Cedar Creek Ecosystem Science Reserve LTER

Photo credit: Jabob Miller

Cedar Creek Ecosystem Science Reserve (CDR) LTER in central Minnesota includes upland habitats – oak savanna, prairie, hardwood forest, pine forests, abandoned agricultural fields – and lowlands dominated by ash and cedar swamps, acid bogs, marshes, and sedge meadows. Early CDR LTER research developed theory and experiments to understand plant succession and nutrient limitation.

Currently, CDR LTER uses long term observations and experiments, theory, and models to understand two main concepts: 1) how ecological systems will respond to human-driven environmental changes that interact at multiple biological, spatial, and temporal scales, and 2) how ecological responses moderate or amplify environmental changes and how this may affect ecosystem services.

Between 2008-2018:

56 investigators

21 institutions represented

72 graduate students

Mixed Landscape

Principal Investigator:

Eric Seabloom

University of Minnesota

Est. 1982

Funding Cycle:

LTER VII

NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Soil resources jointly limit the response of grassland ecosystems to elevated CO_2. In two nested global change experiments, nitrogen (N) and soil moisture jointly constrained the response of biomass production to elevated CO_2 over the long term. When both water and N were limited, elevated CO_2 did not affect plant biomass. When neither resource was limited, elevated CO_2 caused an increase in plant biomass [Product 9].

Chronic N enrichment reduces plant biodiversity and alters plant community composition. Chronic N addition reduced plant species richness and led to the local extinction of species with efficient N use. Species richness returned to its original level after ceasing the addition of low levels of N. These changes in composition were readily reversed after low levels of N were no longer added. However, species richness did not recover two decades after ceasing the addition of high levels of N. Network-wide synthesis projects are testing how applicable this observation may be across different ecosystem types. [3, 6, 7]

Biodiversity increases ecosystem productivity and stability. Research in the 1990s demonstrated that more diverse herbaceous plant communities are more productive and exhibit less year-to-year variability in net primary productivity (NPP). Recently, this positive relationship has also been observed in forect communities. New CDR LTER research also indicates that the relationship increases in strength with experiment duration in grasslands. Recent network-wide synthesis projects are scaling results up from biodiversity experiments to natural communities and testing predictions. [4, 5, 8, 10]

Photo credits: Frank Menschke (top); Jacob Miller (middle, bottom)

Partnerships

University of Minnesota (UMN)
College of Biological Sciences | UMN
Office for the Vice President for Research

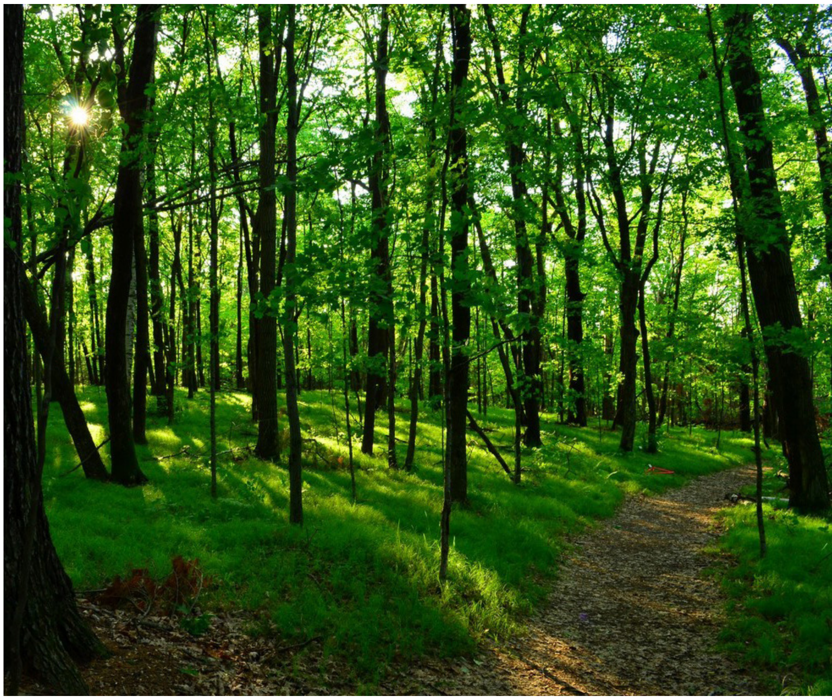
Cedar Creek Ecosystem Science Reserve
University of Minnesota

Synthesis

Lead and participate in observational networks and coordinated experiments. Several networks focus on nutrient manipulation (Nutrient Network), drought (DroughtNet), and tree diversity (IDENT), as well as Urban Homogenization and Yard Futures studies. In particular, the Nutrient Network experiment is demonstrating that work conducted at CDR LTER for herbaceous ecosystems can be generalized worldwide [1].

Founding members and contributors to numerous global ecological databases. Cedar Creek LTER scientists have led and participated in many global syntheses that used databases such as the TRY plant trait database, the ART-DECO decomposition database, the FRED root database, and the EcoSIS spectral library. Each examines relationships among traits and trait effects, and how these affect ecosystem function.

Cedar Creek LTER leads efforts in biodiversity remote sensing. Long term experiments, including grassland and forest biodiversity experiments, the savanna fire frequency experiment, global change experiments, and old field succession experiments, have served as key test beds for developing approaches to remotely sensing biodiversity and linking it to below ground processes [2].



Data Accessibility

Over 500 actively curated datasets (some extending back 80+ years) are made accessible, stored in a central database at the University of Minnesota, backed up off site, and synchronized with the Environmental Data Initiative (EDI) data catalog. Cedar Creek LTER also supports critical information management for the Nutrient Network.

Photo credits: U.S. LTER (top, bottom); Peter Wragg (middle)

Broader Impacts

Building pathways to lifelong science learning. Participants build long term relationships with the landscapes, people, and science at CDR LTER through in-school programs (grades K-3), guided field trips (4-7), student-driven investigations (8-12), independent research projects (undergraduates), and citizen science projects (adults and families). These programs reach over 12,000 participants annually.

Community members contribute to long term science. Through three citizen science projects (Red-headed Woodpecker Project, Cedar Creek Wildlife Survey, and Eyes on the Wild) over 5,000 volunteers from around the world assist in wildlife studies. They monitor woodpeckers, document tracks and sign, and identify and characterize animals in trail camera images on a web interface. Data from these projects fill gaps in CDR LTER's work on wildlife and help researchers maintain records of animal populations, distribution, and relative abundance.

Connecting graduate students and middle school students. Two programs guide 25 graduate students in mentoring approximately 700 7th and 8th grade students to develop questions, collect and analyze data, and present findings to their peers.

Artists in Residence. Each year, several artists work closely with CDR LTER researchers, students, and staff to interpret and represent key experiments and landscapes. Public showcases engage a statewide audience.

Photo credits: Caitlin Potter

Top Products

1. Borer, ET et al. 2014. Herbivores and nutrients control grassland plant diversity via light limitation. **Nature.** doi: 10.1038/nature13144
2. Cavender-Bares, JJ et al. 2017. Harnessing plant spectra to integrate the biodiversity sciences across biological and spatial scales. **American Journal of Botany.** doi: 10.3732/ajb.1700061
3. Clark, CM and D. Tilman. 2008. Loss of plant species diversity after chronic low-level nitrogen deposition to prairie grasslands. **Nature.** doi: 10.1038/nature06503
4. Grossman, JJ et al. 2017. Species richness and traits predict overyielding in stem growth in an early-successional tree diversity experiment. **Ecology.** doi: 10.1002/ecy.1958
5. Hautier, Y et al. 2015. Anthropogenic environmental changes affect ecosystem stability via biodiversity. **Science**. doi: 10.1126/science.aaa1788
6. Isbell, F et al. 2013a. Nutrient enrichment, biodiversity loss, and consequent declines in ecosystem productivity. **PNAS**. doi: 10.1073/pnas.1310880110
7. Isbell, F et al. 2013b. Low biodiversity state persists two decades after cessation of nutrient enrichment. **Ecology Letters.** doi: 10.1111/ele.12066
8. Reich, PB et al. 2012. Impacts of biodiversity loss escalate through time as redundancy fades. **Science.** doi: 10.1126/science.1217909
9. Reich, PB et al. 2014. Plant growth enhancement by elevated CO2 eliminated by joint water and nitrogen limitation. **Nature Geoscience.** doi: 10.1038/NGEO2284
10. Seabloom, EW et al. 2017. Food webs obscure the strength of plant diversity effects on primary productivity. **Ecology Letters.** doi: 10.1111/ele.12754