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# Butterfly Conservation Management in Midwestern Open Habitats

## Part 5: Frequent feedbacks
## by Ann B. Swengel

**In this section I'm considering the ecological and conservation contexts that butterfly science occurs in.** While butterfly data are what they are regardless of any larger context, this context affects the questions asked of butterfly datasets, the kinds of datasets and studies pursued, and the applications made of them.

**No one was more surprised than me by our prairie butterfly results.** The standard ecological texts say that the prairie ecosystem naturally experienced frequent fire and that species living there co-evolved with that. Since most preserves are managed on that premise, no one wishes more than me that our butterfly results and our scientific scholarship could support that. No one wants to find more kinds and numbers of specialist butterflies than me! Unfortunately, butterflies have not read ecology textbooks and I can attest that most people who have heard my scientific perspective react with surprise or dismay. However it does no good for butterflies if I don't share my best understanding of what I've learned about butterflies but instead say what I think's expected. It also does no good for me if I'm not being honest, however astonishing or even distressing my findings may be. I'm not able to reconcile all views and many issues raised in this section warrant books of their own. My goal here is to summarize some of the reasons why there's room for so much disagreement and uncertainty. These varying perspectives allow for orders of magnitude differences in understanding prehistoric fire frequency and ecosystem function. So this section is more about questions than answers.

**FIRE**

**"Back then prairie burned all the time so how can your butterfly research be right?" I see most of the disagreement being over what none of us have seen. It's about what these messed up ecosystems used to be like way back then when they weren't messed up.** None of us has ever actually seen that, and realistically speaking, we never will. Pristine prairie has also not been seen personally to be sampled and documented by scientists, since prairie was greatly altered and damaged prior to systematic scientific study. It amazes me that most people seem to put more stock in an understanding of the prairie of several centuries and even millenia ago than in data observable today. It's one thing if a person judges to weight my research relatively less than others'. I relatively weight others' work too. But I can't fathom the idea that we know more about the prairie of the long past than about the biota and sites we can all see for ourselves now.

**Furthermore, I see relatively little argument over the butterfly data themselves.** For example, Regal Fritillaries repeatedly turn up as more abundant in rotationally hayed sites (e.g, 1/3 to 1/2 hayed in a single cut that year, the remainder not hayed that year) than in rotationally burned sites that are otherwise comparable in size, vegetation, and location. We as well as other researchers entirely independent of us have documented such comparisons in Missouri, Iowa, Kansas, and Minnesota. Studies by and large don't conflict about the status of populations in particular sites and regions. It's not as if one study says Poweshiek Skipper has declined and disappeared in Iowa and Minnesota but another reports abundant and increasing numbers there. I do not know of any studies reporting a reverse of the pattern we've documented of greater specialist and total butterfly richness and abundance in conservation-style hayed prairies than comparable conservation-style burned prairies. Which prairie, savanna, and barrens butterflies are more findable, which less, and when and where are not in meaningful dispute that I've discovered.

**"Since recent fire suppression reduces fire extent, fires had to be more frequent before that, and therefore native biodiversity has to be adapted to that."** It's certainly true that this is a frequently held view. It's not the existence of fire, but its frequency, extent, and consequences that are debated on the scale of orders of magnitude, here in North America and on other continents with fire-prone vegetation.

**Unless fire occurred in all examples of a butterfly's habitat, co-evolution with fire is not inevitable.** If a process or situation (such as fire) is unavoidable, a species must adapt (co-evolve) or die. However, if the process or situation can be consistently avoided, even if only in a few places, then the species may instead hold out as is in those places, neither adapting nor dying out. While numerous examples of adaptation and co-evolution, as well as extinction, have been documented, there are also many examples of a species holding out and continuing to persist as is. An example includes some bog butterfly species in northern Wisconsin. They are taiga/tundra species stranded here since the last glacial retreat. Instead of co-evolving with the changing landscape around them, these species evidently occur only in bogs here and so have become restricted to less than 1% of the landscape. Yet they are widely findable in those habitat patches.

**Fire is a natural phenomenon, primarily caused by lightning ignitions of wood.** The studies I've seen indicate that natural fire is more likely in places with more trees

compared to approximately similar situations in the same region with few trees (i.e., comparing upland forest or scrub to upland grassland, or comparing wetland forest to wet grassland). Thus, natural fire is associated with more trees, rather than being more frequent in primarily herbaceous vegetation. This makes it hard for me to see fire as the evolutionary force (prior to human arrival in North America, relatively recent in evolutionary scales) causing prairie grassland and associated oak savanna.

**Prior to European settlement, Indians ignited some fires in North America but there's a wide range of assessments as to the frequency, extent, and consistency of this behavior.** Native Americans are not a timeless phenomenon of primeval North America, but historical cultures specific to certain places and times. Practices varied greatly among tribes, and changed within tribe over time as well. They did not evenly populate the continent and sometimes uninhabited and sparsely used no-man's-lands separated hostile tribes. As a result, Native Americans did not exert a consistent and uniform effect on the landscape. Even we modern cultures do not do so; witness those pockets of wonderful biodiversity that continue to be discovered. Most references to Native American fire in ecological contexts I've run across do not actually specify data on particular tribal practices in particular places and times. I've also run across literature that attempted to document specific historical fires in specific places (e.g., 1600s onward on the Great Plains). Less fire was found than was expected from ecological theory, and adverse effects on Native Americans were found (e.g., starvation due to paucity of food in the burned area). Thus, it appears likely that burning by Indians was not uniformly frequent throughout the midwestern landscape.

**Fire appears to increase as a result of European contact, peaking right before European settlement, and rapidly plunging afterward.** Various sources of evidence occur for this, including charcoal samples from soil profiles and tree ring data. These seem to indicate that at the time pioneer diaries were first coming into existence, after some period of initial exploration by whites but before much actual white settlement had occurred, fire frequency was increasing. Then once Native Americans were largely contained or deported from an area, fire frequency plunged. Scott and I have noted this pattern in the literature from various parts of North America, the exact timing varying as to when European settlement began in earnest. In the Midwest and further west, these sharp dropoffs primarily occurred sometime in the 19th century. This is well before large-scale fire-fighting machinery using airplanes and trucks were available. I suggest two factors for this. First is a change in human behavior. Fires due to warfare ceased. Perhaps a concern for the welfare of one's family and community also reduced behaviors likely to ignite fires. Second is a change in land use. Plowed fields, continuously heavily grazed pastures, and annually hayed meadows are all effective firebreaks.

**"Pioneer diaries indicate that the 'untamed' wilderness burned a lot, more so than lightning can account for, and so this is representative of long-standing widespread Native practice."** Many pioneers and settlers thought that prior frequent fire explained lack of brush in prairie and savanna, and the subsequent lack of fire (after settlement) explained development of brush. However, these accounts are usually vague, not specific instances of a specific tribe setting a specific spot on fire on a certain date. Some historical studies show that many fires in the 1800s were actually set by white people, and it can be difficult to find direct (positive) evidence for large scale fires set by American Indians, or a routine practice of frequently setting fires as opposed to fire practices during the period of conflict with white people. In my anthropological studies in college, pre-industrial tribes primarily used fire for the following reasons, other than for food preparation and utensil manufacture: driving game (e.g., toward hunters or toward death over a cliff), slash and burn agriculture, and warfare/execution. Presumably human error also resulted in accidental fires then as now. I was not taught about anthropological evidence advanced as substantiating a practice of large-scale or long-term landscape management independent of specific immediate tasks. I haven't come across this since. I welcome any such studies being brought to my attention.

**The time period usually referenced for prairie "back then" to be imitated and re-established in preserves today actually comes from the 19th century.** This period is often called "pre-settlement" (right before European establishment of farms and villages). But it follows decades or centuries of ethnic disruption (tribal deportation, emigration, dieouts from epidemics and conflict) and considerable resource utilization (such as hunting and trapping) by Europeans, all of which could affect vegetative structure, fuel availability, and frequency and extent of burns. While less information is available the further back in time we go, the more time elapsed after European contact or influence in an area, the less representative that time is of "natural" (pristine) ecosystems.

**In one memorable excerpt read at a conference to document that Indians routinely burned the larger landscape as a normal part of their culture, the white writer stated that this was the time of year when the Indians burned everything, he'd ridden for miles with nothing left unburned, but he found a small unburned area that he lit and it burned as far as he could see over the horizon.** Those aren't my definitions of nothing, small, and ignitions only by Indians. By definition pioneer diaries primarily start becoming available during this just pre-settlement period and many white settlers were in conflict with Indians (a possible cause for more fires). As a result, these observations may not be representative of Native American practice or the prairie ecosystem from before then.

I think that all diaries should be subjected to careful historical analysis, as developed by social scientists, to interpret these texts for how much weight should be placed on them. I do not take what anyone says now at face value, but instead consider the source and its substantiveness. I also do not believe something just because it was said by someone who has been dead for over a hundred years. Furthermore, I do not assume that anything a Native American might have done was beneficial to biodiversity and therefore to be imitated without examination of its effects first.

**It's unclear to me whether or how much fire frequency was higher before meaningful European contact than after European settlement.** On the one hand, no effective technology existed to put out fires once they got away. Studies of tree rings from fairly old trees and accounts of fire events may show higher fire frequencies stretching back well before settlement compared to right after. On the other hand, some soil and lake sediment profiles from the heart of tallgrass prairie show very little charcoal and few discrete fire layers (specific fire events) in past millenia. Furthermore, fire in North America often appears to be a function (among other things) of human population density, especially those with technology. The more people and the more technology (meaning more ways for ignitions to occur), the more fires, deliberate and accidental. This holds not just in our modern time, but over past centuries too.

**Fire frequency varies within a given vegetative classification type, due to such possible factors as topography, water features, weather and climatic variation (drought here but not there; lightning here but not there), variability in abundance and food consumption preferences of fauna (consuming or leaving fuel), variation in human behavior, and chance.** Butterfly occurrence and abundance also varies greatly within a given vegetative classification type. As a result, even though fire sometimes occurred, perhaps sometimes even a lot, in a given vegetation type, this does not mean that certain butterfly species particular to those vegetative classification types were actually occurring primarily where that fire was also occurring. Did the places where specialist populations did well enough to persist over the long haul burn as much as average places in the landscape? Do fires "do" things ("services") that these specialists require and/or are fires one more problem they have to survive somehow (along with predators, parasitoids, droughts, frosts, and so on) or be locally extirpated? Some butterflies that are specialists now may not have been specialists then. In that case, these species (not specialists then) may have fared fairly well with fire back then just as non-specialists also do today. But some butterflies may have been specialists for longer than whites have been in North America. These species persisted despite living in a small proportion of the natural landscape. Now that only a small proportion of the landscape is natural, how much of that is suitable for this specialist now?

**"Jack pines, which occur in pine barrens, have 'closed' (serotinous) cones that open during fires to release their seeds to establish on newly burned ground, showing that fire was a frequent event causing this co-evolution."** Pine species in other parts of the country also have closed cones. The species I've seen, including jack pine, do not have closed cones exclusively but also have open cones that expose the seed immediately. Furthermore, closed cones open under other circumstances, such as when the tree dies or the branch falls off the tree. Thus, closed cones are also a way to delay seed exposure, including when the parent tree no longer would be competing with its own seedlings. Animals have also exerted evolutionary pressure on pines. Species past (such as mastodons, ground sloths, and the Carolina parakeet, which despite its name occurred widely in the Midwest) and present (such as finches and squirrels) feed on pine seeds and/or browse on pine needles. Closed cones could afford protection from those feeding behaviors. Thus, serotiny can have various useful functions for a pine tree, including but not limited to adaptation to fire. Oaks also have adaptations to fire (dense bark; ability to resprout densely from the roots). But these are beneficial for defense against insects, browsing mammals, and drought too.

**"How can the prairie butterflies be so averse to prairie fire management when all prairie plants benefit from it?"** Actually, I think vegetation also supports the concept I see for butterfly response to fire, namely that some species benefit, some don't, and more generalist species are more likely to benefit (or not decline from it) over the long run. Concepts of fire dependence of ecosystems are usually based on vegetation, and usually on positive results of native but dominant (that is, more generalist and widespread if native) plants such as oaks and grasses. Many prairie plant species are cool-season growers, a group widely disfavored by cool-season fire. Thus, fire can reduce plant diversity in prairies even as productivity (mass) can increase due to dominant grass growth. Furthermore, I do not see strong effects of brush and weed reduction in burned prairies supported in the science, as discussed in Part 3.

**"We have to burn to control or prevent the spread of non-native cool-season grasses."** This practice is based on the concept that cool-season burning disfavors plants that primarily grow in the cool season. This concept is widely documented for *native* prairie plants in the scientific literature, and it accords with my observations of floristic shifts toward increased dominance of warm-season native grasses in fire-managed prairies (burned primarily in the cool season). However, the studies Scott and I have run across do not indicate this substantial reduction in *NON-native* cool-season grasses. In fact, usually no change or even increase in these grasses is reported. In the few instances where some reduction occurred, these plots were burned annually in a very specific seasonal timing for a number of consecutive years. That may explain why studies of burning do not

usually indicate meaningful reduction in non-native cool-season grasses. With fickle midwestern weather, it may simply not be possible to burn in that narrow timeframe plus long-term annual burning is usually rejected (fortunately) as an acceptable conservation practice. That's because it incurs a great biodiversity cost, not only disfavoring the many fire-sensitive native prairie insects I am talking about in this series, but also cool-season native prairie flora, not to mention nesting grassland birds, which require litter (the fuel for the fire) for nesting.

**Since only some reduction of non-native cool-season grasses has been obtained when fires are done annually for many years in a narrow seasonal timing, then why is it that those fires are each relatively ineffective since so many fires are needed just to obtain this result?** Here are some hypotheses I'm considering. One, these grasses are Eurasian in origin, where they have a long history intertwined with human agriculture. As a result, they have been selected to be more able to cope with frequent clipping throughout the growing season, as from season-long grazing and lawn mowing. For these plants, a single fire may be analogous to a single instance of such a "clipping." Two, these grasses are adventive species that are relatively more benefited by the bared soil resulting from a fire than the native prairie flora as a whole is, and this advantage from bared soil presents itself right when the non-native grasses are growing (in the cool season). Three, cool-season burning disfavors cool-season native prairie flora more than the non-native grasses. Even if all the cool-season growers are set back by the fire, the non-native ones still fare relatively better than native ones. The reduced competition from native prairie flora presents an increased opening for the non-native adventive plants to take advantage of after the fire.

**This still leaves us with the issue of keeping native prairie flora in existence (not overwhelmed and replaced by non-native plants) so that native prairie insects can have the resources and conditions they require.** I see this in two parts. One, how do we keep high-quality native prairie flora intact by preventing non-native plant establishment in it? Two, what do we do with sites that already have exotic plant problems? Based on what is known, though, I would suggest the following approaches. My first goal is simply containment. This applies both to "containing" the already existing exotic plant to be only where it is now in the prairie but also to "containing" an entirely undegraded prairie site to stay "immune" to exotic plant invasion. If you can keep exotic plants where they are now and not have them spread (either into your site, or farther into your site), that's a huge victory. Within the prairie, I would focus on preventing non-native seed set and preventing bare ground that opens the door to non-native establishment from root spread and from existing seeds in the ground or blowing in from elsewhere. Furthermore, reduced infiltration of sunlight to the soil surface via covering by "litter" (dead plant matter) and conservation applications of mowing/haying (discussed in Part 4), which encourage a growth habit of native flora that is dense at ground level, can impede seedling establishment of exotics. The theme of all this is trying to tip the balance relatively more in favor of native plants. They are the ones in the position to do the job of suppressing exotic plants because they are there day in, day out, day after day, constantly in position to "work" at this, while we humans simply cannot be there doing that all the time.

**Reducing existing exotic plant patches is difficult because they are adapted to disturbance of the soil surface and humans do that a lot, unintentionally or not.** Even the strategy that works to control non-native plants the best in scientific studies (herbiciding) may only work in the short-term. That's because the outright kill of exotic plants leaves a bare area where, yes, exotic plants (whether in the seed bed or in the surrounding landscape) have the advantage in re-establishment. As a result, I also suggest a strategy of learning to live with exotic plants. I most certainly do not mean embracing or capitulating to them. I mean accepting the constant vigilant uneasy truce that our modern landscape imposes between us conservationists and these amazingly adaptable, prolific, and prevalent exotic plants. This strategy focuses on helping the natives outcompete the non-natives and focuses more on retention of rare species, no matter how scruffy and imperfect their habitat patch looks.

**But let's assume for now that prairie flora, however you wish to measure it (species richness, composition, productivity, rarities), improves with fire.** The first lesson of both butterfly gardening and butterfly conservation is this. Making more plants, even native ones, doesn't automatically mean making more butterflies, especially rare ones. It's HOW you get WHICH plants that matters to butterflies. Plants in perfect horticultural form may be butterfly poor, and another garden of exactly the same plants in a similar landscape context may be relatively much butterfly richer and horticulturally no doubt far from what is typically taken to be the ideal. Likewise, I've seen floristically excellent prairies that are butterfly deserts and imperfect prairie flora with outstanding butterfly faunas. There are many factors that can contribute to this. One site may happen to have more caterpillar food plants in more favorable microclimates. But historical and current land uses contribute to better butterfly outcomes too, tending more toward the less intensive (unintensive regimes of mowing/haying and/or grazing, with little or no fire) and tending away from the more drastic (plowing, intensive mowing/haying and/or grazing, large-scale fire). It's possible to come up with solutions that can be outstanding, or at least far better than average, for both plants and animals, because I have seen such sites. But this requires accepting the limitations that both plants and animals place on those management answers.

**"I see lots of butterflies in burned prairies."** Yes, but what is the context for these observations? Are you

comparing this to where most humans spend most of their time? In that context, yes, there are likely to be more butterflies in the prairies than in the intensely developed urban/agricultural landscape. Or is this compared to the same prairie before any burning? Is this compared to other prairies similar in size and vegetative composition and range but managed by other means (not fire) that are compatible with the continued existence of native prairie flora? Are these observations from when the prairie was first being conserved and not all of it had been burned yet? Or after all parts of the prairie patch have been through several rounds of fire management? Which species are we talking about? Are they special to prairie or do they occur widely in the non-prairie landscape too? Most species and sometimes most individuals found in a prairie are not prairie specialists but instead occur widely in degraded grasslands or other habitat types (wetlands, savannas, scrub, forest). If you are seeing lots of prairie specialist butterflies in a prairie where all parts of the habitat patch have been in fire management for years, that's a very unusual observation.

**But an isolated small prairie has repeatedly been burned in its entirety and still has some specialist butterflies in it.** This is a remarkable result, akin to an elderly chain-smoking bacon-eater. Possible, but not the usual outcome. Even though such things may occur, that does not appear to be the usual case. Whenever I have encountered this, I am still able to note that the site is depauperate in the usually expected specialists for that vegetation and location and no fire-vulnerable specialist is abundant. There seems to be a strain of thinking that if any individuals survive a fire, or seem to have been surviving a fire management regime, this invalidates that any individuals die in that fire or that fire could be detrimental to the population. The idea seems to be that only instant 100% mortality is harmful. Harmful as the effects of mosquito spraying and Btk spraying have been documented to be for non-target butterfly species, I do not expect instant 100% mortality there for exposed vulnerable non-target species. I'm also amazed at how many smokers survive this behavior for decades. But this does not diminish the high risk of this behavior to health. Let's substitute the word "haying" or "grazing" for "burning" in these sentences and rationales about fire. This mental exercise is meant to encourage our concepts of management to approach the "double-blind" standard used in medical research (where those who get treated, those who take data on these treatments, and those who analyze the data do not know who is receiving what treatment if any). Would you use that standard (any survival at all by any individuals of any rare species) to determine that a management (in this case, haying or grazing) is OK for rare species? I sure don't, and I also don't for burning.

**Some assertions of fire dependence are not based on positive evidence (i.e., experiments or observations on the species showing it abounds with fire and dies out without fire), but rather are assumptions based on the belief that the ecosystem it occurs in is fire-dependent, so that it must also be (assumed to be) fire dependent.** Some of the basis for identifying ecosystems as fire dependent in the scientific literature is extrapolated from what the vegetative structure is. That is, fire is imputed to be the cause of vegetative structure. This is different from providing positive evidence documenting that the fires happened and had the expected effects. Likewise, some assertions in the scientific literature that fire is safe or necessary for particular species is also extrapolated from this assumption that the ecosystem is fire dependent. The thought is this: the species lives in this habitat; this habitat is believed to be fire dependent; therefore the species must tolerate or require fire too. I instead assign a considerable portion of those vegetative effects inferred to result from fire to be a result of fauna instead (see next section). With that intact and abundant fauna, much of the vegetative biomass (fuel) in grassland would be utilized by the animals instead.

**There's a lot of room in the evidence to support a variety of assessments of fire frequency.** Because I see so little adaptation to fire in my study species and little positive evidence for fires occurring in prairie pre-European contact, I weight the evidence toward the lesser end of the spectrum. Indeed, I think fire was rare in prairie. I believe the evidence supports relatively more fire in savannas due to the presence of trees, with particularly flammable pines in barrens. Nonetheless, I do not see positive evidence for more than infrequent fire even there. On the other hand, although I think this less likely, perhaps fire was a bit more frequent than I assess, although still not frequent. This variable background rate of prehistoric fire, as well as huge forestry-related fires post-settlement (e.g., Peshtigo, Wisconsin and Hinckley, Minnesota), could contribute to the lack of some butterfly records in some seemingly suitable patches of habitat in range. A past catastrophe could have extirpated a species and it might not then have been able to recolonize. Furthermore, I may encounter new evidence, or old evidence yet to be read by me, that changes my understanding.

**Europeans have way more information on their past landscapes due to the longer history of written language there, paintings, and so on, yet very spirited debate continues about what landscapes have been like there in the past.** In North America, we have way less information available. How can we be more certain about any of it (flora, fauna, fire)? Expect more interesting developments on this topic in the coming years—more new things to know and new ways to think about old knowledge.

**I don't think it's as urgent to pin down how frequent fire was prehistorically as it is urgent to understand our landscape now.** We most need to study what we have in the landscape now and how it's responding to what's happening in the landscape. I find no solace if an ecosystem is "restored" to its past processes but loses its specialist butterflies native to its flora.

**FAUNA**

**"What else could have favored uncanopied habitats and disfavored woody plants in middle North America back then?"** Bison are justifiably famous prairie inhabitants occurring in only a few of the extant patches of prairie in existence now. They were also written about by the pioneer diarists, as stompers of brush and ascenders of steep slopes. But did you know that elk were also widespread in tallgrass prairie (actually, widespread throughout much of North America)? The places with greatest abundance of the now extinct but once vastly abundant Passenger Pigeon largely coincide with the zone where prairie and forest meet in a large band mixing prairie, savanna, and forest. Acorns and other tree seeds were primary food sources, thus reducing recruitment of tree seedlings. Diarists described how the weight of their flocks sometimes broke trees and their guano sometimes retarded brush growth. Beavers, muskrats, porcupines, and ground squirrels are other animals that make obvious impacts on flora but have been subject to much change in distribution and abundance due to past overhunting and habitat alteration.

**"Bison were rare in Wisconsin, so grazing can't explain the existence of prairie and savanna in Wisconsin."** Indeed, *Mammals of Wisconsin* by Hartley H. T. Jackson (1961) stated that bison were not as abundant in Wisconsin as in the Great Plains. What bison were here were thought primarily to occur in southern and western Wisconsin. Jackson did estimate about 20,000 bison back then, and I take that to be a very rough number that should not be thought of as exact or fixed. Perhaps that number should be lower. With an individual bison at about 5-10 times the mass of a deer, the inconvenience of 10,000 or 20,000 free-range bison to motorists, farmers, and gardeners would make them seem anything but rare if in existence here today. According to A. W. Schorger, who did an impressively thorough compilation and interpretation of data and accounts available on Wisconsin's native fauna, explorers described areas in Wisconsin with abundant bison, including (not surprisingly) Buffalo County, the Chippewa Valley, and near the mouth of the Wisconsin River. On the other hand, difficulties of terminology, especially in French accounts, can make it a challenge to identify what animal is being referred to (bison, elk, or moose). After bison had been eradicated from an area, writers still mentioned evidence of its former presence (wallows, droppings, horns). However, not many bison fossil remains have been recovered in Wisconsin.

**Even though everything I've read indicates that the bison was a reliable part (not just a vagrant) of Wisconsin's native fauna, let's just imagine that bison were of little or no impact on Wisconsin flora. That still leaves elk, a grazer and browser.** The mammalogical references I draw on generally consider elk to have been common statewide. They would appear to have been most numerous in open woodlands, prairies, and savannas prevalent in the southern and western parts of the state.

**Those pioneer diaries so oft referenced for the prevalence (certainly terror) of prairie fires are also replete with stories of myriad fauna.** They describe vast marches of seemingly innumerable squirrels (yes, squirrels!), teeming numbers of beavers, skies blackened by the now extinct Passenger Pigeon and the lack of forage for domestic stock due to "overgrazing" by abundant native ones. Indeed, midwestern correspondents despaired of being believed for their animal tales. Perhaps not all should be believed, or perhaps we do not known how to construe their descriptions accurately. But that applies to all the phenomena they described (including flora, fire, and Native American practices), not just the zoological stories.

**The largest described Passenger Pigeon nesting that I've learned of occurred within the area from about Wisconsin Dells to Wisconsin Rapids to Black River Falls.** The states most frequently mentioned for abundant Passenger Pigeon nesting are Wisconsin, Michigan, Pennsylvania, and New York. They also occurred, commensurate with the availability of trees, out into prairie and the Great Plains, in riparian corridors, for example. This bird was a short-distance migrant, wintering primarily in the southern United States. Their awed or horrified describers throughout eastern North America certainly believed that this bird had a tremendous impact on vegetation, especially to "open" habitat by reducing (or harming) trees and brush through their eating and their nesting and roosting activities.

**I must warn you that reading explorer and pioneer accounts not only requires caution in interpretation but also fortitude to withstand painful reminders of our human nature.** You will read about senseless destruction of flora and fauna and casual violence against people. Dozens of animals were killed in a single bout of target practice. A whole prairie was burned just so that prairie chicken eggs could be found and harvested. Specific fires at a stated place and time by specific individuals of a particular Indian tribe were not so well described but the massive killing of mammals and birds by explorers and settlers was much better recorded in remarkable detail. This provides more ability to judge the scale of these populations prior to overhunting. However, accounts of fauna have to be read with care due to hype, bragging, misidentification, and confusing terminology. Even the most reliable accounts have to be interpreted with care because these are unsystematic anecdotes, not scientific surveys. What did the terms they used, such as "common" or "abundant", really mean to the writer in that context? But then the same concerns apply to any other observations in these accounts.

**As I mentioned previously, bison varied in abundance within prairie.** While bison are famous for their former abundance on the Great Plains, there's considerable evidence indicating their great abundance in Illinois and Iowa prairie too. There the rich soil and long hot humid summers (so productive of corn now) generated much

greater vegetative production in prairie there than in colder Wisconsin. Furthermore, bison had relatively more access to this forage there year-round because the shorter winter reduces the period of ice and snow cover over the grassland. Meanwhile, Passenger Pigeons abounded in Wisconsin, in our more savanna setting, more so than in Illinois and Iowa. Thus, *within* the tallgrass prairie ecosystem, there's wonderful variation and clines, not a single static recipe of processes.

**Explorer and pioneer accounts also described no man's lands between warring tribes, where animals such as elk were noted to be more abundant than in places hunted more intensively by Indians.** This was another way in which grazing and browsing varied within a vegetative classification. I would expect the plants and animals that the writers weren't describing, such as butterflies, also varied in occurrence and abundance relative to this variation in abundance of game animals. But I can't imagine how we can know the specifics of that. Still, this demonstrates that there was no single recipe ecosystem-wide for what was once occurring in pre-European North America.

**"The pastures I see get brushy so grazing can't be how prairie was naturally maintained."** Farm animal management differs from nature. They receive supplemental feed and care. Shade may be actively managed for. Meanwhile, wild animals experience bottlenecks of scarce forage when they consume foods they otherwise avoid. However, I do not expect grazers, whether native or domesticated, to beat back brush, although they do somewhat compared to a field without any grazing. I expect browsers to have the stronger impact on brush and trees. These include elk, beaver, and porcupine. I don't think of the Passenger Pigeon as a browser, but this bird was also reputed to have strong effects of canopy reduction. You might be surprised where all of these species once turned up. I can't emphasize enough how devastating the overhunting by Europeans was, independent of any habitat alteration, prior to 20th century regulation and enforcement.

**"If I allow a beaver to do its thing naturally in my preserve, it will flood the only place where a rare orchid grows."** Exactly. Allowing a perfectly natural phenomenon to occur in a small, isolated preserve can have an entirely natural outcome, but still be unfavorable for conservation. These beavers do a marvelous job of controlling brush, by cutting and eating brush and by flooding where the brush used to be growing. In fact, many of the animals I'm talking about here such as beavers, porcupines, and elk are frequently discussed, including in the scientific literature, for the "damage" they do to vegetation. I don't know the particulars of the site referred to here. I don't know whether the beavers, if left to their natural devices, would have threatened the orchid. There are also simple devices that let beavers be beavers while maintaining adequate water flow to prevent flooding objectionable to humans. However, let's take that concern at face value. It was expressed on a prairie management panel by a manager who burns because it is a natural process, which is meant to restore the ecosystem. I think his concern was valid. I also think the impacts of burning, whether natural or not, need to be evaluated the same way as the effects of animals, native or domesticated.

NATURAL/ECOSYSTEM MANAGEMENT

**"Doesn't it make sense to restore ecosystems to the way there were back then?"** At first blush this sounds logical. Wouldn't what's natural be most appropriate? But think about it some more. Do you apply this to yourself? Relatively few people do for their daily care and medical treatment. If they have a choice, few choose to use only what was naturally available or prevailing over prehistoric evolutionary time. Modern medical approaches can use an evolutionary perspective to understand humans and medicine now, which I think will be more effective for doing so. Likewise, I find paleontology, including on insects, very interesting and useful for understanding how to make biological conservation more effective now. But it's one thing to understand how the past led to the present; it's another thing altogether to assume the present functions the same as the past or that answers applicable to the past are the best choice now too.

**Choosing to proceed with "natural management" or "ecosystem restoration" is not a shortcut or simplifier, as I believe many expect.** As one manager said to me, "We set our natural [management] fires and whatever happens is the way it should be." Indeed, a lot of conservation management today seems to be about the concept of making a site like it once was (whatever that's understood to be), rather than focusing on helping it continue to contribute valuable conservation benefit to biodiversity there now, as it is today. (I would note, though, that the "processes" of grazing and browsing by now missing species of animals do not usually figure much or at all into the implementation of restoring a site to be as it once was. But for now, let's disregard that issue.) Aside from the issues of how well we actually know how these ecosystems once looked and functioned, and how well we are able to replicate that today, there's also the issues of whether those processes will function the same in today's landscape context and how much (or which) processes benefit particular rare species. As a result, it is essential to study and monitor any conservation program, natural or not, to learn how well it is accomplishing its goals and what the results are.

**I'd also note that a lot of modern technology is involved in "natural" management.** Fire management itself usually involves a lot of machinery to set and control the fire, apart from firebreak preparation ahead of time, which often includes mowed or even disked firebreaks. Furthermore, I see a lot of mowing, brush-cutting, and spot-herbiciding in many fire-managed sites. These are no more "natural" by my definition for occurring in the service of fire management. Although usually summarily dismissed, this

statement I made a long time ago bears consideration in this context. Grazing by domesticated livestock done in a conservation regime may replicate the occurrence and effects of natural grazing and browsing by native animals about as well as modern fire management replicates prehistoric natural fire.

**"The ecosystem approach is better than a species-specific approach."** One reason this is advocated is to try to be more efficient and proactive in conservation efforts by helping groups of co-occurring species in need instead of proceeding scattershot one by one. There's a lot of evidence to support the concept that multiple species can be effectively helped through the same program. Scott and I have done a lot of surveys and analysis aimed at multiple-species approaches. But another reason advanced for the ecosystem approach is that what's favorable for one species may not be for another. I think the logic of this is that since nature somehow "managed" habitat to allow for all this biodiversity, then if we just imitate how nature does that, we can get the same outcome. But how exactly does nature do this? While I see a lot of biodiversity out there in nature, I also see nature being quite harsh with that biodiversity. A lot of what happens in nature seems to result in a "struggle to survive"—the concept I most remember from Charles Darwin. It seems as if we need to be pretty careful just what we do in the name of imitating nature on an ecosystem scale, to make sure we get a biodiversity-friendly outcome instead of the equally natural outcome of extirpation.

**Sometimes the "ecosystem" approach feels to me like a response of despair instead of hope.** We (agencies, scientists, environmentalists, hobbyists) are overwhelmed by biodiversity and by inadequate support from the public at large which is in turn overwhelmed by myriad other problems. We throw our hands up at the complexity of individual species and hope that somehow a simple rough recipe of processes will be the best solution to all their problems. I think instead that we humans need to step up. To be honest, if you'd told me 25 years ago that I had to do all the surveying and databasing and analyzing I've since done, and if you'd told me I'd have to defend my work in print and at the podium among the leading experts in butterfly conservation biology in the world, I'd've freaked out and given up before I started. Instead, Scott and I took one step, then another, some things worked, some didn't, but so far, we've kept figuring out more things to do and how to find a way to do some of them. Hopefully, we'll be able to continue. It's not everything, but it's something, and that's better than nothing.

## SOCIOPOLITICS AND POLICY

**"You can't be right because what you say is so different from what most others say."** Yes, it's true that my "take" differs from many others'. But I don't actually contest the data or findings in most studies. Only occasionally do I think the results are so garbled in how they got produced or presented that I can't tell what I can learn from that study. Instead, I disagree with what many people *say* about those results (what they do or don't prove) or about the ecosystem those results occurred in or how these results should be applied for conservation. Or I'm looking at a larger sample of studies and sites while they may be taking one study or some individual examples and asserting they generalize more widely. However, I can find many instances that are contrary to those few examples. But yes, my understanding appears to be a minority view. It sure feels to me like that! However, I'm not alone in my thinking, this may not always be the minority view, and the minority is not by definition more likely to be wrong. If the butterfly data comfortably accorded with ecological expectations, I would gladly say so. I do not say this lightly and never have. I've always put a lot of effort into field work, analysis, and reading the scientific literature before speaking on this topic. You might be surprised how much of these findings that I'm sharing here, not just the butterfly data but also the ecological concepts, have been printed in international peer-reviewed journals, after thorough critique and revision.

**"It's an emergency so doing anything is better than nothing."** I think exactly because the stakes are so high that it's all the more important to be careful, since we don't get a do-over if we pick wrong. It's only through documentation and evaluation in dire circumstances that we learn how to do it better next time. I expect this attitude in a hospital emergency room and it's equally appropriate in conservation.

**"You only want your way."** If that's so, then I'm a very disappointed person! I perceive that my recommendations are a minority approach today. On the other hand, a number of entomologists are concerned about overuse of fire in conservation management. Plus I think it's essential for me to state clearly and completely my best understanding of the biology. But after that, then I'm the first to understand tradeoffs and limitations. After all, Scott and I are greatly constrained by what we have time to do in our research and in our volunteer efforts working with regulatory and managing agencies. We do all of this as volunteers, separate from our employment. We have to make decisions about what we will and won't try to do. However, I think it's better for all of us to be upfront about those disagreements, decisions, and tradeoffs, instead of saying that there's one best way to save an entire ecosystem and all its biodiversity everywhere at all times.

**"What you suggest is too hard and complicated."** I wish there were only simple answers, not just in conservation but in human health too. But whenever a medical issue has arisen in my family, I've been most grateful for entire books written about one issue. Not all applies to the specific situation I'm dealing with, but I sort through what's there to find what applies to my situation, with the reassurance that if my situation changes, I know where to go for more information and help. That's the approach I support for conservation too. I also suggest starting small and working up from there. Identify a site to focus on. Then identify one problem

or one area of the site to focus on. Plus some of my management suggestions, like reducing burning, look less difficult and hazardous to me than the alternative. Or identify a species, or set of species, to focus on for surveying and monitoring. Then add on as able.

**"What you suggest costs too much."** Actually, alternative managements can cost less than fire. Brush cutting and mowing routinely occur in the prairies, savannas, and barrens I've studied, whether these units were also burned or not. Fire uses most of the same equipment as brush cutting and haying (e.g., tractors) but requires additional equipment too (e.g. water trucks, flappers, drip torches), more staff, and higher insurance costs. Burning is more constrained by seasonal timing (e.g., narrow period after spring thaw dries out but before greenup), weather conditions, safety issues (e.g., smoke drift), and requires assembling more people at once to conduct. Managing without fire continues these other managements that already occur but without the added cost of burning. Many prairies have pre-conservation farming histories and are near farms. Periodic haying of prairie preserves can break even or actually produce revenue usually via leases to farmers who supply the equipment and labor. Certain kinds of grazing can also be used instead of burning and can produce money to offset some or all setup costs on preserves. There's much room for further pursuits of beneficial partnerships between those with expertise on the biodiversity and those in the surrounding farm landscape who own the machinery and livestock and know how to use and manage them. Many examples of successful butterfly management do not look more expensive to me. They are not about more effort and cost; they are about different ways of allocating already existing resources. I'm not saying we should do something only because it's cheaper. However, cost always comes into play as to how much of what can get done when and where.

**Again, I advocate being upfront about these tradeoffs and limitations.** It's contradictory to say that what's being done in a conservation program is the best thing for ecosystems and biodiversity, but then tell researchers that their findings can't be applied because they are impractical. I think a more accurate description of conservation programs would indicate how and why priorities get set (because there are priorities being set, whether deliberately or not), which species are targeted, and what can and can't be afforded.

**"It's not possible to mow steep slopes so those areas have to be burned and it may not be feasible or safe to break them into separate burn units either."** It's certainly true that there are some wonderful prairies on some amazingly steep slopes. They're also hazardous for folks like me to survey. I definitely want safety for all humans. I would suggest investigating whether other species, like goats, could more safely manage these sites than humans can. It's also been my observation that fires tend to burn up more than laterally, although that upward burn may fan outward some too. Downward burning is highly unlikely unless wind direction blows that way. Thus, the entire slope might not burn if the fire is set somewhere uphill from the base of the slope or if there is a single ignition point rather than a line of ignition or multiple ignition points at the base of the slope. Otherwise, all I can say is that I can't make the biology fit our convenience. While topography and aspect can be variables that affect the biology of prairie biota, the inconvenience of preserve location or configuration is not. Inconvenience does not alter how fire affects butterflies, prairie flora, brush, and weeds.

**"Nothing (or very little) is known about prairie insects."** I'll admit I'm amazed when that gets said after I've concentrated as much as I can into a 45-minute talk about what I've learned about prairie butterflies! There's lots left to learn, but I've sure worked hard to learn some things, and so have many other people. I take the approach that we know enough to know some next steps to take, both as management actions and as further research projects. And on the other hand, to the extent that nothing's known, that is the extent to which we can't know that any conservation approach we're taking is beneficial or advisable. In that case, different methods need to be tried in different sites, instead of primarily using the same one approach (burning) in most sites.

**"You can't prove that fire is as bad as you say."** Indeed, I can't prove anything any more (or less) than anyone else can. On the other hand, science is more about disproof, which is a lot easier to do than to prove something. I think there is a lot of disproof regarding the appropriateness of investing primarily in frequent fire to conserve prairie biodiversity and I can cite others in that same vein. But to the extent you disagree with me on this is the extent to which there isn't definitive proof or disproof either way. In that case, no one can assert that the best way to manage has been established. Thus, it is essential to have distinct outgroups, the more distinct the better, that are fair outgroups (plausible ways to conserve native flora and fauna) so that we can figure out what works better for what.

**"You are so negative and expect too much of beleaguered agencies."** Actually, my husband Scott and I are among the very few in North America I know of who have statistically defensible long-term data (>15 years) on some really rare butterflies that show (at certain sites) a stable (or even increasing!) trend and that document some conservation management programs as favorable. Those are the most positive things I can imagine contributing to this discourse! We immensely enjoy presenting those outcomes in international peer-reviewed print. But what matters isn't feelings, mine or yours. What matters is figuring out how to get the most benefit to biodiversity from available resources—and hopefully, getting more people wanting to allocate more resources toward figuring out what works and doing that.

**"Fire management is done so widely; it can't be wrong."** Unfortunately, a practice being widespread or a system being large is not a safeguard against unfavorable

consequences. We relearned that in the economic realm to our dismay in 2008. So the way to determine the safety of something is by data collection and monitoring, not by the "vote" of how many adopt the practice. When proponents of fire management state that the "best" way to manage prairie is with burning and that the entire prairie ecosystem is "fire-dependent", I think it's reasonable to expect the benefit to be strong and clear and consistent, not just for plants but also for butterflies. If not, then this begs the necessity of having controls and outgroups, to figure out the "best" way, although that's not a concept I accept either (here I go again!), as "best" would be defined differently by each species. More precisely, we need to make it possible to figure what is compatible with conserving what species. Has a particular benefit been authoritatively documented (which is different from coming up with a lack of significant negative effect in a relatively small study)? How often has this benefit been shown compared to disfavorable outcomes? If fire is essential and beneficial to all, then there should be prevalent studies, fairly designed with similar effort and timing for both the before and after periods, that show the "before" sample for specialist species, including butterflies, as rare and less likely to be found in a sample, but the "after" having them more frequently found.

**"The fire managers I know are nice reasonable people."** Yes, most Midwesterners are. But the likelihood of good outcomes from habitat management is not determined by the congeniality of human personalities. This is instead determined by how much is known and how much we're trying to learn more and how well this is applied. Likewise, if I or someone I know requires major medical treatment, I want them treated by the most expert doctor, not the most friendly one. Fifty years ago, most people probably thought their doctors were nice reasonable people too. Most probably do today as well. Hopefully, doctors today are doing different better treatments than fifty years ago. Hopefully, doctors fifty years from now will do different better treatments than now. Likewise, I hope for that improvement based on science for habitat management, regardless of human personalities. From the butterflies' perspective, it doesn't matter who's nice and who's not. What matters are the choices humans make in land use and management and the consequences those have for butterfly populations. In the 2008 economic disaster, there were some villains, yes. But I also think a lot of nice, reasonable people got caught up in concepts that turned out not always to apply as believed. (Example: Housing always appreciates, so buying a home is always economically preferred, and buying more home is more economically preferred. Other examples: Past medical treatments, such as bleeding to treat fever, were based on the best understanding of the time. But it turned out that the underlying interpretations or assumptions used to understand these maladies were incorrect.) Likewise, I'm hoping for us to grapple with how habitat management turns out not to be so easy and simple as it may have looked at first and with what we should learn from the track record to make future management choices produce desired outcomes more.

## CONCLUSION

**"What is realistic? If butterflies are so hard to conserve and they're disappearing anyway, why bother?"** Yes, a lot of the news about butterflies is discouraging. Plus it seems as if many of the problems (habitat destruction, fragmentation, degradation, climate change) are all but intractable. We humans have had a lot of impacts on the environment. We've set in motion trends in the landscape that will continue to register their impacts on butterflies (and us) for years to come. It's not reasonable to expect easy solutions. Despite our best efforts, some conservation efforts won't be enough to save some populations. Management certainly isn't the only problem and isn't the only solution needed either. But management is something conservation managers have a lot of control over on preserves, much more so than these many other problems rampant in the larger landscape that affect preserves also. We can make outcomes not as bad, and in the process perhaps we'll find some outcomes better than we could have expected. I think about examples of very rare butterfly populations that are still persisting in this very same intractable landscape. I keep probing to figure out how these populations are succeeding at continuing to persist. Some populations are just lucky. For them, I'd like us to figure out how to make those appropriate conditions consistently continue to exist not merely by chance. Other populations are getting appropriate, deliberate conservation effort. That takes effort; no doubt about it. But it doesn't necessarily take *more* work. It takes *different* work. That's why I've written all this: to encourage us all to keep trying to find better ways that produce better outcomes.



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