behavior and sensory Malathion and its toxic malaoxon metabolite accumulate in fogwater, where they have been detected at concentrations up to 8.7 and 7.8 ug/liter, respectively (Schomburg et al. 1991, p.157 Table II). Malathion is also prone to drift, and drift concentrations can still be high enough to harm terrestrial invertebrates 1,000 feet from a ground-sprayed field and 2,500 feet from a field sprayed aerially (EPA 2009, p.1-42). Drift is exacerbated with the ultra-low volume formulations used for mosquito and grasshopper control, with one study finding deposition of up to 21%, 11.5%, 2.9% and 0.7% of the applied malathion (1 lb/acre) at 100, 200, 500 and 1,000 meters, respectively, downwind; the EPA authors note that drift deposition in this study is considerably higher than drift estimates EPA relies upon in regulating malathion (EPA 2005b, p.26). Given these facts, and the data cited above on a skipper's extreme sensitivity to malathion, the maximum 20-foot wide, untreated swaths that APHIS employs in its RAAT method of grasshopper control will not save any Iowa skippers that happen to occupy them from death by malathion (APHIS 2019, pp.34-35).

The Iowa skipper could be exposed to malathion residues on foliage and pollen and in the nectar of plants that are directly sprayed or drifted upon. EPA reports a 90th percentile foliar dissipation half-life of 5.5 days (EPA 2005b, p.27).

Malathion residue levels on the foliage of sprayed alfalfa, however, remained relatively stable for four days at 19-29 ppm (EPA 2005b, p.30 Table 6). Malathion has a number of toxic impurities that can comprise up to 5% of the insecticide, several of which are more toxic than the parent to various organisms (EPA 2017b, pp.1-68 to 1-69). For example, the O,O,S-trimethyl phosphorothioate impurity is over 800 times as acutely toxic to rats as malathion and persists in soil nearly 19 times longer (EPA 2017b, pp.1-68; EPA 2005c, p.53). EPA concluded that while malathion's manufacturer has, over time, taken some steps to reduce impurity levels, the agency would not exclude toxicity data from older studies, in part because storage conditions beyond the manufacturer's control play a role in formation of toxic impurities (EPA 2017b, pp.1-68 to 1-69). function" (USFWS 2022, p.251).

Diflubenzuron

Diflubenzuron is an insect growth regulator that interferes with synthesis of chitin, essential for formation of an exoskeleton during molting, leading to death (EPA 2018, p.3). It's most effective against insect larva (EPA 2018, p.3). Diflubenzuron's volatility is considered to be relatively low when compared to carbaryl and malathion (APHIS 2019, p.48). Although it is not considered to be persistent in water or soil, diflubenzuron on foliage may remain for several weeks, increasing the likelihood for non-target insects like the Iowa skipper to be exposed to (APHIS 2019, pp.48-49).

APHIS (2019, p.51) acknowledges that the risk to non-target species is greatest for sensitive terrestrial and aquatic invertebrates that may be exposed to diflubenzuron residues. Diflubenzuron is toxic to larval honeybees (APHIS 2019, p.50). Sublethal effects have been documented for bumble bees and honeybees (APHIS 2019, p.57). EPA (2018, p.4) identified risks to larval bees from potential residues in pollen and nectar brought back to the hive as the primary risks to terrestrial taxa. Residues in pollen and nectar may be present for several days at levels that can result in mortality and growth effects for larval bees when diflubenzuron is applied at bloom (EPA 2018, p.4). Butterfly and moth larvae appear to be more susceptible to diflubenzuron than other invertebrates (APHIS 2019, p.55).

In their recent preliminary risk assessment for the registration review of diflubenzuron, EPA (2018, p.5) determined that the chronic effects levels from chronic exposure of honeybees, the surrogate used to assess impacts to all terrestrial invertebrates, are above the highest estimated dose for any use pattern. They also identified acute risk concerns for larval bees for all modeled uses, with refined residues in pollen and nectar indicating acute risk concerns for foliar uses (EPA 2018, p.5).

Braak et al. (2018, pp.12-13, 17) summarizes several studies that found negative impacts of diflubenzuron on the cabbage white butterfly (*Pieris brassicae*) at field-realistic exposure levels, including a study that found that drift levels were high enough to cause larval mortality, with increased mortality the closer the larvae were to the sprayed area.

Runquist et al. (2018, p.21) detected diflubenzuron for the first time in pesticide sampling of native prairie grasses in Minnesota prairies in 2018. It was detected at Felton Prairie, a site that at least historically was home to the Iowa skipper (*See* Table 9).

(3) Soybean Aphid Control

The soybean aphid, a crop pest in soybeans, was first detected in North America in 2000, initially in Wisconsin but it quickly spread through soybean growing areas in the U.S. within a few years (Runquist and Heimpel 2017, p.5). Soybean aphids are currently the most important insect pest in soybeans in the north-central U.S. (Runquist and Heimpel 2017, p.5). Management of soybean aphids relies on application of foliar insecticides using airplanes or ground sprayers, including chlorpyrifos, lambda-cyhalothrin, and bifenthrin, the three most commonly used insecticides to control soybean aphids in Minnesota (Goebel et al. 2022, p.2; Runquist and Heimpel 2017, pp.5-6). All three have been shown to be toxic to non-target organisms in laboratory settings; they all disrupt nervous systems in organisms and can cause mortality at high doses (Goebel et al. 2022, p.2)

Chlorpyrifos is a broad-spectrum organophosphate insecticide that can disrupt the nervous systems of non-target organisms through direct contact, ingestion, or inhalation (Goebel et al. 2022, p.2). It is broadly toxic to both invertebrates and vertebrates (Runquist and Heimpel 2017, p.6). Chlorpyrifos is highly toxic to honeybees (Goebel et al. 2022, p.2). Chlorpyrifos can persist in the environment, with a half-life of 7-120 days in soils and the potential for residues to remain on plant surfaces up to 14 days after spraying, with potential for accumulation (Goebel et al. 2022, p.8).

Lambda-cyhalothrin is a broad-spectrum pyrethroid insecticide that is highly toxic to pollinators and other invertebrates (Goebel et al. 2022, p.2; Runquist and Heimpel 2017, p.6). Bifenthrin is a broad-spectrum pyrethroid insecticide that affects the central and peripheral nervous systems of organisms through direct contact or ingestion (Goebel et al. 2022, p.2). Bifenthrin is highly toxic to bumblebees, and other terrestrial invertebrates are also highly sensitive to this insecticide (Goebel et al. 2022, p.2). Preliminary results from an experiment on the impacts of bifenthrin on the larvae of grass-feeding skippers, including Sachem and Dakota skippers, show that some mortality may be expected at levels detected in prairies adjacent to crop fields (Runquist et al. 2018, pp.21-23). No Sachem skipper larvae survived after 24 hours in the 12% or 100% spray treatments, 3 of 20 survived the 1% treatment, and 13 of 30 survived the 0.1% treatment, and while Dakota skipper larvae appeared to fare slightly better, they were not tested at all treatment levels due to limited numbers (Runquist et al. 2018, pp.21-23).

The use of lambda-cyhalothrin and bifenthrin against soybean aphids has declined since the mid-2010s, as aphids have evolved resistance to these two insecticides, although they may still be used as a tool for other pests (Runquist et al. 2021, p.28). Chlorpyrifos is still used widely throughout the Iowa skipper's range (Figure 17).

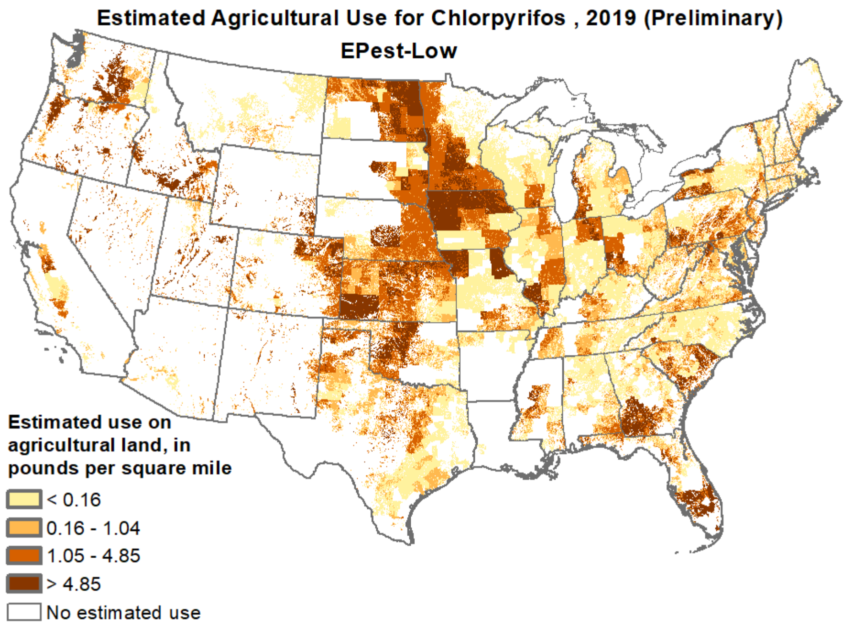

Figure 17. Estimated chlorpyrifos use on agricultural land in 2019 (U.S. Geological Survey 2019d).

Runquist and Heimpel (2017, pp.5-6, 10-11) discuss a working hypothesis that butterfly declines in Minnesota, including the precipitous losses of the Dakota skipper and Poweshiek skipperling, may be in part due to insecticide drift from management of the soybean aphid. The timing of the soybean aphid's arrival in Minnesota in 2000, and the subsequent increases in broad spectrum insecticide use beginning in 2001, including in soybean fields adjacent to prairie habitats, aligns with the timing of declines of endangered skippers and other butterflies in the state (Runquist and Heimpel 2017, pp.4-5).

Non-target organisms may be exposed to these insecticides through drift associated with routine aerial and ground-based spraying for soybean aphids (Goebel et al. 2022, p.2). In Minnesota, Goebel et al. (2022, p.3) used passive sampling devices to quantify the spray drift of chlorpyrifos in mesic tallgrass prairie sites adjacent to soybean fields (focal sites), and to estimate wildlife exposure to this insecticide through drift. Chlorpyrifos was detected at all focal sites, and at all distances from the field edge (up to 400 m) (Goebel et al. 2022, p.5). As expected, the amount of insecticide detected decreased at increasing distances from the field edge (Goebel et al. 2022, pp.5-6). Chlorpyrifos residues exceeded the contact lethal dose (LD50) for honeybees in sampling devices at mid-canopy and ground heights up to

25 m from the field edge, for sites bordering soybean fields sprayed by airplane (Goebel et al. 2022, p.6). Chlorpyrifos residues were greater in mid-canopy devices than in ground-level samplers, which indicates that a species like the Iowa skipper, whose larvae nests higher up in grasses and not in the soil, is more likely to be harmed by drift of this insecticide, and likely others as well (Goebel et al. 2022, p.6).

Goebel et al. (2022, pp.7-8) also detected chlorpyrifos in sampling in cornfield reference sites, which are typically not sprayed with this insecticide, indicating that there are likely background levels of this insecticide drift occurring across the landscape.

In another study of pesticide residues in Minnesota prairies, including sites that have at least historically been home to the Iowa skipper, chlorpyrifos has regularly been found to be widespread over seven years of sampling of grassland vegetation near agricultural fields across multiple sites (Runquist et al. 2020, p.28; Runquist et al. 2018, p.21). It was not detected in 2021, and the authors hypothesized that an extreme drought that year may have suppressed soybean aphid populations to such a level that the cost of spraying chlorpyrifos was not worth it that year (Runquist et al. 2021, p.28).

(4) Mosquito Control

Florida scientists determined that use of organophosphate insecticides for mosquito control in south Florida and the Florida Keys was likely responsible for the demise of the Schaus' swallowtail (*Papilio aristodemus ponceanus* Schaus) and suggested rapid declines in populations of the Florida leafwing (*Anaea troglodyte floridalis*) and Bartram's hairstreak (*Strymon acis bartrami*) in the Lower Keys could be attributed to mosquito control insecticides (Salvato 2001, p.8).

Experiments to test the potential toxicity of mosquito control chemicals on long-tailed skipper (*Proteus urbanus*) (an Iowa skipper relative in the Hesperiidae family) in Florida showed the active ingredients naled and permethrin to be most toxic, with lethal dosage (LD50) values of 1.0 µg/g of body weight, and 48.1 µg/g of body weight with malathion (Salvato 2001, pp.1, 13). In another study, the acute toxicity (LD50) of adult long-tailed skipper to naled ranged from 0.189-0.36 µg/g of body weight, and the equivalent risk of exposure to aerial spray of naled for adult butterflies was between 67-80% (Bargar 2012, p.2).

As discussed above in more detail in the section on grasshopper control, malathion may also be used for mosquito control and may harm non-target insects like the Iowa skipper.

c) Fungicides

Although fungicides are often considered to be non-toxic to pollinators, they may increase in toxicity when pollinators are also exposed to other types of pesticides (Main et al. 2020, p.7). Studies show synergistic effects of fungicides with insecticides, with testing of fungicides acting synergistically with insecticides to cause lethal and sublethal effects on insects (Main et al. 2020, p.7; Peterson et al. 2019, p.6). The fungicide Tebuconazole may be especially detrimental when mixed with pyrethroid, neonicotinoid, or diamide insecticides (Main et al. 2020, p.7).

Main et al. (2020, p.7) found fungicides in the majority of wild pollinators collected in conservation areas near agricultural fields, in tests of butterfly and bee tissue samples.

2. Climate Change

Climate change is an important threat to insects, including butterflies (Halsch et al. 2021, pp.1, 7; Raven and Wagner 2021, p.4; Wilson and Maclean 2011, p.266). Insects are expected to show rapid responses to climate change since they have short life cycles and are strongly influenced by temperature (Wilson and Maclean 2011, p.259). There is strong evidence of climate change impacts on insect distributions and phenology, as well as evidence of contributions to species declines or restricting distributions in insects, with most studies focused on butterflies (Wilson and Maclean 2011, p.266). Research focused on butterflies and moths show that climate change can produce detrimental impacts from resource asynchronies, with many studies reporting early emergence from diapause and increasing asynchrony with host plants (Hill et al. 2021, p.2121-22; Hanberry et al. 2021, p.226). Climate change is altering the distribution of butterfly populations, most commonly observed as population retraction and local extinction (Hill et al. 2021, p.2121).

Wilson and Maclean (2011, p.264) expressed concern that many imperiled butterfly species have "highly specialist habitat requirements and therefore fragmented distributions of habitat" making it "unlikely that most will be able to colonize regions that become climatically favorable" and suggested that future projections based on a "no dispersal" scenario are likely more realistic for threatened species. When combined with habitat deterioration and fragmentation, climate change and land use change interactions can lead to collapses in butterfly populations (Oliver et al. 2015).

In an analysis of expert and community scientist datasets of butterflies in the American West over the past decades, Forister et al. (2021, pp.1042-44) found a downward trend in populations of a majority of species in each of the three datasets. Overall, they found a decrease in the total abundance of butterflies over time, with an estimated rate of 1.6% fewer individuals per year, which was primarily influenced by climate change indices (Forister et al. 2021, p.1044). Locations that have been warming more in the fall months have seen fewer butterflies over time and the opposite was seen in locations that have been warming in the summer months (Forister et al. 2021, p.1044).

Breed et al. (2012, p.1) also found a strong indication of climate driven changes in butterfly abundance when looking at population trends of Massachusetts butterflies from 1992-2010. They found butterflies that are univoltine, as the Iowa skipper is in parts of its range, were significantly overrepresented in declining species (Breed et al. 2012, p.3). Wepprich et al. (2019, p.15) found an impact of climate change on declines in butterfly abundance in Ohio over 20 years, as species with northern distributions and fewer annual generations declined more rapidly.

In addition to increasing temperatures, climate change is predicted to increase the frequency of extreme weather events such as droughts and floods (Warren et al. 2021, p.5). These types of adverse weather events can be the proximate cause of making a butterfly population inviable, increasing local extinction rates, and affecting the viability of metapopulations (Swengel 2013, p.83; Warren et al. 2021, p.5). In one example from the United Kingdon, a rapid drop in butterfly abundance was reported after a drought in 1976 and some species never recovered (Warren et al. 2021, p.5). Dankert (2022, personal communication) identified prolonged droughts as a threat to Iowa skippers as they likely make larval hostplants unpalatable.

Swengel (2013, p.82) also reported that butterfly populations plummeted after extreme heat and drought in 2012, with habitat affected in most of the endangered Poweshiek skipperling's range by late Summer 2012, and the southward monarch migration called "a bust" for that year. This situation also served as an example of extreme reversals in weather, likely to become more common with climate change, as the following spring was very snowy and cool, and grass-skippers were again found in low numbers in many midwestern areas in 2013 (Swengel 2013, p.82). These two extremes meant there was only breeding success for eggs laid in places that could survive both the 2012 heat and drought and the wet, cold spring of 2013. This was likely difficult as "few managers in the working or ecological landscapes maintain a consistent array of diverse vegetative conditions to buffer all weather contingencies" and may help to explain previous population declines.

Climate change is a threat to Iowa skippers and other butterflies in their range (Skadsen 2009, p.12; Olsen 2018, p.8). The states that assessed the effects or vulnerability of the Iowa skipper to climate change in their State Wildlife Action Plans found differing results; however, none of them found climate change would positively affect the species. Climate change is expected to have negative effects for the Iowa skipper in South Dakota because the species "[p]refers cool season grass (C3) dominated conditions or mixed cool/warm (C4) season conditions" (South Dakota Dept. of Game, Fish, and Parks 2014, p.123). In Nebraska, Schneider et al. (2018, p.33) classified the Iowa skipper as not vulnerable to climate change and presumed stable. But the Iowa Dept. of Natural Resources (2015, p.358) determined the Iowa skipper is "extremely vulnerable" to climate change in Iowa. And in Kansas, Rohweder (2015, p.167) found the Iowa skipper to be moderately vulnerable to climate change.

Arkansas did not complete species-specific climate vulnerability assessments in it 2015 Wildlife Action Plan, so instead provided generalizations about how each species group may be impacted by climate change (Fowler and Anderson 2015, p.1576). For insects with specialized habitat requirements and/or host plants, like the Iowa skipper, Fowler and Anderson (2015, p.1578) explained they could be "negatively impacted if populations of the obligate host plant are reduced." They also explain that "[m]ost insects have the ability to disperse and some may migrate northward as climatic conditions shift;" however, this is unlikely to be the case for the Iowa skipper given its highly fragmented habitats, its expected limited dispersal capabilities, and its presence in only two counties in Arkansas (Fowler and Anderson 2015, p.1578).

The Iowa Dept. of Natural Resources (2015, p.357) also notes that while butterflies are a fairly mobile group with some possible dispersal, but may not be the case in Iowa as "habitat fragmentation is of particular concern to Iowa's butterflies because of their reliance on prairie, grassland, and wetland habitats that are becoming less common on the landscape." They also note that Iowa butterflies may suffer impacts via the effects of climate change on plants that serve as their larval hosts and sources of nectar for adults, as these plants may become less common or the timing of their flowering may change, shifting out of balance with the butterfly species' life cycle (Iowa Dept. of Natural Resources 2015, p.357). Climate change will likely also affect habitats and potentially host or nectar plants by increasing the threat of invasive non-native species to terrestrial habitats (Fowler and Anderson 2015, p.1575).

In the Great Plains, recent shifts in climatic patterns show increasing precipitation in the northern part of the region and decreasing precipitation in the southern Great Plains, which affects the frequency and duration of drought (Hanberry et al. 2021, p.226; Oglesby et al. 2015, pp.104, 106). These trends are expected to continue and become even more pronounced, with the southern Great Plains continuing to become drier by midcentury and beyond (Oglesby et al. 2015, p.104). Droughts can cause physiological stress or mortality for plants which can reduce the quality and quantity of nectar sources and larval host plants and make it difficult for pollinators to locate their necessary resources, and as such are considered to be a major threat to the abundance and diversity of pollinator communities (Hanberry et al. 2021, p.226).

While Nebraska lies in between the northern and southern Great Plains, it is expected that drought frequency and severity will increase in the state (Oglesby et al. 2015, p.104). Nebraska's temperature is predicted to increase by 3°-4°F under a low emission scenario, up to 8°-9°F under a high emission scenario, by the last quarter of the 21st century (2071-2099) (Oglesby et al. 2015, p.103-4). The frequency and intensity of extreme weather and climate events is expected to increase in Nebraska, particularly for droughts and heat waves (Oglesby et al. 2015, p.105).

Average annual temperature is predicted to increase by 3.6°F by 2050 in Arkansas under a scenario with dramatic decreases in emissions (Fowler and Anderson 2015, p.1568). Precipitation is expected to decrease in Arkansas by 2050, with the greatest decreases in the southern portion of the state. (Fowler and Anderson 2015, p.1571). Climate change models also project that this precipitation will be produced in fewer and heavier rainfall events, which can result in an increase in drought and flooding events. (Fowler and Anderson 2015, p.1571-2).

Oklahoma is predicted to have a warming trend of 3-5°F over the next 50-75 years under intermediate emission scenarios, with the highest temperature increases expected in the summer and fall seasons (Oklahoma Dept. of Wildlife Conservation 2016, pp.14-15). The models also predict a 3-6% decrease in annual total rainfall across the state, with the magnitude of change expected to be slightly higher in the southern and western parts of the state (Oklahoma Dept. of Wildlife Conservation 2016, pp.14-15). Small increases in rainfall predicted in winter are expected to be more than offset by declines in spring and summer rainfall (Oklahoma Dept. of Wildlife Conservation 2016, pp.14-15). Oklahoma is also expected to experience an increased frequency and duration of droughts (Oklahoma Dept. of Wildlife Conservation 2016, pp.14-15). The potential for impacts of these changes is particularly concerning for Iowa skippers since they appear to be relatively more common in Oklahoma than in other parts of their range.

3. Invasive Species

The invasion of non-native plant species that outcompete the Iowa skipper's native nursery and forage species has contributed to the species' declines and continues to pose a threat to the Iowa skipper's habitat throughout its range (Minnesota Dept. of Natural Resources 2022; Sievert and Prendergast 2011, p.2; Skadsen 2009, p.12; Backlund 2009, p.12; Schlicht and Orwig 1998, p.82; Royer and Marrone 1992, p.16). In a literature review on the effects of non-native plants on lepidoptera (butterflies and moths), Yoon and Read (2016, pp.989-990) found non-native plants were associated with reduced overall lepidopteran abundance and reduced species richness.

The invasion of the introduced and now naturalized grasses smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) are an ongoing threat to all remaining native tallgrass arid midgrass prairie site in the Dakotas (Royer and Marrone 1992, p.16). Many eastern South Dakota tallgrass prairies have been taken over by Kentucky bluegrass and smooth brome is the most common of the introduced pasture and hay grasses in eastern and central South Dakota. Smooth brome is an aggressive perennial sod grass that has vigorous rhizomes (Royer and Marrone 1992, p.16). The invasion of Iowa skipper habitats by these invasive plant species may cause long-term declines in the skipper's population levels (Royer and Marrone 1992, p.16). Purple loosestrife may also threaten wetland associations that border some Iowa skipper habitats (Royer and Marrone 1992, p.16).

Smooth brome, as well as leafy spurge (*Euphorbia virgata*) are also considered to be serious threats to the Iowa skipper in Minnesota (Minnesota Dept. of Natural Resources 2022). And in Colorado, the Iowa skipper is associated with xeric tallgrass prairie that are themselves threatened and impacted by the invasion of aggressive non-native species such as cheat grass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*), and diffuse knapweed (*Centaurea diffusea*) (Essington et al. 1996, pp.11, 15).

In its designation of the Iowa skipper as a sensitive species in Region 2, the U.S. Forest Service (2018b, p.2) explains that the Iowa skipper's habitats along the prairie/forest ecotone in the Black Hills of South Dakota and Wyoming and Colorado's Front Range are "highly fragmented and invaded by non-native sod forming grasses and invasive species such as smooth brome (*Bromus inermis*), cheatgrass (*Bromus tectorum*), leafy spurge (*Euphorbia esula*), Dalmatian toadflax (*Linaria dalmatica*), Canada thistle (*Cirsium arvense*), and other exotic species."

In addition to degrading the Iowa skipper's habitat and replacing the Iowa skipper's preferred larval host plants and nectaring plants, invasive plant species may create population sinks and ecological traps for the Iowa skipper if they use these invasive plants as oviposition sites or larval hosts and the plants are poor quality and reduce the chances of survival (Nordmeyer et al. 2021, pp.302, 312; Yoon & Read 2016, pp.989-94; Keeler & Chew 2008; Schlaepfer et al. 2005, p.242). In a literature review intended to quantify the effects of invasive plants on butterflies and moths, Yoon and Read (2016, pp.990-91) overwhelmingly found reduced performance and survival for larvae developing on non-native host plants when compared to native hosts.

Nordmeyer et al. (2021, pp.302-303) offered the threatened Dakota skipper larvae one of five commonly occurring native grasses or two invasive grass species found across their historic range and observed their mass, time to pupation and survivorship over time to compare host plant quality. Although the Dakota skipper larvae fed on the invasive smooth brome and Kentucky bluegrass, as it did the native grasses, the larvae provided with these invasive species fared the poorest for all of the observed metrics, including a survival rate from pupae to adult eclosion that was drastically lower for smooth brome compared to all other treatments (Nordmeyer et al. (2021, pp.306-310).

Attempts to control invasive plant species in the Iowa skipper's habitat with pesticides can also negatively impact the Iowa skipper's native prairie habitat, and may also cause direct impact to the skippers, as described in further detail in the pesticide section above (*See* Section IV(E)(1)). For example, in the Dakotas, Royer and Marrone (1992, p.15) explain that attempts to control leafy spurge (*Euphorbia podperae)* by helicopter spraying in the area dramatically reduced broadleaf prairie plants, including the Iowa skipper's favored nectar sources. Similarly, prescribed burning that is used as a management tool to suppress non-native species may also be harmful to the Iowa skipper, as discussed further above (*See* Section IV(E)(1)).

4. *Small, Isolated Populations*

Where the Iowa skipper continues to persist, its populations are typically small and isolated in similarly small, isolated patches of native prairie habitat. Small colony sizes and isolation are themselves important threats to the Iowa skipper's continuing survival (Minnesota Dept. of Natural Resources 2022; Olsen 2018, p.8; U.S. Forest Service 2018b, p.2). The ongoing and anticipated future reduction of native prairie ecosystems, such as through conversion to cultivated agriculture, urbanization, overgrazing, fire, pesticides, or non-native or woody plant invasion, continue to reduce the amount of suitable habitat patches for the Iowa skipper and further isolate those that remain (U.S. Forest Service 2018b, p.2; Sievert and Prendergast 2011, p.2).

Because insect populations, like the Iowa skipper, experience natural cycles of population increases and declines, they are especially vulnerable to extirpation when they are fragmented into small populations (Schlicht 2001, p.199; Orwig and Schlicht 1999, pp.6-7). A population in these circumstances can easily be wiped out by random extreme weather events, such as a drought or an ill-timed hailstorm, pesticide drift, disease, poor habitat management, overgrazing, genetic deterioration, and other circumstances (Minnesota Dept. of Natural Resources 2022; Olsen 2018, p.8; Orwig and Schlicht 1999, pp.6-7). All the threats discussed elsewhere in this petition are heightened by the fact that the Iowa skipper primarily exists in small, isolated populations.

The Iowa skipper's dispersal capabilities and their life expectancy are unknown, though there is some evidence of long-distance dispersal for its sister subspecies, *Atrytone arogos arogos* (Minnesota Dept. of Natural Resources 2022). However, even if dispersal may have been important for the Iowa skipper historically when their habitat was much more extensive and continuous, it "must now be assumed to be extremely low or nonexistent" (Royer and Marrone 1992, p.13) as the isolation of populations surrounded by a landscape on unsuitable habitat makes immigration unlikely (Minnesota Dept. of Natural Resources 2022; U.S. Forest Service 2018b, p.1). Because the populations are so isolated, when a natural or manmade event wipes out a population there is unlikely to be another population nearby capable of recolonizing and "we may quickly lose rare species on these isolated preserves" (Orwig and Schlicht 1999, pp.6-7; Schlicht 2001, p.197).

With small, isolated populations and a lack of dispersal between colonies the Iowa skipper is susceptible to a loss of genetic diversity, genetic drift, and inbreeding depression. Low levels of genetic diversity reduce the capacity to persist in varying environmental conditions and respond to environmental change, and can decrease their population fitness by reducing longevity, fecundity, offspring viability, and dispersal (Mattila et al. 2012, p.E2501-503; Vandewoestijne et al. 2008, pp.4-8).

V. CONCLUSION

The Iowa skipper is a small bright yellow-orange butterfly with a once extensive range across fourteen states, "roughly coincident with the midcontinent grassland biome," that is now patchily distributed in small, isolated populations in those places where the species has not yet disappeared. The Iowa skipper suffers from significant past and continuing losses and degradation of its native prairie habitat, primarily caused by conversion of their habitat to industrial agriculture and its accompanying harms. This has left remaining populations confined to small prairie remnants typically surrounded by a landscape of inhospitable intensive row crop agriculture. Even where isolated habitats that are home to the Iowa skipper are "protected" in preserves, the species often continues to be at risk due to harmful management practices that are not designed to conserve this species, such as frequent burning or spraying pesticides to control invasive species. Iowa skippers on preserves and elsewhere are also at risk from harmful practices occurring on adjacent lands, such as the spraying of toxic pesticides on agricultural lands, as they can drift to preserves and directly harm Iowa skippers or indirectly harm them through damage to the species' habitat. The Iowa skipper's survival is also threatened by loss of habitat to urbanization and other uses, livestock grazing, climate change, invasive species, and its small, isolated colonies. Based on the best available science, the Iowa skipper is in danger of extinction and qualifies for protection under the Endangered Species Act. The U.S. Fish and Wildlife Service must act promptly to protect the Iowa skipper in order to halt and reverse its ongoing declines and disappearances throughout its range, and to plan for the species' future survival and recovery.

VI. REFERENCES

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