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The Status of Iowa's Lepidoptera

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The Status of Iowa's Lepidoptera

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Including strays, 122 species of butterflies have been confirmed in Iowa. However, since European settlement the populations of taxa of Iowa Lepidoptera have declined. While certain generalist species have experienced declines, species with life cycles that include native habitats, especially prairies and wetlands, have been particularly vulnerable. In a 1994 revision of the Iowa endangered and threatened species list, the Natural Resource Commission (NRC) listed two species of butterflies as endangered, five as threatened, and 25 as special concern, using general legal definitions of those rankings (NRC 1994). But after examining recent records, we have revised that list, using numbers of remaining sites as a scale of rarity. Of the 100 species of resident butterflies, one species is believed extirpated, eight are critically endangered, 15 are endangered, and 21 are threatened. Iowa's moth fauna is poorly sampled but may show similar trends of decline in restricted habitats. Monitoring and habitat preservation efforts are ongoing. However, the effects of current efforts to manage lepidoptera populations are unproven and may even be detrimental. With continued habitat fragmentation, pesticide use, succession, and fire management, Lepidoptera diversity in Iowa is likely to continue to decline. Preservation of native remnants and management plans that recognize the key role of invertebrates are essential for the long-term health of remnant ecosystems.

INDEX DESCRIPTORS: Lepidoptera, butterflies, endangered, prairie, management.

"There is little doubt, despite the relative inconspicuousness of many kinds, that insects and other invertebrates are the most important animals in maintaining the natural basic functions of ecosystems and communities."—T. R. New (1991)

There are approximately 50,000 vertebrate species worldwide, but scientists have formally recognized one million insects. Estimates of arthropods run to "several tens of millions" (New 1991). Erwin (1982) estimates that there are 30 million species of arthropods in the rainforest canopy alone. Insects and other invertebrates are the most significant elements of Earth's fauna, both in species number and biomass. Invertebrates are vital to the pollination of most cultivated and wild plants, they also do the major work of recycling organic matter, and are essential in forming and maintaining soils. "Beneficial" invertebrates control "harmful" plants and invertebrates, and invertebrates are the major food source of many vertebrates, from warblers to whales. Invertebrates provide food for human beings (honey, shrimp, oysters, grasshoppers), and are valuable for medicine (leeches, bee stings), industry (silk, sponges), and crafts (pearls, shells). Invertebrates also have substantial scientific and aesthetic value. However, invertebrates are the most diverse, least understood, and potentially most endangered faunal element of Iowa's ecosystems; for example, nearly 25% of our butterflies have been seen at fewer than 20 sites in recent decades.

In an average Iowa prairie, there are more species of invertebrates than plants and vertebrates combined. Acre for acre, invertebrates represent a greater biomass than all vertebrates; however, we know little about most prairie invertebrates.

The first preliminary study by Reed (1996) listed 728 species of insects and other invertebrates that may have been restricted to prairie habitats, but we predict at least five insect species per plant species or about 1000 to 1500 insect species on a high quality prairie. High-quality Iowa prairies sustain 50–60 species of butterflies; one-third to one half of these species are habitat-restricted. Excluding agricultural pest species in non-native habitat, Lepidoptera are probably the most intensely studied of the state's invertebrate fauna. For these reasons Lepidoptera, particularly butterflies, can be studied as indicator species of the health of Iowa's invertebrate populations and, by extension, their ecosystems.

HISTORICAL PERSPECTIVE

Pre-European Settlement

Resident butterfly species were tied to native habitat and declined with that habitat. In their study on forests, Thomson and Hertel (1981) estimated that at settlement Iowa was 19% forest (6.7 millon acres), but in 1980 only 4% of that forest remained. Forty-three species of resident Iowa butterflies are found in forest habitat.

Pre-settlement prairie was believed to cover 85% or 26 to 28 million acres of Iowa, with 0.1% remaining in 1980 (Smith 1981). There were 41 species of prairie butterflies.

More than 95% of the estimated six million acres of prairie wetlands thought to have existed in 1800 are also gone in Iowa. By 1922 the United States Department of Agriculture inventories listed only 368,000 acres of wetland, while by 1981 just 26,470 acres of natural marsh (Bishop 1981). There were about 17 species of wetland butterflies.

Savanna is now believed to have covered some areas earlier plant surveys listed as either forest or prairie. There are about 28 species of butterflies that may have preferred savannas to other ecosystems, but survive today as forest or prairie fauna. True savanna has essentially disappeared in Iowa.

It is impossible to know the status of Iowa butterflies before European settlement, but we can assume that many species declined in

abundance proportionally to the decline in native habitats. A few habitat-generalist species that can use degraded, agricultural, or early successional habitats may have actually increased, but most species have suffered dramatic declines.

Post-European Settlement

Historical accounts of Iowa butterflies were first published by Scudder (1868). Scudder (1869) also published the first list of Iowa butterflies, based on collections and observations made in 1867 by J.A. Allen near Boone, Denison, and Exira. Scudder mistakenly assumed that his total of 42 species was the majority of Iowa species, because "we may reasonably assume that the level prairie lands and wooded river banks of Iowa, with their comparatively uniform vegetation, support a much smaller number" than the 100 species then recorded from New England. Allen considered the silvery crescentspot [*Charidryas nycteis* (Doubleday and Hewitson)] to be more abundant than all other species combined, flying over open prairie, near wetlands, and in woodlands. He captured the first known specimens of the Iowa skipper [*Atrytone arogos iowa* (Scudder)] and said: "This is one of the most abundant Hesperians seen in Iowa; it occurred almost exclusively on flowers of *Echinacea angustifolia* D.C., which grew on knolls on the open prairie."

The species that most impressed Allen in 1867 was the monarch [*Danaus plexippus* (L.)]:

> "This extremely abundant butterfly seems to prefer open prairie, but is driven to the groves by the winds which sweep furiously over the prairies in the summer months, and especially in September; here the butterflies are collected in such vast numbers, on the lee side of trees, and particularly on the lower branches, as almost to hide the foliage, and give to the trees their own peculiar color. This was not seen in one grove alone, but in all of those which were visited about the middle of September. . . . At New Jefferson, a little later in the year, when the gales had abated, they were seen leaving the groves in vast flocks, and scattering through the air almost beyond the reach of the eye." (Scudder 1869).

While both the silvery crescentspot and the monarch are habitat-generalist species, we do not see them today in the numbers reported by Allen, and the Iowa skipper has declined as precipitously as Iowa prairie. Another prairie restricted Lepidopteran, the Poweshiek skipperling [*Oarisma powesheik* (Parker)], was named (but misspelled) after the county where Parker first collected it in 1870. Parker described it as being abundant "on a grassy prairie slope" (Parker 1870) at Grinnell, and easily collected 31 males and two females. Today the Poweshiek is limited to fewer than 20 sites in the northern two tiers of Iowa counties.

Iowa native Arthur Ward Lindsey (1894–1963) documented the decline of Iowa's Lepidoptera in the first two decades of this century. In ten years of boyhood collecting around Sioux City, Lindsey scoured the "many remnants of the prairie typical of this part of the country which harbor great numbers of butterflies . . . both in and near town" (Lindsey 1914). His favorite site, though, was the forest/savanna/prairie complex known today as Stone State Park and Mt. Talbot State Preserve:

> "Most of the ravines are heavily timbered with small trees, all native species. . . . The timber is bordered on the hillsides by dwarfed Burr Oaks which blend into the wild grasses with a fringe of Sumac and Snowberry thickets. Near the mouth of the hollows are a number of sparsely wooded, grassy meadows which are the favorite haunt of many species of butterflies. . . . Bounded by the road and the river is a marshy thicket of willows and small shrubs. On a number of pasture thistles by the roadside may always be found hordes of fritillaries during the hot days of August and September" (Lindsey 1914).

Frustrated that only Holland's outdated *Butterfly Book* was available for identification, Lindsey began publishing, first a Woodbury County list, then Iowa lists, and finally technical monographs that classified skippers nationwide, returning often to his Sioux City records. Lindsey (1917) published the first comprehensive list of Iowa butterflies, listing 102 species, and a few years later (Lindsey 1920, 1922) he published records of over 600 species of Iowa moths. Some of the woodland moth species that he listed as common are seldom recorded today.

As late as 1961, Miller added four new state records of habitat-restricted butterfly species to the state lists. The Zabulon skipper [*Poanes zabulon* (Boisduval and Le Conte)], a species that Miller listed as "well-established in the Des Moines area" (Miller 1961) is seldom seen today.

Since Miller's 1961 records, remnant habitats have been frequently surveyed by Downey (1975, 1978) and several others, and we have a fairly comprehensive picture of the state's fauna. Current cumulative county species lists reflect both richness of remnant habitat and the number of historical and present observers. The highest species diversity has been recorded from Linn (84), Woodbury (82), Fremont (81), and Allamakee (79) counties, while the fewest species have been recorded from Winnebago (7), Worth (9), Monroe (12), and Wayne (14) counties (Nekola and Schlicht 1995).

Two European species of butterfly have joined the Iowa fauna. The European cabbage butterfly [*Pieris rapae* (Linnaeus)] was introduced to North America around 1860 and became common throughout the eastern U.S. by 1871 (Scott 1986). It is undoubtedly the most common species of Iowa butterfly today. The European skipperling [*Thymelicus lineola* (Ochsenheimer)] appeared in Ontario in 1910, spread throughout the northeast and is expanding westward. First sighted in Keosauqua in 1981, it has since been seen in a number of eastern Iowa counties.

Lepidoptera species have been constantly battered by wave after wave of change, all stemming from habitat destruction or alteration. Most of the original habitats have been reduced to a fraction of their initial extent. Besides this fragmentation, remnant habitats were changed further through logging, draining, dredging, development, road-building, succession, fire suppression, removal of most natural grazers, over-grazing by cattle and deer, haying, invasion of exotic species, and pesticide use. All these forces have altered ecosystem dynamics and differentially selected certain species.

Some of these habitat fragments have been protected as state parks or preserves, but then further altered by various experimental management practices. For example, outside of the Loess Hills, native prairie remnants in Iowa are isolated islands. Their isolation disrupted the cycles of growth and decline, overabundance and dispersal, and extirpation and reintroduction that characterize insect population dynamics, a factor that further selected out various populations. Since settlement, most of these areas were subjected to intensive grazing or haying, pressures that could select out certain species. When these sites were acquired for conservation purposes, all management ceased and successional pressures further changed the sites. Beginning in the 1970s, many of these prairies were managed intensively by fire, still another different selective pressure.

CURRENT PERSPECTIVE

Only one species of Iowa butterfly is currently presumed extirpated. However five species had been extirpated from Illinois by 1973 (Irwin and Downey 1973), and current conditions will lead to further extirpations in Iowa. Current Iowa losses may be most dramatic at the county level, and are not reflected in cumulative species

Table 1. Resident Iowa butterfly species of restricted distribution.

Extirpated
P Hesperia dacotae Skinner
Dakota Skipper

Critically Endangered (1–5 sites)
S Hesperia leonardus leonardus Harris
Leonard's Skipper
F Amblyscirtes hegon (Scudder)
Salt and Pepper Skipper
F Battus philenor (L.)
Pipevine Swallowtail
F Eurytides marcellus (Cramer)
Zebra Swallowtail
W Euphydryas phaeton phaeton (Drury)
Baltimore Checkerspot
F Euphydryas phaeton ozarkae Masters
Baltimore Checkerspot
F Nymphalis vau-album j-album (Boisduval and Le Conte)
Compton's Tortoiseshell
P Coenonympha tullia benjamini McDunnough
Prairie Ringlet

Endangered (6–20 sites)
F Erynnis lucilius (Scudder and Burgess)
Columbine Duskywing
P Oarisma powesheik (Parker)
Poweshiek Skipperling
P Hesperia leonardus leonardus x pawnee
Leonard's X Pawnee Skipper
P Hesperia leonardus pawnee Dodge
Pawnee Skipper
P Problema byssus (Edwards)
Byssus Skipper
W Poanes massasoit (Scudder)
Mulberry Wing
P Poanes zabulon (Boisduval and Le Conte)
Zabulon Skipper
W Poanes viator (W.H. Edwards)
Broad-winged Skipper
P Euchloe olympia (W.H. Edwards)
Olympia White
F Feniseca tarquinius (Fabricius)
Harvester
W Epidemia helloides (Boisduval)
Purplish Copper
S Satyrium edwardsii (Grote and Robinson)
Edwards' Hairstreak
F Satyrium caryaevorum (McDunnough)
Hickory Hairstreak
F Satyrium liparops strigosa (Harris)
Striped Hairstreak
P Glaucopsyche lygdamus (Doubleday)
Silvery Blue

Threatened (21–100)
F Staphylus hayhurstii (W.H. Edwards)
Scalloped Sooty Wing
F Erynnis brizo (Boisduval and Le Conte)
Sleepy Duskywing
P Erynnis horatius (Scudder and Burgess)
Horace's Duskywing
P Erynnis martialis (Scudder)
Mottled Duskywing
P Erynnis baptisiae (Forbes)
Wild Indigo Duskywing
P Hesperia ottoe W.H. Edwards
Ottoe Skipper
P Wallengrenia egeremet (Scudder)
Northern Broken Dash
P Atrytone arogos iowa (Scudder)
Iowa Skipper
W Euphyes dion (W.H. Edwards)
Sedge Skipper
W Euphyes bimacula (Grote and Robinson)
Two-spotted Skipper
P Atrytonopsis hianna (Scudder)
Dusted Skipper
S Amblyscirtes vialis (W.H. Edwards)
Roadside Skipper
S Satyrium acadicum (W.H. Edwards)
Acadian Hairstreak
S Mitoura grynea (Hubner)
Olive Hairstreak
F Incisalia henrici (Grote and Robinson)
Henry's Elfin
P Hemiargus isola alce (W.H. Edwards)
Reakirt's Blue
P Lycaeides melissa (W.H. Edwards)
Orange-bordered Blue
P Speyeria aphrodite alcestis (W.H. Edwards)
Aphrodite
P Speyeria idalia (Drury)
Regal Fritillary
F Polygonia progne (Cramer)
Gray Comma
F Enodia anthedon A.H Clark
Pearly Eye

Habitat: P—prairie, F—forest, S—savanna, W—wetland

totals for the entire state. For example, of the species of butterflies recorded by Lindsey in Woodbury County prior to 1923, eight resident species (not counting several strays) have not been sighted since and are presumed extirpated on the county level (Orwig 1990). For instance, Lindsey swept at a swarm of butterflies on a flower and netted three silver-bordered fritillaries [*Clossiana selene myrina* (Cramer)] and one meadow fritillary [*C. bellona bellona* (Fabr.)], but he saw very few in subsequent years (Lindsey 1914). Despite diligent searches, he was able to net only a single female of *Hesperia dacotae* (Skinner) in 1909 (Lindsey 1920). None of these three species have been seen in Woodbury County since then.

While we have more information about butterflies than most other invertebrates, we still do not have agreement on their current status. The Department of Natural Resources (Natural Resource Commission 1994) in a revision of the Iowa endangered and threatened species list, categorized two species of butterflies as endangered, five as threatened, and 25 as special concern. While these status categories were defined in general terms in state law, it is difficult to quantify them in any meaningful way. Using state rank data from recent surveys by contributors of the Iowa Lepidoptera Project, we estimate that eight species are found in only one to five sites, 15 in six to 20 sites, and 21 in 21 to 100 sites. These sites are remnant prairie, forest, or wetland habitats of varying quality. Of the 100 resident

Table 2. The status of Iowa's butterflies by habitat.

	NUMBER OF SPECIES					
	ORIGINAL	EXTIR.	1–5 SITES	6–20 SITES	21–100	%
Forest	43	0	5	4	5	33
Prairie	41	1	1	7	11	49
Wetlands	17	0	1	3	2	35
Savanna	28	0	1	1	3	14
Total	129*	1	8	15	21	Ave. 32.75

*Some species occupy several habitat types

species, 44 are listed in these three categories and seem vulnerable to further losses (Table 1).

Certainly the habitat fragmentation that has occurred since European settlement was the dominant cause of species decline in the past. When grouped by habitat, almost half of prairie-resident species appear vulnerable, while a third of forest and wetland species and only 14% of savanna species appear vulnerable (Table 2). Since we have lost a greater percentage of prairie than forest or wetland, the greater scarcity of these prairie species would be proportional. Savanna species may have naturally been more adaptable to changing habitat, due to the dynamic nature of savannas. However, the ongoing effects of isolation in a predominantly agricultural landscape will continue to be detrimental.

A state-listed endangered species, the Dakota skipper (*H. dacotae*), should be considered extirpated. It was originally described as *Pamphila sassacus dacotae* by Skinner (1911). The type-locality was "Volga, South Dakota and Grinnell, Iowa." Following that determination of the type, Lindsey recorded it in 1921 (Lindsey 1921), 1922 (Lindsey 1922) and 1931 (Lindsey et al. 1931). Its Iowa distribution was long believed to be Dickinson, Poweshiek, and Woodbury counties. The latter two localities represent historical records, while Dakota skippers were found in Dickinson County into the last decade. The Dakota skipper is an indicator of virgin prairie. It was last found on a gravel ridge within Cayler Prairie Preserve in northwestern Iowa. This ridge had been in a single management unit, a factor that made the skipper's extirpation by prescribed fire management highly possible. Despite frequent searches, there were no confirmed records from Cayler Prairie from 1980 to 1992, when a single male was confirmed. None have been seen since. The Dakota skipper continues to occur in tenuous populations within a few tall-grass prairies in Minnesota and the Dakotas on xeric gravel substrates (Dana pers. comm., 1991; Orwig 1997; Royer 1997; Schlicht 1997).

The regal fritillary [*Speyeria idalia* (Drury)], a prairie obligate, has been in steep decline nationally (Dunwiddie and Sferra 1991) and is now disappearing in the Midwest. Iowa DNR surveys in the 1990s failed to reconfirm regal populations in a number of Iowa counties that had previously listed populations. A survey of 52 southern Iowa prairies by Debinski and Kelly (1998) recorded extant populations in only 11. In Wisconsin the range had collapsed from 16 counties to four by 1995.

This species' decline is probably due to continuing habitat fragmentation and management regimes. Schweitzer (pers. comm.) indicated that the regal has been extirpated by fire management. The larvae do not survive fire and the females have difficulty finding the small prairie violet in fire-stimulated lush prairie. Grazing and/or haying management solved both of these problems. Swengel (1996) noted that the largest populations in Iowa and Missouri are in hayed prairies.

In 1996 and 1997 surveys of 11 Loess Hills sites, regal fritillaries were most abundant on a hayed site both in numbers seen and individuals per 100 meters of transect. Regals were abundant at five of the eight burned sites where recolonization was possible, but were also abundant at a grazed site and an unmanaged site.

The prairie ringlet [*Coenonympha tullia benjamini* (McDunnough)] is sometimes the most common butterfly on prairies in Minnesota and the Dakotas, but has disappeared at several important Iowa sites, including Gitchie Manitou State Preserve, and is listed as endangered by the State of Iowa. The Cayler Prairie population was last seen in 1978. Recent surveys have found a sizable breeding population on the unique dry prairies and savannas of the Blood Run watershed in northwest Lyon County near Granite. These sites probably hold greater long-term potential for survival of northern prairie butterflies than the isolated Cayler Prairie.

Two species, the Baltimore checkerspot and Leonard's skipper, are listed in Table 1 separately at the subspecies level, because they occupy different ranges and habitats.

The Baltimore checkerspot [*Euphydryas phaeton phaeton* (Drury)] has two critically endangered forms in Iowa, a fen subspecies and a forest subspecies. *E. p. phaeton* is restricted to fens where its distribution is limited by its larval foodplant, turtlehead (*Chelone glabra* L.). It is, however, much more limited than the foodplant, and recolonization of isolated habitats is very unlikely. The larger and less red in color *E. p. ozarkae* (Masters), is found on forest sites in Lee County. Its larval foodplant in that habitat is believed to be *Gerardia pedicularia* (Benth.).

The subspecies of *Hesperia leonardus* (Harris) are quite different in appearance, and were long considered to be separate species. Scott and Stanford (1981) suggested that they were conspecific and proposed a phenotypical blend zone based on scattered specimens from Wisconsin, Minnesota, Iowa, and Nebraska. After the rediscovery of the species by Orwig in the Loess Hills in the 1980s, Spomer et al. (1993) demonstrated that specimens form a complete north-to-south cline of intergraded traits in the Loess Hills, thus supporting Scott & Stanford's (1981) findings. Specimens in the north are typical *H. leonardus pawnee* Dodge, a light buff-colored prairie dweller. Specimens from Fremont and Mills county are typical *H. leonardus leonardus,* a brick-red forest meadow dweller. A third group, found in Pottawattamie, Harrison, and Monona counties, intergrades between the former two. Because of the unique characteristics of each subgroup and lingering questions about whether they represent divergence or reconvergence, each of these three populations is worthy of individual consideration and protection.

Moths and Other Invertebrates

Although hundreds of scattered records exist, there are no comprehensive state lists, published or unpublished, yet compiled of Iowa moths, and this daunting task should be undertaken as soon as possible. In a preliminary survey of species of moths from prairies and savannas in the Chicago area, Panzer et al. (1995) identified 78

which are remnant dependent, including over ¾ of the species of flower moths (*Schinia* spp.) and root-boring moths (*Papaipema* spp.). The phlox moth [*Schinia indiana* (Smith)] has only recently been confirmed on one prairie in Iowa. Peterson et al. (1990) identified 19 species of *Papaipema* in Iowa, 12 of which are on Panzer's restricted list. Schweitzer (pers. comm.) noted that these species are "highly sensitive" to fire. Recent collections have confirmed the presence in Iowa of a number of other species of moths on Panzer's list.

Out of the nearly 1100 invertebrate species examined by Panzer et al. (1995), 256 were remnant-restricted, and the researchers concluded that roughly ¼ of the 1100 species studied were not adaptable to habitat degradation. Habitat restriction seems to be particularly significant for several other taxa besides butterflies: underwing moths, leafhoppers, froghoppers, katydids, walking sticks, tiger beetles, leaf beetles, long-horned beetles, weevils, agromyzid flies, and jumping spiders (e.g. Opler 1981, Coffin and Pfannmuller 1988, Panzer 1988, Panzer et al. 1995, Williams 1995).

CURRENT QUESTIONS

Current Factors in Lepidoptera Decline

The most extensive literature on the health of invertebrate populations is from Great Britain, and concerns the 58 recorded species of British butterflies, four of which have been extirpated. Thomas (1984) showed that 85% of British butterflies "form closed sedentary populations"; 44 of the 55 native resident species have declined in a major part of their range.

Management undertaken with the best of intentions can still hasten extinction. Thomas (1984) described how conservation efforts made specifically to preserve the large blue [*Maculinea arion* (L.)] caused its extirpation by 1977.

Erhardt and Thomas (1991) noted the folly of managing only for plants:

> "It follows that many populations of these butterflies disappeared from sites where their foodplants were still relatively common, at least for a few years. This is one of the general conclusions from conservation research into butterfly species in a wide range of biotopes in the Netherlands and in Britain. For example in the English county of Suffolk, 42% of butterfly species have become extinct in the past 140 years, but all the foodplants of these species are still present and only 5% of all vascular plants have disappeared over the same period. Comparable figures for other groups of wildlife in Suffolk are the loss of 12% of amphibian species and 3% of mammal species, while the number of bird species has increased by 14% during this period. There has even been a high rate of extinction among Lepidoptera populations on British grassland nature reserves, although again most foodplants remain."

Dempster (1991) believed that "the vegetation on [reserves and surrounding habitats] should then be managed, out of phase with one another, so that one or more [areas of habitat] is always at any one stage of vegetational development. In this way, it may be possible to ensure the maximum availability of habitat in the right condition for different species, for as long as possible."

Erhardt and Thomas (1991) believed that slight changes in grazing practice had caused the greatest damage to British butterflies. "It is now clear, from the British studies of butterflies, that those grassland species that react very quickly to abandonment or intensification occupy extremely narrow niches during their egg and larval stages." Furthermore, "foodplant populations also eventually decline (or increase) [because] their reproduction is affected by the same habitat changes." Finally, ". . . most quick-reacting species of British butterfly are restricted to much narrower niches than those occupied by their foodplants."

Warren (1992) suggested rotational grazing as one of the best systems of management for butterflies and "many other insects" in British grasslands. He wrote, "of course, not all protected areas can be managed primarily for butterflies but, in nearly every case, measures taken to conserve this group will also benefit a great variety of wildlife."

In Iowa, fire management has been used, ever since the pioneers, to control or eliminate invertebrates, especially grasshoppers. Warren et al. (1987) listed a number of European lepidoptera species that were negatively affected or actually controlled by fire.

The effects of occasional wildfire on a functioning prairie ecosystem would have been very different from the effects of intensive rotational burns on an isolated, ungrazed prairie island. Depending on the timing of the burn, some species will be unaffected by fire management; others may be extirpated. Informal comparisons of overgrazed and overburned halves of a prairie hillside in Monona County (half on private land and half in the Sylvan Runkel State Preserve) show much better brush and tree control by grazing; quick examination of cowflops on the overgrazed site revealed invertebrates not seen on fallow or burned sites.

We understand very little about the obligate relationships between invertebrates and plants, other than that some invertebrates have been extirpated when their host plants have disappeared. For example, four species of moth went extinct when the American chestnut tree was decimated by blight early in this century. Similarly, some plants cannot reproduce without obligate pollinators; yucca need yucca moths.

FUTURE PERSPECTIVES

Warren (1992) noted that "the decline of Britain's butterflies has been extremely severe, probably more so than in any other well-known group of plants or animals." He noted that three reasons are usually cited for how habitat fragmentation causes extinction:

1. inability of populations to survive in small habitat areas,
2. genetic problems from inbreeding and reduced gene flow, and
3. lack of recolonization following local extinctions.

Of these three, Warren argued that the third has the most impact on invertebrate populations.

Pollard and Eversham (1995) noted "there is a consensus of views that the decline of the localized butterflies in Britain has been caused largely by the loss of areas with suitable food-plants, or by changes in the character of such areas." The most frequent cause of loss in Britain was the lapsing of traditional agricultural practices, particularly coppicing in woodlands and grazing of downland. Even slight changes in these practices can cause rapid declines of butterflies as microhabitats are disrupted. Some recent declines have been "spectacular." Mobility of remaining individuals in a species seems to decrease as populations become more isolated.

Dempster (1991) suggested that "there is now a growing body of evidence to suggest that insect populations are far more dynamic, both spatially and temporally, than current theoretical models would suggest, and that persistence owes more to repeated recolonization after extinction than to any internal population regulation." Because of this, "there is clear evidence of continuing losses of species from nature reserves . . . . To conserve such species in the long term, we need to ensure that populations in reserves are kept as high as possible, so as to reduce the likelihood of local extinctions."

Probable Future Losses

In the United States, there is particular concern over the future of one species that we ranked as currently threatened in Iowa, the

regal fritillary. Iowa is at the edge of the regal fritillary's decreasing range; it has been decimated to the east and is declining to the west. If the losses of the past ten years continue, it surely will not survive in most sites through the next decade.

The combination of succession to woody species in the southern Loess Hills and fire management are both likely to eliminate Leonard's skipper (*H. l. leonardus*) from its remaining Iowa sites. The prairie ringlet, now limited to one large site in Iowa, could be eliminated by one adverse climatic event such as a drought or unfortunately-timed hailstorm. Its site is also threatened by the urban expansion of nearby Sioux Falls, South Dakota. The Baltimore checkerspot is restricted to six widely separated sites in Iowa, each ten acres or smaller in size. These isolated populations are in danger of inbreeding, loss of genetic vigor, and localized ecological disturbances such as continuing wetland drainage.

Ecological Problems

Today the survival of as many as half of our butterflies depends on the intentional activities of humans. Many endangered Iowa butterflies live in rare habitats that are managed for the good of other species (i.e. plants or cattle). Our remaining prairie fauna, for example, has been artificially selected since settlement by haying and grazing management. Large scale fire management in the last 25 years has added a new selection criterion for invertebrates on these sites. As a result, we have continued to lose butterfly species from nature preserves. The ecological needs of each stage of the life cycle of lepidoptera are poorly known, as are the effects of various "prescribed" management practices on each life cycle stage, including neglect, which is also a management action (Schlicht and Orwig 1992). For rare species, little time remains to learn enough of their ecology to make wise decisions. For the Dakota skipper, it probably is already too late.

Despite repeated warnings based on worldwide evidence (New 1991), Iowa prairies are still heavily fire-managed. For example, Wearin Prairie, a 45-acre rare floodplain prairie in Mills County, was completely burned in April of 1997, after half had been burned the year before (Rosburg 1997). Conservation agency management plans continue to call for extensive fire management, out of all proportion to natural fire frequency and percent of the landscape covered.

As the Iowa Academy of Science position statement on biodiversity (Iowa Academy of Science 1997) states, biodiversity is a treasure that belongs to each of us. It further repeats our long held feeling that species are being lost before we have time to study their biological and ecological characteristics. We believe action needs to be taken to preserve all of Iowa's native biodiversity. A biological survey of invertebrate animals needs to be undertaken so that wise decisions can be made for the protection of all living entities. Management of biological resources, by any agency or individual, needs to be coordinated and controlled to stop the ongoing losses of one group at the purported benefit of another.

All scientific names in this paper follow Opler and Krizek (1984) and Ferris (1989).

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