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# Soil health and productivity in riparian grass buffers: A re-evaluation after 13 years

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**Keywords**
Ecology Evolution and Organismal Biology, Natural Resource Ecology and Management, Conservation practices, Soils and agronomy, Water quality quantity and management

**Disciplines**
Ecology and Evolutionary Biology | Natural Resources and Conservation | Natural Resources Management and Policy | Plant Biology | Soil Science | Water Resource Management

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## Principal Investigator:

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**Budget:**
$32,082 for year one

**Q** Do soils within formerly cropped, perennial-grass riparian buffers continue to change after more than ten years of establishment?

ECOLOGY

**A** The buffers sampled in 2014 had far better developed soil food webs than they (i.e., the very same plots) did 13 years earlier.

## Background

In 2001, an extensive survey of soil health and productivity was undertaken in riparian grassland buffers adjacent to Bear Creek in northern Story County, Iowa. The investigators for this project resampled the same 24 plots in 2014, using the same techniques. The overall objective was to evaluate changes in soil health and aboveground biomass production that occurred over the past 13 years across this diverse array of grass buffers on five different farms. The buffers were planted on row-cropped and heavily grazed pasture soils in 1990, 1994, 1997, 1999 and 2001, and thus were zero to 11 years old during the initial sampling in 2001. In 2014, they were 13-24 years old.

Specific project objectives were to quantify changes in four areas of soil tilth that occurred after 13 years as assessed by:

- Biomass of active and total soil bacteria and fungi,
- Abundance and diversity of soil organisms,
- Total soil respiration, and
- Plant biomass and production.

## Results and discussion

Measurements of bacterial biomass provide an assay of the overall health of a soil, in that bacteria serve as the base of the food chain for much of the soil food web; process plant detritus into smaller, soluble compounds; and stimulate nutrient cycling. Active biomass refers to those bacteria that are actively metabolizing, that is, consuming oxygen. Total biomass includes inactive and dead bacteria that are important constituents of soil organic matter. A high active-total bacteria ratio indicates lots of activity but, perhaps, a shortage of the processed organic matter that is more important for nutrient supply.

Based on direct comparison of data collected from the same plots in October 2001 with data from October 2014, active bacterial biomass was similar. Also, in both 2001 and 2014, researchers found similar active bacterial biomass in the cool-season (C3) and warm-season switchgrass (C4) plots. However, total bacterial biomass in the switchgrass (C4) buffers increased from an average (± S.E.) of 150 ± 2 μg/g in

*Multi-species riparian buffer strip system comprised of a grass buffer strip adjacent to the crop field, two strips of native shrubs, and native tree species adjacent to Bear Creek, Ron Risdal's farm, northern Story County, Iowa. (Photo courtesy Richard Schultz.)*

2001, to 2110 ± 70 µg/g in year 2014. The upward trends among C3 buffers, C4 buffers, and all grass buffers were similar.

Fungi also are important components of the soil food web, and some species form mycorrhizal associations with plant roots. In comparison to bacteria, fungi may be more important in nutrient retention and transport, and their hyphae contribute to soil structure. The responses of fungi were similar to those of bacteria. Active fungal biomass was similar across years in C4-dominated grass buffers, but total fungal biomass increased from an average of 190 µg/g in 2001, to 1020 µg/g in 2014. This represents an increase of 450 percent.

The team was unable to address the temporal aspects of this hypothesis because of the untimely departure of the doctoral student responsible for sampling. However, they made a direct comparison of the protozoan data from October 2014 to the original data from the October 2001 sampling. There was an average of 17 times as many soil protozoans in the surface soils of the switchgrass buffers in 2014 (404,200 ± 206,100 per gram of soil) as in 2001 (23,400 ± 15,100 per g). Protozoans are very important contributors to nutrient cycling in soils. Flagellates and amoeba, both of which apparently increased substantially between 2001 and 2014, are obligate aerobes that do best in well-aerated soils. Only ciliate populations were lower in 2014 than in 2001, but that difference was not meaningful. Nematode numbers were relatively low in both 2001 and 2014. However, nematode diversity was good in both years. Thirty-eight nematode genera representing five trophic categories (bacterial-feeding, fungal-feeding, fungal/root feeders, root feeders, and predatory) were found within grass buffers.

In 2014, researchers also sampled crop fields very close to riparian-buffer plots. This was not done in 2001, but the data obtained nevertheless provided comparative information for 2014. Ciliate populations, nematode abundances, and nematode generic richness (number of genera found) were generally similar in the crop fields and riparian buffers. However, the abundances of flagellates and amoeba were lower, on average, in the crop fields than in the buffers. In general, flagellate and amoeba densities in the crop fields in 2014 were higher than they were in the grass buffers in 2001.

Work on the project's third and fourth objectives was not concluded or analyzed due to the departure of the project's graduate student researcher.

## Conclusions

Findings from this project suggest changes in the soil food webs of riparian grass buffers that were planted in the 1990s, first sampled in 2001-2002, and resampled in 2014 (this study). Unfortunately, based on the limited data, the investigators cannot make firm conclusions or suggestions, but an interesting trend was observed that deserves further investigation.

In switchgrass-dominated buffers, total soil bacterial biomass was 14 times greater in 2014 than in 2001. Total fungal biomass in the switchgrass buffers was five times greater in 2014 than in 2001. Total protozoan densities increased by 18 times. Nematode diversity was similarly high in both years, from both generic and trophic-

*Old cool-season grass buffer at Ron Risdal's farm along Bear Creek in northern Story County, Iowa.*

guild perspectives, despite relatively low nematode densities. These data suggest that the populations of soil microbiota continue to develop as already-established riparian-zone grass buffers continue to grow over their second decade after establishment. The data collected from crop fields (in corn-soy rotation) next to the grass buffers, on the same soil type, support the conclusion that improvement in soil food web communities occurred in the second decade following establishment. Soil bacteria and fungi are primary decomposers present in these soils; they are responsible for the breakdown of complex carbohydrates and proteins into substrates that are used by plants and other organisms.

Protozoans accelerate the turnover of bacterial biomass and thus stimulate nitrogen cycling and availability within the soil. The data collected for this project suggest that soil food webs in existing riparian-zone grass buffers continue to change and improve across their second decade post-establishment. That is, the buffers sampled in 2014 had far better developed soil food webs than they (i.e., the very same plots) did 13 years earlier.

The PIs intended to evaluate plant and soil processes related to and possibly supporting their existing soil-food-web data. Due to the inability to carry out the final two objectives of the project, the PIs returned $18,710 to the Leopold Center.

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