GLBRC
Great Lakes Bioenergy Research Center
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The Biodiversity Front

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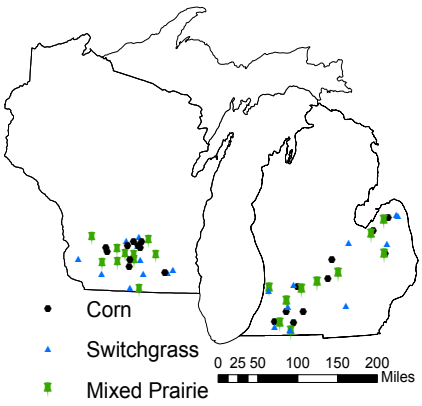
INSIDE THIS ISSUE:

Biodiversity-based services in biofuels: an emerging picture

Agricultural landscapes don't just produce food; they are also home to a multitude of organisms that affect humans in a variety of ways. Some, like birds and butterflies, are of intrinsic value because of their beauty or rarity. Others, like predatory or pollinating insects, may increase crop yield, while a host of invisible microbes (bacteria, viruses etc.) affect plant and soil health, and even help to regulate greenhouse gases and ultimately our climate. This issue of the Biodiversity Front highlights our emerging understanding of how biofuel cropping systems may impact biodiversity and the ecosystem services these organisms provide humans.

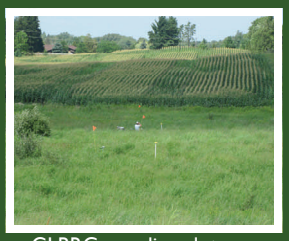
A few of the organisms we study.

Expanding experiments to better predict biofuel impacts



GLBRC Extensive sites in Wisconsin and Michigan, 2009

Biofuel crops will be grown in many different environments across the Midwestern US. For this reason, the 2009 Biodiversity Team expanded sampling to include corn, switchgrass and prairie sites across a 120 mile swath of southern Wisconsin and a 200 mile span of lower Michigan. This involved the cooperation of Michigan State University and University of Wisconsin researchers, state natural resources officers, farmers, county extension agents and many private landowners. Thanks to these individuals, we have been able to collect a wide variety of data to take a rigorous first look at how biofuel production might influence biodiversity and ecosystem services.



GLBRC sampling plots, Michigan

On the wing - grassland birds

Researchers: Bruce Robertson and Doug Schemske

In 2009, Dr. Bruce Robertson and the bird team completed surveys of over 60 corn, switchgrass and mixed-grass prairies throughout southern Michigan. Over 50 species of birds were found to use biofuel crops including rare species like Henslow's Sparrow, Grasshopper Sparrow, Upland Sandpiper and Northern Harrier. In general, the team found that switchgrass supported more breeding species than corn, but fewer than mixed-grass prairie restorations. Larger fields also supported more species than small fields, and the surrounding landscape influenced how birds perceived the value of biofuel crops as habitats. Specifically, grassland birds appeared to avoid crops surrounded by large tracts of forest, suggesting that biofuel production aimed at enhancing grassland bird populations should target open landscapes. On the whole, grassland-based biofuel crops could provide habitat for rare bird species if strategically deployed on the landscape.

Grasshopper Sparrows were found in switchgrass and mixed prairies

"Over 50 species of birds were found to use biofuel crops including rare species like Henslow's Sparrow, Grasshopper Sparrow, Upland Sandpiper and Northern Harrier"

Six-legged service providers

Researchers: Doug Landis, Claudio Gratton, Rufus Isaacs, Tim Meehan, Julianna Tuell and Ben Werling

The goal of the Insect Team is to determine how production of different biofuel crops will affect insect pollinators and predators. In 2009, the team again sampled native bees: results confirmed 2008 trends, showing bees are more abundant in perennial grasslands compared to corn. The team also examined reproduction of stem-nesting bees and wasps (bees use many nesting sites ranging from hollow stems to abandoned burrows) by placing nest boxes at 36 sites. More bees and wasps were found nesting adjacent to grasslands. In 2009, the team also measured the ability of predators to consume insect pests, a key ecosystem service. To do so, the team placed eggs of a common pest in each habitat and calculated the percentage eaten by predators. Data suggest that predators in switchgrass and prairie consume more eggs than those in corn. Interestingly, not all prairie and switchgrass sites were equal: predators ate more prey in grasslands that contained multiple plant species. Not all landscapes were equal, either: more eggs were consumed in landscapes with a large area of perennial habitat compared to landscapes dominated by annual agriculture. Together, these results suggest that diverse grasslands could provide key habitat for insects, supporting high rates of the ecosystem services they provide.

Sampling in corn.

Sampling insect predators in switchgrass, a perennial biofuel typically grown in single species stands.

Insect-vectored plant viruses

Researchers: Carolyn Malmstrom and Abbie Schrotenboer

Organisms that cause plant disease, or "plant pathogens," could negatively affect biofuel crops and other plants in the surrounding landscape. Dr. Carolyn Malmstrom and her student Abbie Schrotenboer have focused on the interaction of switchgrass and a group of *Barley and cereal yellow dwarf viruses* (B/CYDVs). These plant pathogens are transmitted by aphids and can reduce plant growth and yield. They are interested in learning if biofuel crops could harbor these viruses. In 2008, they measured virus incidence in several switchgrass fields in southern Michigan and found B/CYDV infection rates ranging from 0-30%. Pan traps were set up to catch aphids in these same fields in 2009 to assess whether aphids are associated with virus incidence. They found that fields with higher aphid numbers also had higher incidence of B/CYDV infection. This indicates that local differences in aphid abundance may affect the frequency of aphid-vectored pathogens in biofuel crops. Future work will focus on how aphid abundance within a field is affected by the surrounding landscape.

Soil bacteria and greenhouse gases

Researchers: Tom Schmidt and Tracy Teal

Recent work by Drs. Tracy Teal and Tom Schmidt at Michigan State suggests that biofuel crop-choice could affect the diversity of greenhouse-gas consuming microbes inhabiting the soil. Specifically, the team focused on "methanotrophs:" bacteria that consume methane as part of their metabolism. In 2009, the Microbe Team collected soil from Michigan GLBRC extensive sites with corn, switchgrass and prairie. They then used DNA techniques to determine how many methanotroph species were present. Their results suggest there are more methanotroph species in soil from prairie and switchgrass than in soil from corn sites. The amount of methane consumed (and hence the amount removed from the air) tends to increase in soils with many methanotroph species. As a result, soil bacteria from prairie and switchgrass sites may remove methane from the atmosphere at greater rates than bacteria from soil in annual crops like corn. This suggests that conversion of lands to different biofuel crop types could impact rates of greenhouse gas exchange between the soil and atmosphere.

Top and left: Sampling soil for microbes

"...conversion of lands to different biofuel crop types could impact rates of greenhouse gas exchange between the soil and atmosphere."

Spotlight on Collaborators

Michigan collaborators — Jerry Stewart

Jerry Stewart of Native Connections (http://nativeconnections.net/blog/) has been landscaping commercial, corporate, farm and residential landscapes for the past 23 years, with an eye towards using native Michigan plants. His background in Environmental Science and an increasing interest in native Michigan plant communities led him to found Native Connections. Currently, his company uses approximately 700 species of native plants, tailoring specific seed mixes to local site conditions. These diverse plantings beautify the landscape while providing homes for diverse types of wildlife, an important function in today's often low-diversity landscapes. Jerry has collaborated with GLBRC by providing access to sites under his management as well as planting many of MSU's switchgrass and mixed prairie research plots. His hope is that demonstrating the biodiversity benefits of native plants will encourage landowners to plant them. Ultimately, this could help create working landscapes that provide homes for diverse species in addition to producing food, fuel and fiber.

Wisconsin collaborators — Riverland Conservancy

The Riverland Conservancy (www.riverlandconservancy.org) was incorporated in 1997 to promote the conservation of Wisconsin's diverse natural heritage. The Conservancy manages over 1800 acres of forest, prairie, savanna, wetlands and streams in the Merrimac Reserve, nestled between the Baraboo Bluffs and the Wisconsin River. The Conservancy actively engages the public in restoration and education to cultivate stewardship and connect people to the land around them. As a part of these efforts, the Riverland Conservancy has developed partnerships with scientists and community-members. The GLBRC sampled insect communities at the Merrimac Reserve in 2010; their findings, and those of other partnerships, will inform the Conservancy about the organisms inhabiting the Reserve and allow them to transmit these findings to the public.

Big bluestem

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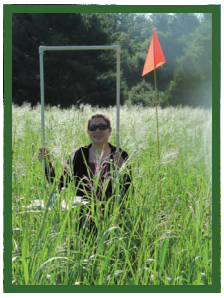
Describing plant communities

Researchers: Kay Gross, Carol Baker and Randy Jackson

The Plant Team, under the direction of Dr. Kay Gross and Carol Baker, hit the road again this summer to continue studies of plant composition and production at the GLBRC extensive sites. This completed data collection that began in 2008; data is now being used by the entire Biodiversity Team to examine relationships between plant species diversity and changes in insect, bird and microbial communities. For example, we now know that bird species diversity varies in relation to the species composition and height of plant communities. The plant team also finished measuring biomass production in the three community types. Results suggest annual productivity in mixed prairies and switchgrass fields is similar—prairies averaged 650 grams/m^2 dry biomass vs. 575 in switchgrass. Corn had by far the highest biomass production with an average of 2200 grams/m^2 (9.8 tons/acre). In the end, the best biofuel crops may need to produce high yields while providing a favorable mix of ecosystem services to society.



Left, center and right: Sampling plant biomass in mixed prairie, a diverse alternative biofuel.

A Special Thank You to all of our Collaborators !