

## Conservation Matters: Contributions from the Conservation Committee

# How insects justified creating the highest diversity, large-scale grassland restoration in North America

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Back in 1996, when The Nature Conservancy in Indiana first imagined the Efroymsen Restoration at Kankakee Sands as a strategy to heal a landscape, we were in rarified territory. While it has been all the rage to talk big about restoring ecosystems, until then it had typically been confined to talk. Prairie restorations were mostly limited to a few acres here and there, and restored prairies were primarily for show – not for conservation. When it came to actually purchasing disrupted lands for large-scale restoration, few organizations had the intestinal fortitude to move beyond talk. Buying agricultural land, lots of agricultural land, when critical native habitats remained to be purchased, was a bold step that few others were willing to contemplate.

But at the time, our analysis of prairie and oak barrens (typically referred to as “sand savanna”) conservation in Indiana indicated that isolation and fragmentation were the biggest threat to some of our best remaining habitats. The bulk of the prairie remnants and the best oak barrens themselves were already protected. Restoration and healing of the intervening landscape was necessary if we expected to have thriving grassland habitats for future generations. So, with a great deal of trepidation, we made a bold decision. In 1996 we purchased over 12-square miles of cropland that could reconnect three important prairie and barrens reserves, creating a contiguous block of conservation land covering 30 square miles! Once restored, Indiana would have a grassland/oak barrens system that could stand the test of time as a reservoir of biodiversity. That is, *if restoration really works*.

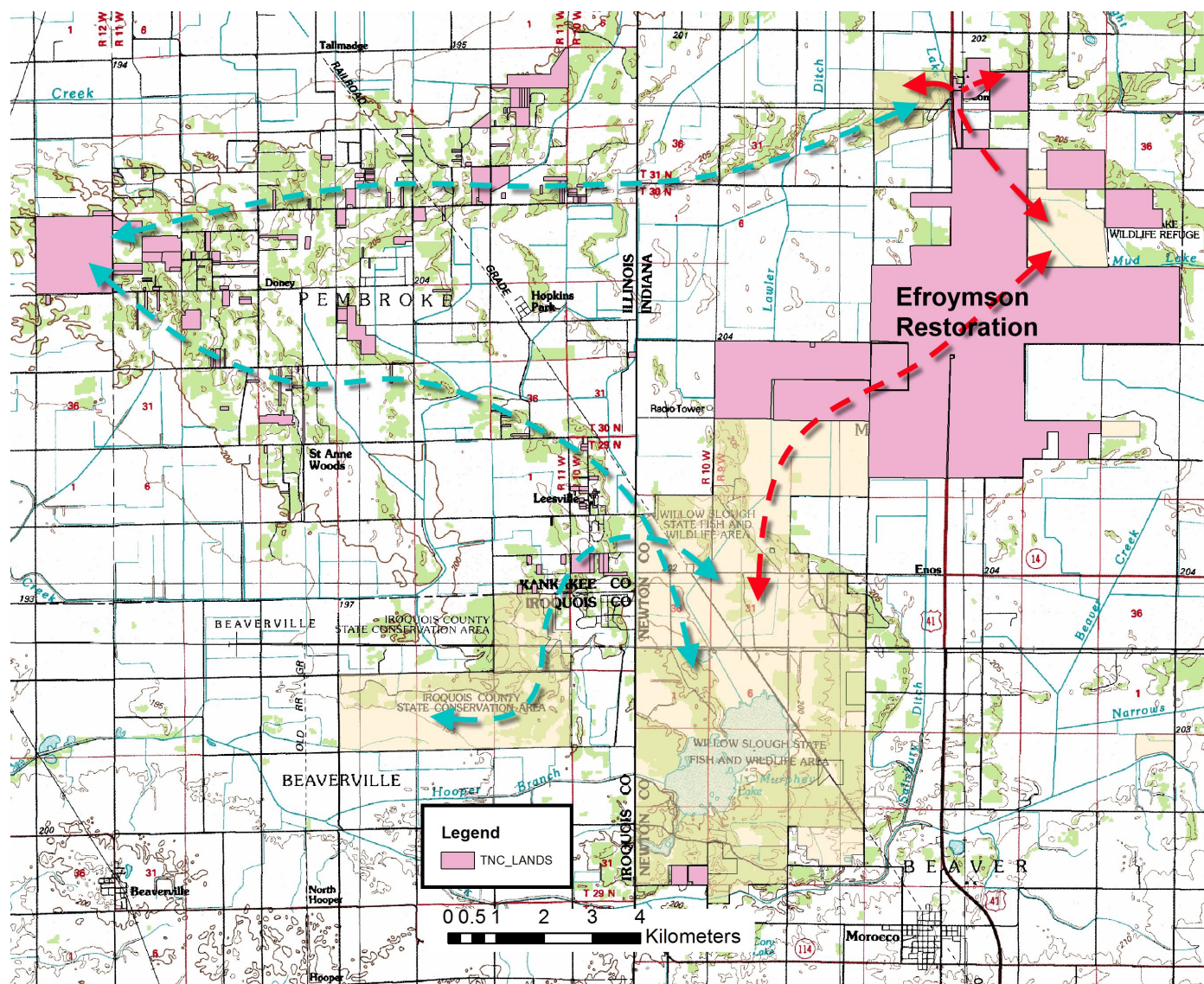
Our goal, to use the restoration as a strategy to alleviate the stressors that can cause species loss over time in isolated habitats, required serious planning. The realization that the bulk of habitat restricted species at the site were insects shaped the trajectory of the restoration. Because of my entomological background and experience (Shuey 2005) and previous on-site work from Ron Panzer's research group (e.g., Panzer *et al.* 1995, 1997, 1998), we knew that the ecosystem remnants at the site supported a diverse assemblage of “remnant-dependent insects” – insects that depend on natural habitats for their survival and do not survive in the surrounding human-dominated agricultural/urban landscape. Most notably, Indiana's only population of Regal Fritillary was limited to two small mesic prairie habitats on one remnant. Almost every other butterfly you would expect at the site was still clinging onto

some small scrap of suitable habitat and over 600 species of moths have been recorded from the site. Our guess was that there were likely a few hundred insects trapped on these “island nature preserves”, floating in a sea of soya and maize. For these butterflies, moths, leafhoppers, and other insects clinging onto survival across the site, the question was simply “how much longer can they hang on”?

We wanted the restoration to accomplish two things. First, it should create expanded habitat for species that were trapped on the ecosystem remnants. And second, we hoped to restore connectivity within artificially fragmented communities and metapopulations. Philosophically, we set out to accomplish this by restoring “landscape attributes” across the restoration to produce repeating patterns of recognizable habitats across ecological gradients. In this case, the gradient is the near surface water table that undulates over and under the sandy soils of the site. A secondary ecological gradient, point-return frequency of fire disturbance, is more of a post-restoration management tool used to maintain habitat structure. Kankakee Sands is at the eastern, rainy edge of the Central Tallgrass Prairie Ecoregion, and rapidly converts to woodland or dense forest in the absence of disturbance (Shuey *et al.*, 2012).

Of course there are many ways to achieve these objectives, depending on what groups you care about. For example, if you are only worried about wetland amphibians and reptiles at the site, all that is really required is to restore the water table itself – if you build it, they will come (e.g., Brodman *et al.* 2006). If declining grassland birds are your targets, they are most sensitive to habitat size and structure (Helzer & Jelinski 1999, Herkert 1994), as is probably true for almost every vertebrate at the site. They just want some herbaceous cover that they can call home. They don't really care if that habitat is native to North America or not! It's worth noting that vertebrate-oriented thought drives most conservation efforts across the globe.

We defined “community” to include the entire community (not just plants and vertebrates!). It's a game-changer if you are interested in expanding habitat for remnant dependent insects, the bulk of which you know little about relative to hostplant requirements or habitat structure. We all know how choosy insects can be about host plants, not just the specific species but hostplant abundance and habitat structure as well. And don't even ask me about the mycorrhizal fungi community – but trust me – we've



The Kankakee Sands conservation area is located in both Indiana and Illinois. The Efroymsen Restoration addresses connectivity at the site in Indiana (red arrows), and is part of an effort to conserve a dynamic grassland/barrens landscape across the larger site. The area supports the largest concentration of high-quality oak barrens and sand prairie/wetland habitats in the Central Tallgrass Prairie Ecoregion. Among the many threats to biodiversity at the site, is historic land conversion to agriculture and the resulting fragmentation and isolation of remaining habitats.

pondered pretty much everything (see Middleton *et.al.* 2010, Bever *et.al.* 2009). Realizing that habitat-restricted insects would be one of the hardest groups to address, we designed a unique approach for re-planting the restoration.

- In support of plant conservation, everything planted would be from local genotypes, and also because the resident insects coevolved with the resident plant populations. There are very likely some subtle coevolutionary adaptations and relationships that are worth preserving at the site.
- We would also restore the entire plant community in order to establish host plants for rare insects we know nothing about (over 600 species known from the project area). Some of the naturally

rare plants would be planted in trace amounts across the restoration, but hopefully they would establish at enough sites to eventually find their own ecological niches as the restoration heals over the decades (or centuries).

- Seed mixes that emulated natural plant communities were designed for the range of soil types and hydrologic conditions across the site, kick-starting the “landscape patterning” across the restoration. We wanted that repeating ecological pattern ranging from small open wetland, through sedge meadow, wet prairie, mesic prairie, dry sand prairie, to sand blowout across the entire site. In my mind, creating this ecologically complex mosaic is essential for restoring insect population



connectivity across the site and for providing a rich array of occupiable habitat patches for species that are locally impacted by fire management.

- Some plants that are difficult to establish and which are known to support guilds of insects or regionally imperiled insects would be raised as plugs and planted into the restoration. For example, late successional sedges do not seed well into restorations, and an entire guild of butterflies, skippers and leafhoppers use this habitat at the site. *Carex stricta* and *Carex lacustris* plantings were supplemented with plug installations to help kick-start sedge meadow formation at selected sites. Likewise, violet hostplants of *Speyeria idalia*, *Speyeria aphrodite* and *Boloria selene* were planted at strategic sites to increase habitat for these locally rare species. In the name of plant conservation, we used this method for a few plant species that were critically imperiled in the area as well.
- Finally, the bulk of the restorations would have very low seeding rates of the “highly aggressive” warm season grasses that dominate most restorations. Instead of planting the typical 4-5 pounds of big bluestem, Indian grass and switch grass per acre, we would limit the combined seeding rate of these three species to around ¼ - ½ pound per acre. This would allow everything else a chance to establish and set seed for a few years before intense root competition from bunch grasses started to control successional pathways. We really wanted to establish rich, patchy prairies within a few years, and to avoid the virtual monocultures of head-high grass that most restorations eventually become.

Believe it or not, this is a fairly radical and costly approach for restoration, especially at this scale. Semi-local genotype prairie seed mixes can typically be purchased for \$350 - \$450 per acre for an 80-species seed-mix (a very rich mix by most standards). By the time you factor in our costs to build and manage an onsite native seed nursery and seasonal green house, as well as paying for an annual wild seed collection crew that worked nearby railroad right-of-ways and other small scraps of prairie (the majority of plants don't thrive in a nursery setting), our costs soared to over \$1,000 per acre for the initial planting phase (hydrologic restoration and long-term habitat management not included!). To my

knowledge – and I'm pretty well connected in the grassland restoration world – no other restoration has attempted or accomplished a similarly diverse planting at this scale. While there are indeed few larger prairie restorations in North America, none of those attempted to restore the entire plant community. Interestingly, despite the very high costs, it was not difficult to convince our team that this was the right approach to take. We are serious about conservation, and the concept of doing conservation at the 50% level just doesn't fit with our commitment.

So, after a few dollars spent and sixteen years into this project, we are still wondering if the strategy is working! Operationally, we have planted 6,350 acres and we will continue to chip away at the remaining agricultural land we own for many years. By my math, over 11 billion seeds have been planted, representing over 600 species of plants, at a targeted rate of over 40 seeds per square foot. With a little work, you can find most of these species scattered across the restoration. Just as importantly, when you walk through the restoration, you can see that it is settling out into recognizable plant communities. To me it still obviously looks like a restoration, but it is not at all typical. The bunch grasses are shorter and patchier and short-statured warm season grasses such as little bluestem, sideoats grama, and prairie drop-seed give the restorations a “natural”, knee-high look. There are lots of native cool season grasses and sedges in the mesic and dry prairies, and of course these groups dominate some of the wetter habitats. Forbs bloom in discrete patches, not the even-spread you typically see across restorations. There are clumps of unusual species across the site, things like leadplant, twig-rush, prairie clovers, prickly-pear cactus, sensitive fern, as well as odd species of liatris and phlox. And in a subtle difference from typical older restorations, you don't see much bare soil between the taller plants. Small species and seedlings are starting to fill the gaps, which is important if you care about violets and fritillaries. At our recent BioBlitz on the site (July 2012), in a couple of hours work the botany teams found between 120 and 180 plant species in each restoration unit assessed. (I am assured that this is doubly impressive because all spring ephemerals had senesced and most of the grasses and sedges were un-identifiable to species this late in the season). The bottom line is that at the gestalt level, the plantings are looking good.

But does all this translate to success? The planting after all,

**Figure (next page):** The Restoration at Kankakee Sands. **A** - Heavy equipment restoring hydrology to eliminate surface drainage from the site; **B** - Small seed stripper working a nursery bed; **C** - Hand collecting *Carex stricta* seed from a nearby wet prairie remnant; **D** - Climate-controlled storage of seed lots prior to planting season; **E** - Mixing seeds in preparation for planting; **F** - Staff and volunteers preparing individual plugs for later planting in the restoration; **G** - Volunteers planting sedges and rushes in wetlands; **H, I and J** - typical views of the mesic and wetland restorations after a few growing seasons; **K** - *Erynnis martialis*, an oak barrens species that has not yet been found to use the restoration; **L** - *Eurema nicippe*, one of several southern immigrants that become common in the restoration each summer; **M** - *Speyeria idalia* has expanded from two known demes to occupy almost all seemingly suitable habitats in the restoration and beyond - a strong signal of restoration success; **N** - *Hesperia metea* was seen on a small oak barrens opening a few years prior to restoration. It has not been seen since, but hopefully hangs on in some small clearing waiting for its chance to expand into new habitats; **O** - *Poanes massasoit*, found only in Illinois at the moment, and which if found on the restoration would be strong evidence of “restored connectivity” across the landscape. Other sedge feeding skippers are using the restoration. (See C above for a look at the habitat in Illinois)







was **just a strategy** designed to increase occupied habitat and restore connectivity between sites. My botanically oriented friends get a little irritated when I take this position, and on my less confrontational days I can freely admit that there is a lot of outright botanical conservation value in the plantings. But the bottom line is this: the real goal of the restoration was to expand habitat and to create ecological connections between the old nature preserves. If you look at the more traditional conservation groups, also known as vertebrates, there is little doubt that it worked. Amphibian populations responded exponentially to the initial hydrologic restoration at the site (Brodman et al. 2006). Hundreds of pairs of otherwise declining grassland birds established territories across the restoration, and a few years ago over 300 Henslows Sparrow male territories were counted in a single day. Eastern glass lizards, almost never seen prior to the restoration, now abound across the drier restoration units. Pocket gopher burrows, once confined to roadsides and ditch spoils, have spread into the thousands of acres of restoration. Interestingly, there are even a handful of regionally rare fish that are limited to sandy, emergent wetlands at the site – but I have no idea how they are doing! With a few exceptions (such as ornate box turtles), the terrestrial vertebrates that were on the old nature preserves seem easy to please. And to be honest, if we had just restored the water table and let the site grow up in Eurasian weeds, they would probably be just as happy.

Insect response has been a little harder to gauge, in part because of high diversity and the difficulty they pose in identification for the average person. Early in the restoration, we had Ron Panzer take a look at some conservative species in the restoration, and things were encouraging. He found hostplant-limited, flightless leafhoppers well out into the restoration, a few habitat-conservative butterflies cruising through the plantings, host-specific weevils attacking our legumes, and so on. Perhaps most telling were the results from a BioBlitz last month and the butterfly transects. We found *Speyeria idalia* in every restoration unit and in native prairie – a total of 19, mostly females, flushed out of the grasslands. There were almost no nectar sources to speak of thanks to the record setting drought this year, and the butterfly literally had to be flushed out of resting places. To me, this indicates that they view the restoration as habitat.

Interestingly, *Cercyonis pegala*, not exactly a rare species, was found only in remnant oak barrens and remnant sand prairie during the BioBlitz. Two of the surveyed restoration units were directly adjacent to the sites where this butterfly was common – but the butterfly seemingly won't make the jump! Something about the restorations isn't right for this particular species, and I suspect that *C. pegala* is typical of a sub-set of insects that are going to be difficult. There is something besides the presence of suitable hostplants that factor into habitat suitability for these species and perhaps as the restorations heal and settle out into more natural grasslands, they will become

more acceptable. But perhaps not.

Of course, none of this entomological evidence would stand up to the scrutiny of a peer-reviewed journal, but I have a plan. In 2014 we hope to implement a multi-disciplinary approach to assessing our restoration strategy. If you have ever ventured into the philosophical arena of what constitutes "restoration success", you will understand when I tell you that we are not too sure exactly what research questions we want to address at this time, especially relative to the plant communities themselves. But if you look at animals, especially insects, and focus on our explicit *a priori* goals of expanding occupied habitat for habitat restricted species and increasing ecological connectivity between the old preserves, the questions become a bit clearer and easier to answer. And while I'm convinced the strategy worked for at least some portion of the insect community, I am just as interested in knowing where and how it might have failed. High-diversity ecological restoration is probably the most expensive approach to conservation in the toolbox. If we expect others to follow our lead, we have to document evidence that it is worth the investment.

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