DATA, DISTRIBUTIONS AND HYPOTHESES:
EXPLORING DIVERSITY AND DISTURBANCE IN THE TALLGRASS PRAIRIE

BIOL 585, Fall 2011
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Week 2: Plant Responses to Burn Season at Prophetstown State Park

Lab handout developed by P. Waser and N. Emery

"As I looked about me I felt that the grass was the country, as the water is the sea. The red of the grass made all the great prairie the colour of wine-stains, or of certain seaweeds when they are first washed up. And there was so much motion in it; the whole country seemed, somehow, to be running."

--Willa Cather, My Antonia

LAB OVERVIEW

Prairie ecosystems provide ideal sites for agriculture because of their rich, deep topsoil and relatively flat topography. Prairie soil that is too wet or dry for agriculture is ideal foraging habitat for livestock. As a result, almost all of the native prairies have been converted to agriculture, ranching or suburban development. Today, tallgrass prairies and savannas cover less than one percent of their original range (Kline, 1997). As a result, many organizations have invested significant resources in re-establishing prairie ecosystems throughout their original range. Prairies are excellent subjects for restoration efforts because they can be re-established within a few years, can draw upon traditional technology established for gardening and agriculture, and have a favorable public draw in their beauty and link to the past. The fine texture of the prairie community makes it amenable to being recreated in areas as small as an acre, and prairie plants are relatively small and easy to handle. The original prairies possessed a soil structure and species composition that might take centuries to recover, but a significant portion of the species can be replaced in a relatively short time.

In last week's lab, we investigated the importance of fire disturbance in structuring the natural prairie plant communities at Konza Prairie Biological Preserve in northeastern Kansas. Just as burning – and the timing of that burning – is critical to determining plant community composition and diversity in the large tallgrass prairie remnant at KPBS, it is also a key tool for the successful management of restored prairie communities. Fire has the same beneficial impacts on restored prairie plants that it has on the remnants: it prevents the invasion of woody species and removes insulating layers of vegetative debris, allowing the soil to heat up more quickly in the spring; it rapidly returns nutrients to the soil that might otherwise spend long periods of time in dead vegetation; and it removes woody vegetation that might otherwise come to dominate prairie regions. Prairie restoration efforts therefore require a regime of burning to be successful, and can manipulate the burn timing and frequency to favor certain species. The Tallgrass Restoration Handbook (Packard and Mutel 1997) recommends small-scale burns with several years between burns for recovery because, for example, fires that are too large or frequent can damage the insect community. This guide also recommends conducting burns at different times of the year because different burn seasons can favor certain native species over others – this is the principle that we focused on in last week's figure set activity.

Today we will collect our own data on plant community composition in a recently restored tallgrass prairie site at Prophetstown State Park. We aim to compare the communities of two parcels that are burned in different seasons, and ultimately compare our results to those reported for Konza by Towne & Kemp (2003).

<u>The ecological questions</u>

1) ***How does plant community composition differ between parcels that are burned in different seasons (fall vs. spring) in restored tallgrass prairie at Prophetstown State Park?***
2) ***How does plant community structure at Prophetstown compare to the remnant tallgrass prairie at Konza Prairie Biological Station?***

<u>Objectives of this lab</u>

1. Become familiar with the field of "Restoration Ecology."
2. Experience a tallgrass prairie ecosystem first-hand.
3. Engage in transect-based vegetation sampling to estimate plant community composition, richness and diversity in two different prairie restoration parcels with different burn regimes.

CONCEPTUAL FRAMEWORK: RESTORATION ECOLOGY

Human activities have changed the global landscape significantly over the past few hundred years. Forests, grasslands, prairies and other ecosystems have been cleared at an increasing rate to make way for agriculture, housing and other forms of development. As this rate of development has increased, so has public concern over the fate of the remaining natural lands.

Over the past few decades, new fields of science have arisen in response to these massive changes and the desire to conserve intact ecosystems. **Conservation Biology** is a relatively new, multidisciplinary science designed to investigate human impact on ecosystems, prevent species extinctions and restore ecosystem functions to damaged or degraded lands. **Restoration ecology**, a subdiscipline of conservation biology, largely studies the structure of plant and animal communities with respect to succession and their ability to regenerate after disturbance. The primary concern of restoration ecologists is to restore areas that have been "degraded". A degraded ecosystem in this case is one that experiences a loss or decline of one or more species as a result of human changes, especially when a key function of that ecosystem is lost, such as erosion control. It may take hundreds or thousands of years for an area to "recover" from a large disturbance (soil horizon formation and mineral leaching may take up to 10,000 years), but most of the species, and much of the ecosystem function lost in a disturbance can return in a period of years or decades (Dobson et al. 1997). Humans can greatly speed up the restoration process by acting as dispersal agents and meeting the needs of late-successional species. We can also increase the potential for success through involvement of local communities, which ameliorates the political climate behind a project, both here and in developing nations (Janzen, 1988).

The natural process of ecological succession does not always restore an area to the same community that was there before the disturbance. This is especially true if the disturbance is very large or occurs for a long period of time, or if critical species have been lost from the area and are unable to immigrate. Sometimes, restoration involves active management: for example, a prairie that is plowed for corn might become a forest if left alone after farming if fire is suppressed. Disturbances might also allow the invasion of exotic species, in which case a grassland dominated by non-native species might replace the same cleared prairie.

Restoration ecologists target human-disturbed sites in which natural succession most likely won't restore the original ecosystem, or sites in which "recovery" will take longer than a desired amount of time. Typical restoration projects involve restoring degraded lands to pre-disturbance conditions, for example revegetating mine talings, or converting a drained agricultural field back to the wetland that was originally there. Other projects involve creating an ecosystem in one area in response to that same type of ecosystem being destroyed elsewhere, a process known as **mitigation**. For example, if a company wanted to develop an existing wetland, they might have to "create" a wetland on another site, resulting in no net loss of wetland acreage. We will discuss the various goals and constraints associated with these different approaches to prairie restoration in the final week of this lab module.

Once a given site is established for restoration, several questions must be answered.

1) Is the polluting/degrading agent (e.g. toxins, cattle) still present? If so, can it be removed?
2) To what historical point are we trying to restore an area? (how it was 10 years ago, 100 years ago, pre settlement, etc.) In defining the goals, what historical, political, and cultural factors must be considered in addition to the strictly biological ones?
3) Is active management (planting, burning, weeding, herbicide application) needed or will it speed the restoration process?
4) How will success be measured, or how close to the "original" must the ecosystem get before it is considered a success?

Most restoration efforts focus on reestablishing the plant community, as it typically contains the majority of the biomass, provides structure around which other communities can develop, and is easily transplanted (as seeds, seedlings or young plants of early-mid or even late successional species). However, other components could prevent restoration from succeeding if they are ignored. Fungi, bacteria and other microorganisms play an essential role in soil dynamics, and can be introduced by importing soil (sod) from other sites. Some restoration seed companies now inoculate the seed of some forbs with mutualistic microorganisms before planting. Birds and insects act as pollinators and dispersers for much of the plant community, and herbivores often promote plant diversity by reducing the effects of competition. These macroinvertebrates and vertebrates are sometimes captured from other areas and released into the restoration site.

It is important to remember that restoration is usually less desired than protecting an already-intact ecosystem. Some even look upon restoration as an unnecessary distraction from preservation efforts and an excuse for development and exploitation if the system can be rebuilt (Halloway 1994). However, there is only so much land that can be preserved given political and financial restraints and restoration can be seen as a means to supplement preservation. Also, much of the land degraded by humans will continue to have deleterious effects on biodiversity, biogeochemical cycles, energy balances, the global economy and social stability until action is taken to "fix" the problems (Daily 1995).

Corporations often use mitigation or restoration as a front to gain public support, when in fact their restoration policy is inadequate or never carried out (Zedler 1996). Is it justifiable to destroy an existing wetland by "creating" a wetland elsewhere as compensation, considering mature ecosystems may take centuries to develop? If development of a site is inevitable, the success of mitigation or restoration of the site afterwards can be enhanced by removal of plants and topsoil prior to development to be used in starting the new restored community (Cairns and Heckman 1996).

THE ECOLOGICAL CONTEXT: INDIANA PRAIRIES AND PROPHETSTOWN STATE PARK

In Indiana, 93% of the native prairie, forests and wetlands have disappeared over the past 150 years; an analysis in the mid-90's indicated that Indiana ranked 48th among the states in terms of the proportion of native habitat still present, and it has lost 99.9% of its prairie (Robertson et al. 1997). In Tippecanoe County, only *one* of the original 300,000 acres of prairie remains. Today, there are several areas in the county that are undergoing prairie restoration.

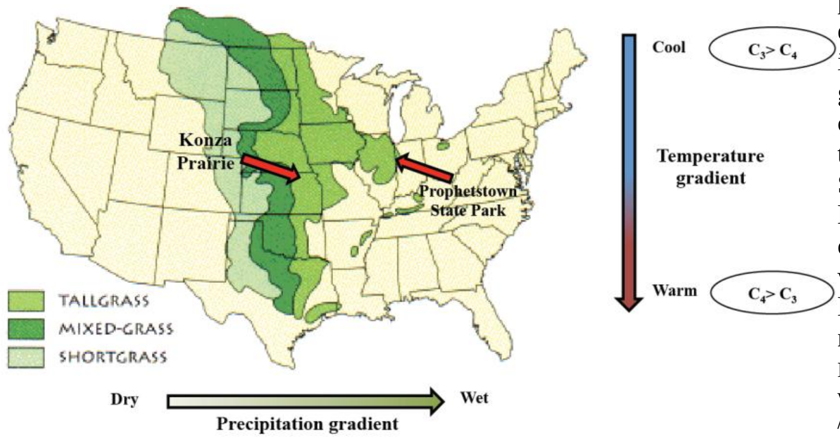

Fig. 1. Historical extent of North American Prairie. The prairie becomes progressively more productive as one moves from east to west as precipitation increases, and warm-season grasses become relatively more common at lower latitudes as temperatures increase (Knapp & Seastedt 1998). Konza Prairie is located on the western edge of the original range of tallgrass prairie, while Prophetstown State Park lies at the extreme eastern margin.
Map modified from: www2.mcdaniel.edu/Biology/wildamerica/grasslands/graslandoutline.html

The State of Indiana has established a new State Park centered on the historical events surrounding the Battle of Tippecanoe in 1811, just north of Lafayette (Fig. 1). In that battle, a Native American coalition led by the Shawnee leader Tecumseh and his brother was defeated, their town ("Prophetstown") burned and Native American resistance to European invasion east of the Mississippi was effectively ended. The vegetation in much of this ~3000-acre Park will eventually be restored to its state ca. 1800. This process is at a very early stage, although in a smaller area within the Park owned by a nonprofit foundation, The Museum at Prophetstown, attempts to restore 200 acres of soybean fields and woodlots to native prairie and oak savannah are already well underway. Elsewhere in the County, there are efforts by the local non-profit land trust NICHES to restore prairie; similar restoration efforts exist in many communities, often "powered" almost completely by local volunteers (keep it in mind!).

Today we will be sampling two areas of restored prairie at Prophetstown State Park. Up until 2008, this area was full of invasive species, particularly red clover. In the early spring of 2008, these two parcels were seeded (by drilling) with a mixture of native tallgrass prairie grasses and forbs. They were maintained at a height of 8-15 inches (by mowing) for three years. The eastern parcel was first burned in the fall of 2010 and the western parcel was first burned in the spring of 2011. These burn season treatments will be maintained on each parcel for the foreseeable future. We will compare plant community composition between the two parcels after this first round of alternative burn season treatments. Furthermore, by using a sampling design similar to that implemented in Towne & Kemp (2003), we will compare the patterns observed at Prophetstown to those you explored in the Week 1 figure set activity.

FIELD LAB ACTIVITY

In first lab of this Prairie module, you explored the data from a long-term plant community data set at Konza Prairie Biological Station (Towne & Kemp 2003). Today, we will conduct our own sampling at Prophetstown State Park. Our sampling design will be very similar to that implemented in the Towne & Kemp (2003) so that we can compare our results to the patterns at Konza Prairie. We will explore the following specific questions:

i. How does the relative abundance of different plant functional groups differ between the spring- and fall-burned parcels at Prophetstown?
ii. How do plant richness and diversity differ between the spring- and fall-burned parcels at Prophetstown?
iii. How do the relative abundances of warm-season and cool-season grasses at Prophetstown compare to the patterns at Konza reported in Towne & Kemp (2003)?
iv. How do plant richness and diversity at Prophetstown compare to the patterns at Konza?

In your writing assignment for Week 1 you have generated at least one hypothesis and prediction for each of these questions, as well as an original question that <u>you</u> want to address with this data set. This brief assignment must be turned in to your TA at the beginning of this lab.

The data we collect will be added to a long-term data set collected by subsequent BIOL 585 classes that will allow us to monitor long-term changes in the quality of the restored prairie. Our class conducted pre-treatment surveys in 2008, 2009 and 2010 to establish baseline data prior to the initiation of the different burn conditions.

<u>Sampling Design - Overview</u>

Working in teams of four, each lab will sample vegetation in 5 randomly-placed plots along five different transects in each of the two prairie restoration parcels (Fig 2). Each team will be assigned a single transect (5 plots) in each parcel. At the end of the day, our two lab sessions will have collected plant community composition data from 100 plots across the entire site.

Fig. 2. Two restoration parcels at Prophetstown State Park that will be sampled in today's lab. Note that this satellite image was taken in 2005, before the restoration was installed. The entire sample site is enclosed in the red square, and an example of one transect and the associated sample plots are indicated in blue. The East parcel (called APM2 by the State Park) was first burned in the fall of 2010, and the West parcel (APM1) was first burned in the spring of 2011.

Sampling Design – Step-by-Step

1) Find the first transect assigned by your TA.
2) Set up your spreadsheet: write the parcel ID (East or West), your Transect Number, and the names of every member of your group.
3) Using your transect tape, find the location of your first plot (as indicated on your data sheet). *Note: these locations were randomly chosen within the total distance of your transect, and then sorted in ascending order, prior to lab.* Tie a piece of flagging tape to your transect string at this position to mark the location of your plot. Place the center of your hula-hoop at this position.
4) Identify each plant that is rooted within your hula-hoop. **Use your visual keys to identify the species; ask your TA or plant-oriented students if you are unsure of a plant's identification**. **If you are *still* not confident of the identification**, assign it an dummy ID and collect a sample so that you can consistently identify this species throughout your survey, and your TA can take it to the herbaria for assistance after lab.
5) After you have identified all of the individuals of a species in your plot, estimate the cover class for each species. **Use the "CNPS COVER DIAGRAM" handout to guide your cover class estimate.** Indicate the estimate for each species on your data sheet. You do not need to record cover for plants that account for less than 2% cover in a plot.
6) Repeat steps 1-5 for the remaining four plots along your transect. **Each plot should take an average of roughly 8 minutes:** if you are going faster than this, you may need to slow down and be more careful and thorough; if you are taking longer than this, you may be being more careful than we can afford in this limited lab session!
7) Repeat steps 1-6 for your second transect in the other parcel.

When all groups have finished sampling, we will go to the State Park Offices for a debriefing and to talk about the issues that face groups interested in habitat restoration.

POST-LAB ASSIGNMENTS

1) Each group is responsible for entering their data into a copy of the blank spreadsheet posted on Blackboard and e-mailing it to their TA by 5 PM on Wednesday, Oct. 12.
2) Complete the Week 2 writing activity (due at the beginning of next week's lab).

Your TA's will collate the data from the entire class and standardize unknown plant collections to develop a single data set for the entire class. Next week, you will analyze this data to test the hypotheses generated in the Week 1 writing assignment.

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