

# 2018 LTER Standard Sampling Report

## Main Cropping System Experiment (MCSE)

### **Soil**

Soil was regularly sampled on the LTER to a depth of 25 cm at each of 5 stations in all replicates (R) of all treatments (T) 1-8, CF, DF, and SF. Samples were taken once or twice each month, for a total of fourteen times between March 19 and November 12. Soil was sampled using a ¾" diameter push corer. Two cores were taken from each station with all 10 cores composited for each plot. However, on July 9 and August 13, the soil was too dry to use a push corer in T1-8. A bucket auger, with 2¾" diameter, was used instead and only 3-4 cores were taken per plot. Inorganic nitrogen extractions and soil moisture determinations were done on subsamples from all soil sampled. Analysis of the extracts for nitrate and ammonium will be completed by Cathy McMinn during winter 2018-2019.

The April 11 soil samples were air-dried and archived. A subsample from each of the June 25 samples was incubated in the field for 21 days and then inorganic nitrogen extracted to evaluate mineralization potential.

A post-harvest extensive grid soil sampling was done in all replicates of T1-6 and T8NT on November 5. This soil was air-dried and sent to the MSU Soil and Plant Nutrient Lab for standard analysis which includes pH, lime requirement, P, K, Ca, and Mg.

### **Gas**

Gas was sampled throughout the LTER using round static chambers between April 10 and November 9. MCSE plots that were sampled include T1-7 R1-4, as well as the fertilized, untilled microplots in T7 R1-4. Static chambers were also sampled in T8 R1-4 and all replicates of successional and forested sites, CF, DF, and SF. Sampling in the forest sites included the Nitrogen Deposition Study microplots. With a sample frequency of about twice each month, gas samples were taken thirteen times during the 2018 field season. The MCSE (including T8) was sampled in the morning and forest sites sampled in the afternoon of the same day. Winter sampling began on December 6 and should continue monthly through March 2019. This sampling includes only T1-7 and DF. All gas samples were analyzed for nitrous oxide, carbon dioxide and methane by Kevin Kahmark and Cathy McMinn using the Agilent/Gerstel automated GC in Academic 330.

Soil temperature and soil samples to determine moisture content were taken near each chamber when gas was sampled during the field season. Air temperature was logged both inside and outside, while light was measured outside, of some chambers using HOBO dataloggers.

### **Water**

Soil water samplers, or lysimeters, were used to collect water from the soil at about a 1m depth in T1-7 R2-4 and all replicates of CF, DF, and SF. Samplers were evacuated and leachate collected about twice a month. Fourteen collections were made between March 15 and November 14. The volume of leachate collected was recorded. When 20mL or more of leachate was collected, the sample was filtered and frozen for analysis and archive. Analysis for nitrate and ammonium of all leachate samples taken should be completed by Cathy McMinn during winter 2018-2019.

## **Plants**

Plant biomass samples were taken from plots prior to tillage and/or harvest in T1-4, around weed-control measures in T6 and at peak biomass in T5, T7, T8 and SF. Plant species separations were completed for most but not all samplings. Cover crop samples were taken in T3 and T4 on May 8-9, prior to tillage and planting of soybeans. Plants were sampled in T6 four times during the 2018 season as agronomic practices worked to eliminate alfalfa and weeds in preparation for planting of switchgrass. Sample dates in T6 were May 10 (just after herbicide application), June 4 (just prior to mowing), August 15 (pre-mowing), and October 9 (pre-herbicide). At peak biomass, early August through mid-September, plant samples were taken from T5, T7, T8, and SF. Leaf litter was collected in traps in CF, DF, and SF between August 23 and November 30. Leaf litter traps were checked and leaves collected bi-weekly. Leaf litter traps were not installed in T5 in 2018 because the trees had all been harvested; see the next paragraph for more information. Soybean samples were taken from T1-3 on October 9-10 and T4 on October 17-18, just prior to machine harvest. On October 23 and 24, post-frost biomass samples were taken from T7. All plant material from all samplings was dried at 60°C for at least 48 hours. All dried biomass will be weighed, ground and archived. Subsamples will be analyzed for carbon and nitrogen by Stacey VanderWulp.

Root Tree Service harvested poplar trees from T5 between February 28 and March 9. They completed harvest of all microplot poplars. West Michigan Tree Service finished the harvest of T5 March 29 – April 10. All harvested trees were chipped into a truck that was driven over scales at the KBS Dairy farm and load weights recorded. Subsamples of the chips from each plot were bagged, weighed and dried for moisture determination. These dried samples will be ground, archived and analyzed for carbon and nitrogen.

In all replicates of CF and DF, all trees with a dbh (diameter at breast height) greater than or equal to 5cm are marked with a unique numbered tag. The dbh of all tagged trees was measured in January. As noted above, poplar trees were not present in T5 this year, so no diameter measurements were taken in those plots.

All replicates of T7 were burned on March 23 to help control woody growth.

Two drone flights were completed over the MCSE to collect visual/multispectral data. A flight for multispectral imagery was also done during poplar harvest. Drone flying was done by Kevin Kahmark and Sven Bohm.

Yield data was collected from all of the mechanically harvested plots.

## **Insects**

The Landis lab continued to monitor generalist insect predators for spatial and temporal dynamics following the updated version of the Insect Abundance protocol. Coordination of that research was done by Elizabeth D'Auria. Monitoring was conducted by attaching one yellow sticky card (Great Lakes IPM, IPM-CRW-100) to a T-post about 1.2m above the ground at each of the five stations within each replicate of T1-T7 (except T5 since trees had been harvested) and the nine forest plots. Weekly sampling started on June 5 and concluded on September 12. The target taxa consisted of 14 common to rare ladybug species (Order: Coleoptera, Family: Coccinellidae); soldier beetles

(Cantharidae); fireflies (Lampyridae); scorpionflies (Order: Mecoptera); and other non-target generalist predators (e.g. 20 spotted ladybug).

A 22 foot tall aphid suction tower onsite is part of a network of towers used to monitor regional aphid migration patterns in the Midwest. The fan on the tower was turned on and the first collection cup deployed on May 11. The collection cups were collected and replaced every Friday through October 19 at which time the tower was turned off. The samples were mailed to the University of Illinois at Urbana-Champaign for analysis.

### **MCSE Microplot Experiments**

**Herbicide-free Microplots (T1 R1-6, T2 R1-6):** No sampling was done in 2018.

**Rainfall Manipulation Experiment (T1 R1-4, T2 R1-4):** Two soil water samplers were installed in the northern-most 15m of each of T1 R1-4 and T2 R1-4 in 2014. These were not sampled in 2018. However, data was tabulated by Dave Weed for 573 water leachate samples collected from the T1 and T2 rainout shelter/control sites in 2016 and 2017. This dataset contains bromide and nitrate-N data that may be useful in looking at leaching and nitrate uptake rates. Data also includes other anions and cations quantified by ion chromatography.

Rainfall was manipulated in this experiment in 2018 by Kate Glanville. One notable difference from previous years was the inclusion of T1R5 and exclusion of T1R1. Shelters were installed on the east microplot beginning May 30. Rain water was collected and applied under the shelter every three weeks. The west microplot was left unsheltered and water was added to meet the 30 year mean. Non-nodulating soybeans were planted in both the east and west microplots as a method to detect symbiotic nitrogen fixation. Soil was tested for pH and inorganic nitrogen midway through the growing season. Shelters were removed from the plots for the season around September 17. Soybeans were then hand-sampled and oven-dried. Samples will be weighed, ground, and prepared for 15N analysis to determine symbiotic nitrogen fixation.

**Weed-control/Fertilization Microplots (T3 R1-6, T4 R1-6):** ended in 2014

**Poplar Fertilization Gradient (T5 R1-6):** In 2011, microplots were established in the northern-most 15m of each T5 plot to look at the effect of varying nitrogen fertilizer levels on poplars. All trees in T5 were harvested during winter 2018. A sub sample of the poplar chips from each microplot was dried at 60°C for at least 48 hours. Dried samples will be ground and archived. Subsamples will be analyzed for carbon and nitrogen by Stacey VanderWulp.

**Disturbance/Fertilization Microplots (T7 R1-6):** Started in 1989, these microplots are in the northwest corner of each T7 plot. There are four microplots in each plot; each microplot measures 5x5m. They combine disturbance/tillage and nitrogen fertilization in a full factorial design. Greenhouse gases were sampled thirteen times in the untilled, fertilized microplots of T7 R1-4, as detailed in MCSE Gas section above. Soil and plant sampling was led by the lab of Jen Lau. Soil samples for inorganic nitrogen, soil moisture and air-dried archive were collected once from all T7 microplots in 2018 on April 26. Five soil cores were taken to a depth of 10 cm in the 3 x 3 meter center of each experimental plot and composited. The T7 microplot biomass was sampled near its peak on August 17 for untilled and September 13 for tilled. All samples were dried and weighed. Species were separated for the untilled sampling only, prior to drying. This was the 30th year of

above-ground net primary productivity (ANPP) sampling in these microplots. The decision to sort the untilled to species was because of interest in that data for the 30 year mark. Legumes and clonal species are especially interesting functional groups that have changed here in previous years. In June of 2018 a project was started to isolate rhizobia bacteria from clover plants. Four soil samples (five 0-10cm cores pooled) were taken from each untilled microplot. These soils became the “live” inoculants containing rhizobia that have evolved in the presence/absence of 30 years of nitrogen fertilization. The soils were used as inoculate for greenhouse-grown clover. Clover plants were harvested, including root nodules. Root nodules were sterilized and their rhizobia were further isolated to single strain. This yielded 60 strains from fertilized plots and 271 strains from unfertilized control plots. Because the fertilized microplots did not yield enough strains a second experiment was started in the fall of 2018 and clover nodules should be harvested in January 2019.

### **Nitrogen Deposition Study**

Nitrogen is applied to subplots at each of the three replicated sites of CF, DF, and SF. Fertilizer solutions were applied to the 1F, 3F and 10F subplots in this study on three dates. Urea (46% N) was applied on April 25, July 5 and October 16. Rates of fertilization are 1gN/m<sup>2</sup>/year for the 1F subplots, 3gN/m<sup>2</sup>/year for the 3F subplots, and 10gN/m<sup>2</sup>/year for the 10F subplots. Gas was sampled on a routine basis in this study; see the Gas section under MCSE.

### **Resource Gradient Experiment**

From March through September 2018, 134 water leachate samples were collected from the LTER Resource Gradient soil water samplers. These samples were analyzed for anions, cations, non-purgeable organic carbon (NPOC), total dissolved nitrogen (TDN), alkalinity, and NH<sub>4</sub>-N (via IC). Silicate and total dissolved phosphorus (TDP) will also be analyzed on these samples. Dave Weed was responsible for sampling and analysis.

Soil samples were taken on November 7 and the field-moist soil analyzed for pH by Cathy McMinn in the Robertson lab. Four cores (0-25cm) were pooled from each plot, two in the crop row and two between rows.

The LTER Resource Gradient experiment automated trace gas system was dormant in 2018.

Yield data was collected when plots were harvested mechanically.

### **Interaction Experiment**

On October 15, soil samples were collected from all sixteen of the historically-tilled Interaction plots. In addition, samples were collected from the four monolith lysimeter areas. This soil was sent to the MSU Soil and Plant Nutrient Lab for standard analysis which includes pH, lime requirement, P, K, Ca, and Mg. In October and November 2018, buried mesocosms were installed in three (of four) no-tillage, no-fertilizer plots to measure rates of associative nitrogen fixation (ANF) in switchgrass. Rainout shelters will be added to those plots in 2019 to manipulate soil wetting/drying regimes to examine the relationship between ANF and switchgrass phenology, diazotroph communities and nitrogenase iron protein (nifH) expression. This work is led by Sarah Roley.

**Biodiversity Study**

Yield data was collected from all of the annual crop treatments when harvested mechanically.

**Cellulosic Biofuel Experiment**

Yield data was collected from all of the treatments when harvested mechanically.

**Scale-up Fields** – ended in 2013

**Living Field Laboratory** – ended in 2014

Written by Stacey VanderWulp (with contributions from Elizabeth D’Auria, Kate Glanville, Mark Hammond, Kevin Kahmark and Dave Weed)

## Archived Material

Experiment	sample type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
LTER MCSE	leachate										
LTER MCSE	plants										
LTER MCSE	T7 microplot plants										
LTER MCSE	surface soil										
LTER MCSE	T7 microplot surface soil										

  

Experiment	sample type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
LTER MCSE	leachate										
LTER MCSE	plants										
LTER MCSE	T7 microplot plants										
LTER MCSE	surface soil										
LTER MCSE	T7 microplot surface soil										
LTER MCSE	deep core soil										
LTER Biodiversity Study	surface soil										

  

Experiment	sample type	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											
LTER MCSE	deep core soil											
LTER Biodiversity Study	surface soil											
LTER Resource Gradient	surface soil											

## Agronomic Soil Analysis

Experiment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
LTER MCSE											
LTER Resource Gradient											
GLBRC BCSE main											
GLBRC BCSE micro											
GLBRC BCSE deep core											
GLBRC Scale-up											
GLBRC MLE											
GLBRC Switchgrass Gradient											