

# Enabling the study of multi-trophic responses in restoration

---

Rebecca Hufft

# Landscape of a Living Farm

Over the centuries, South Africa has established a proud heritage of farming. Today's farmers ensure that the country's growing population is self-sufficient in virtually all major agricultural products, while producing more than half of southern Africa's maize requirements and exporting many agricultural products around the world.

Yet demand continues to grow and agriculture now faces the challenge of producing sufficient, quality agricultural product while conserving biodiversity and managing natural resources, and improving human health. To meet these challenges, farmers must adopt good and efficient management practices and view their farm, neighboring farms, rivers and natural areas as interdependent features in a living landscape.



## Biodiversity

Biological diversity – or biodiversity – is essentially ‘all life on earth’, from bacteria and fungi to flowering plants, crops, birds and bees as well as the full range of natural cycles and processes. These diverse life forms and natural processes provide us with the basic goods (e.g. food crops, wild food, fibre, medicines) and services (e.g. clean water, waste decomposition and carbon storage) that promote human wellbeing.

Agricultural biodiversity (the biodiversity associated with agricultural ecosystems) is indispensable for plant and soil health, and therefore sustaining crop production, food security and livelihoods.<sup>1</sup>

## Water

Clean, fresh water is a ubiquitous facet of human existence – a crosscutting feature of our health, prosperity and culture. Agriculture is the largest human use of water, accounting for more than 70% of the freshwater withdrawals from rivers and groundwater.

Good agricultural practice can contribute to improved water availability. Practices include protection of catchments, storing water, maintaining year-round vegetative cover of soils, improving rain-fed agriculture and upgrading rain-fed systems and water- and rein-water management, irrigation efficiency, reducing agrochemicals, and clearing invasive alien plants.

## Soil

The health of an agricultural ecosystem depends largely on the way the land is used. The quality of the soil and the input and output of nutrients.

The top soil, the fertile source of our food, can be conserved and improved by utilizing on-farm nutrient cycling. Farm resources such as manure and plant residues can be used.



## Natural Cycles

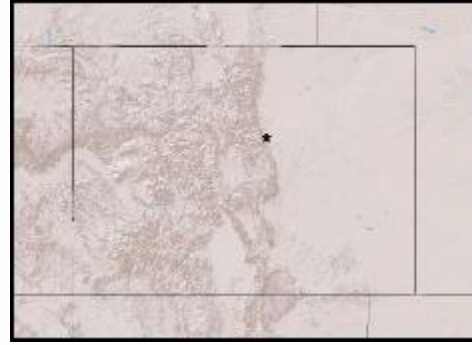
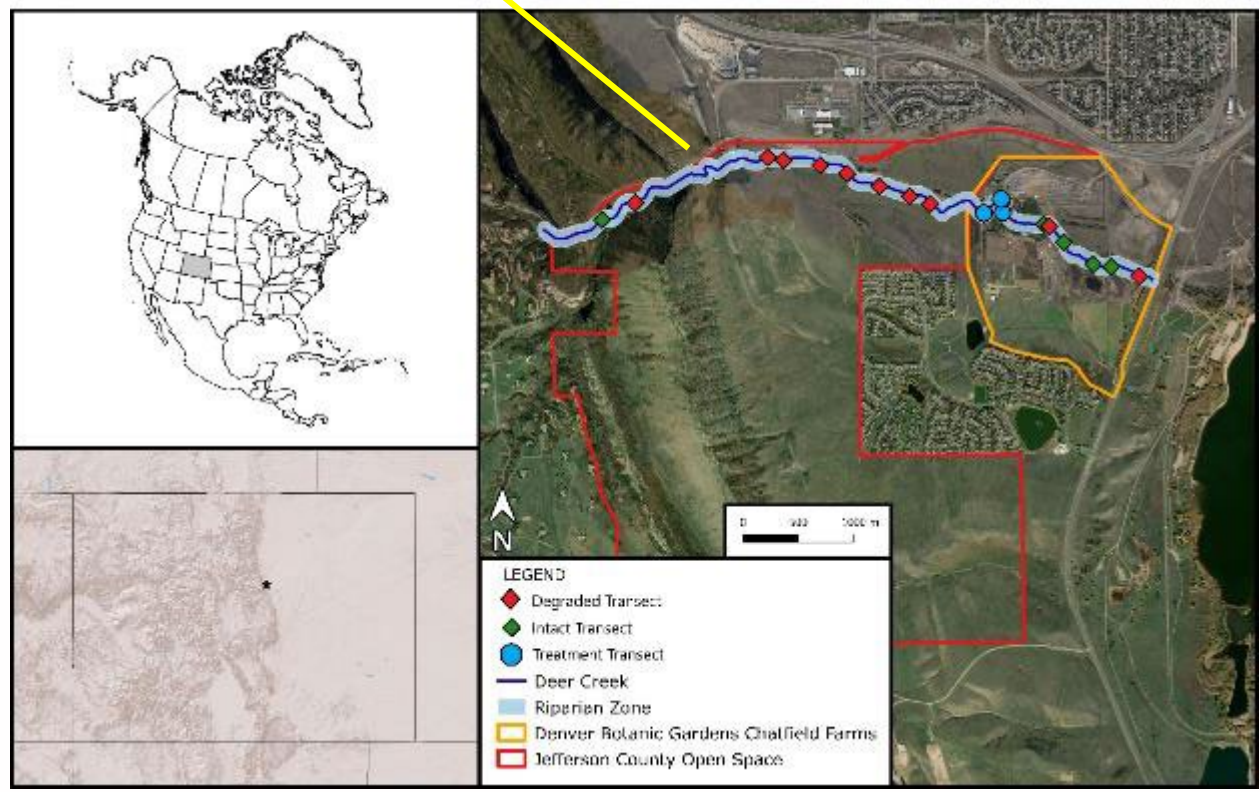
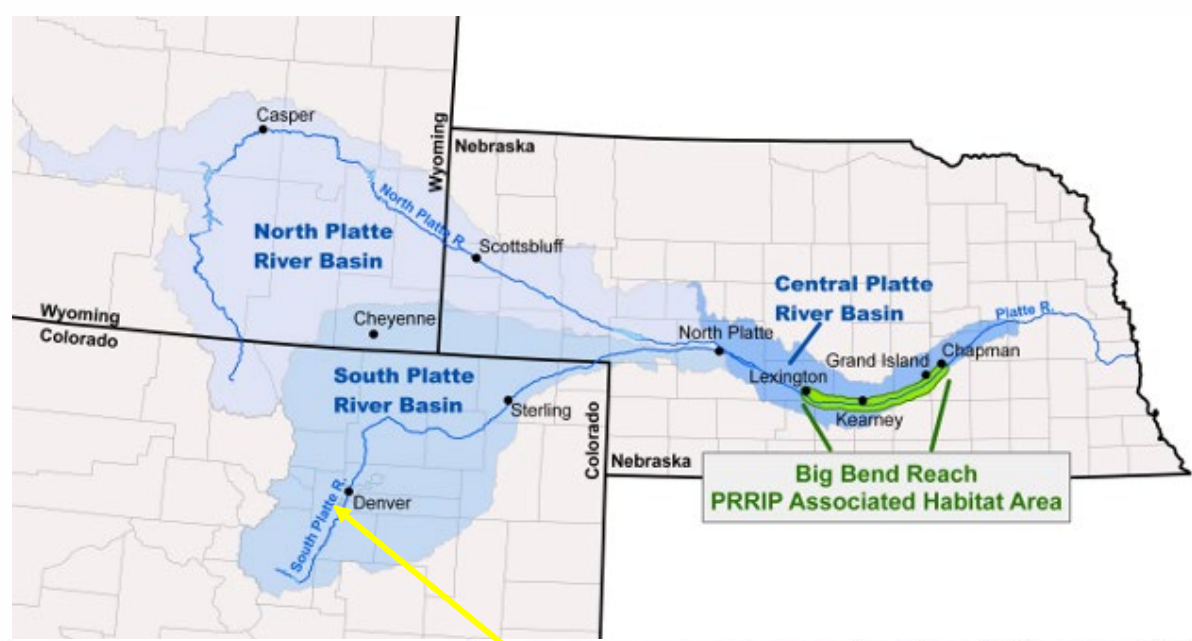
Sequestration of carbon (where CO<sub>2</sub> is a greenhouse gas (GHG)) takes place above and below ground so that bio-ground carbon comprises more than the combined amounts occurring in vegetation and the atmosphere.<sup>2</sup> Proper soil management results in less CO<sub>2</sub> and N<sub>2</sub>O (nitrous oxide, another GHG) loss than poorly managed, over-fertilized soils.<sup>3</sup>

Good agricultural practice integrates natural biological cycles and controls, such as nutrient cycling, nitrogen fixation, soil regeneration, weather cycles and integrated pest management into crop production processes.



<sup>1</sup> Agricultural Ecosystems, World Bank Group for Sustainable Development and CGIAR, the International Centre for Conservation of Nature, July 2008.  
<sup>2</sup> Agricultural Ecosystems, World Bank Group for Sustainable Development and CGIAR, the International Centre for Conservation of Nature, July 2008.  
<sup>3</sup> Report to the Department of Water and Sanitation, Dr. Dirk Louw, 146, 2007-01.  
<sup>4</sup> Smith, P. et al. 2008. Quantifying greenhouse gas emissions in agriculture. The Science of Soil, 8, 202, 204-05.





# Chatfield Farms

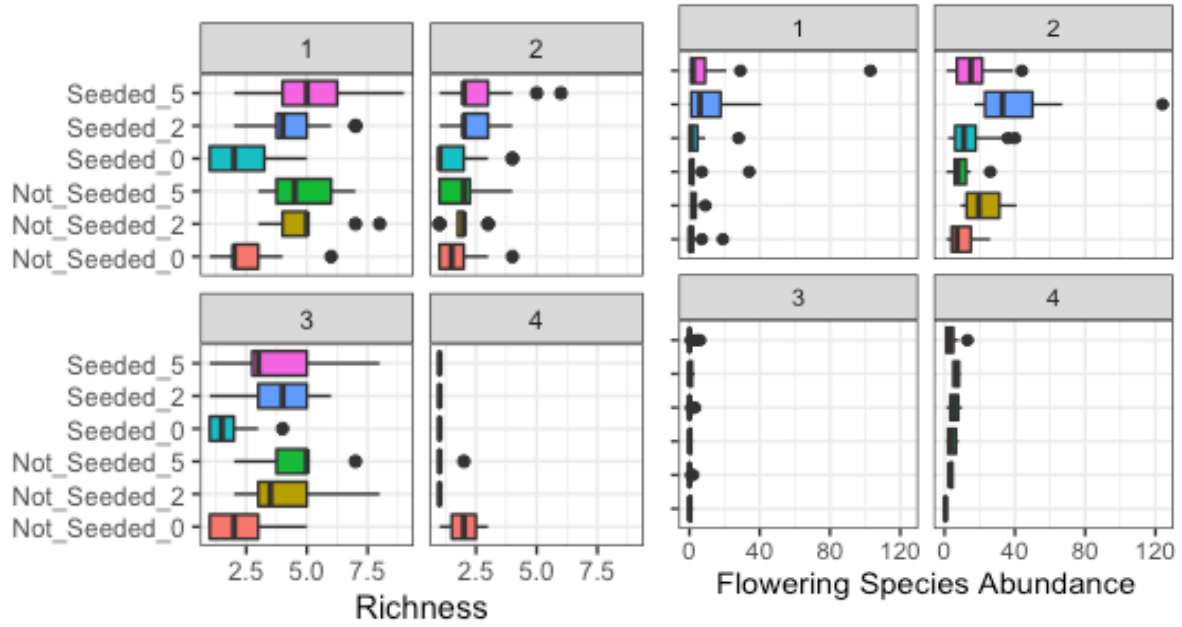
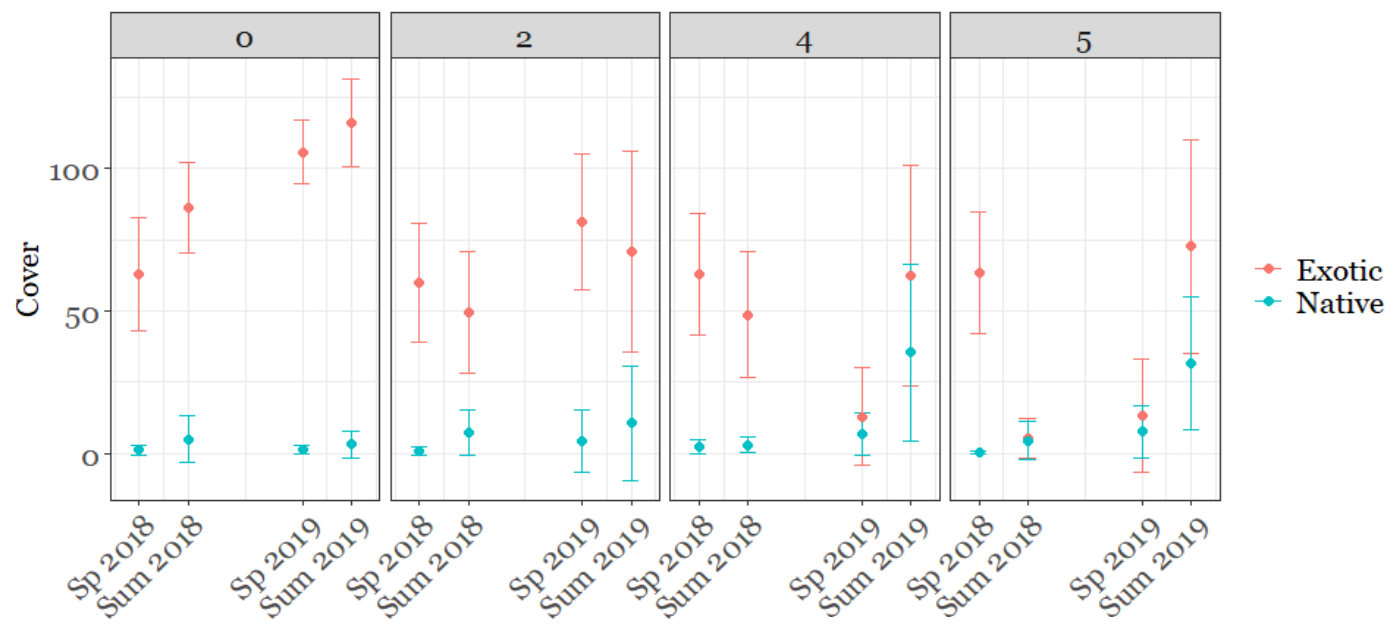




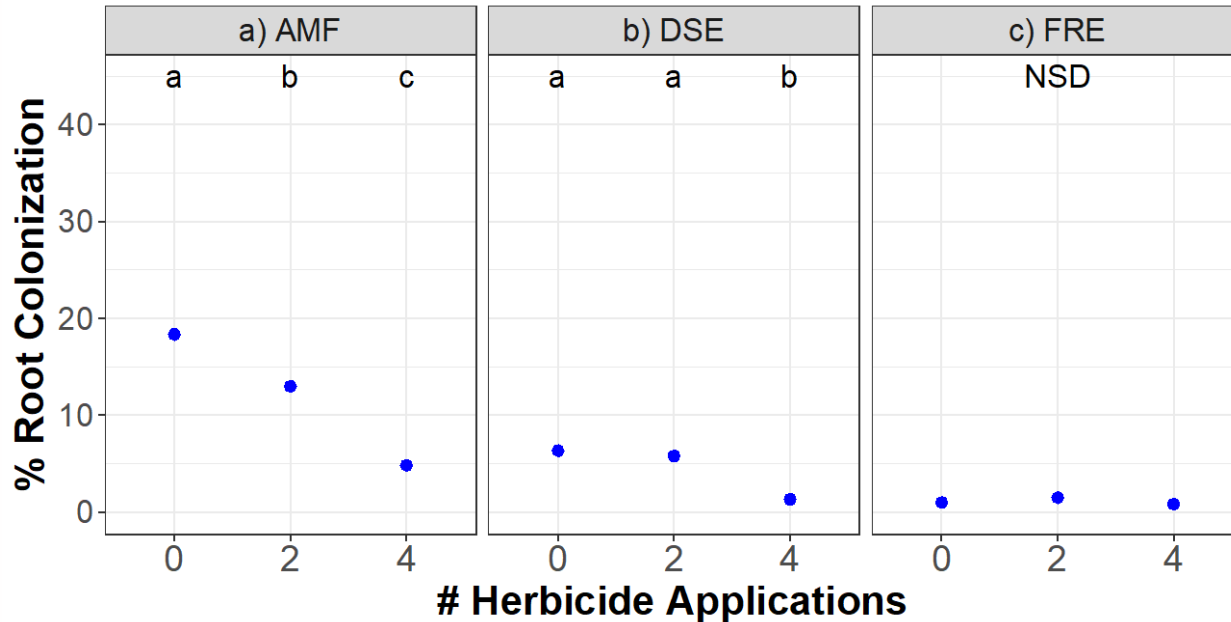
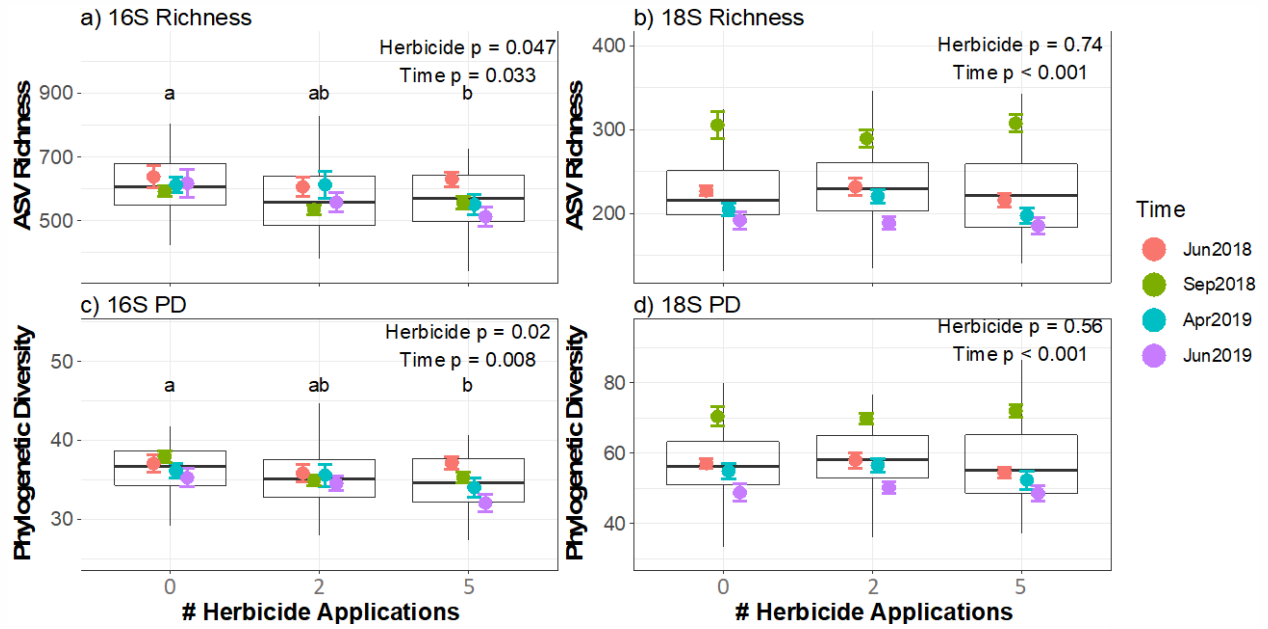


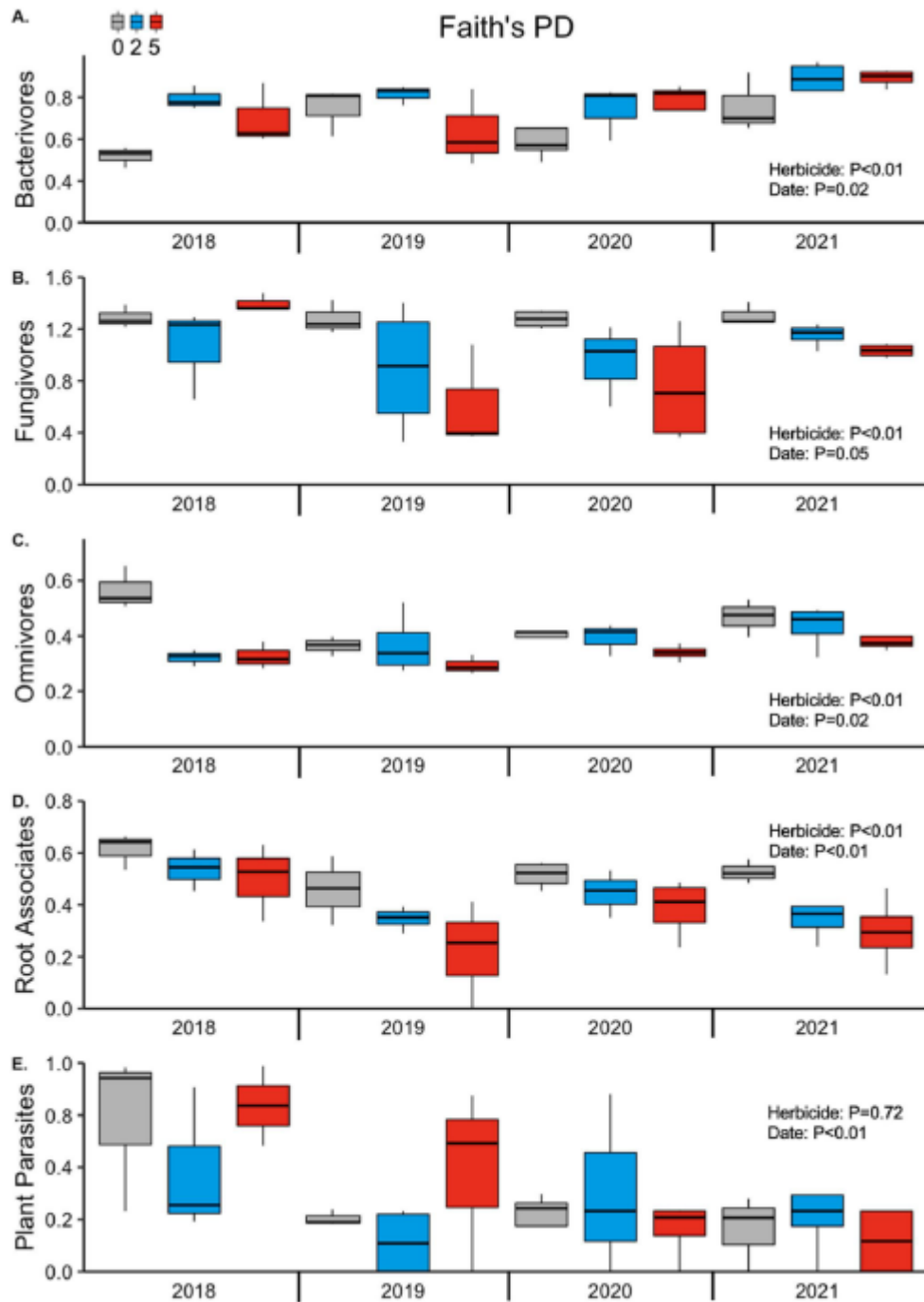


Figure from A. Miller 2021









## Soil Nematode Diversity

McQueen et al. 2024. *Soil Biology & Biochemistry* 191: 109350

## Chatfield Farms



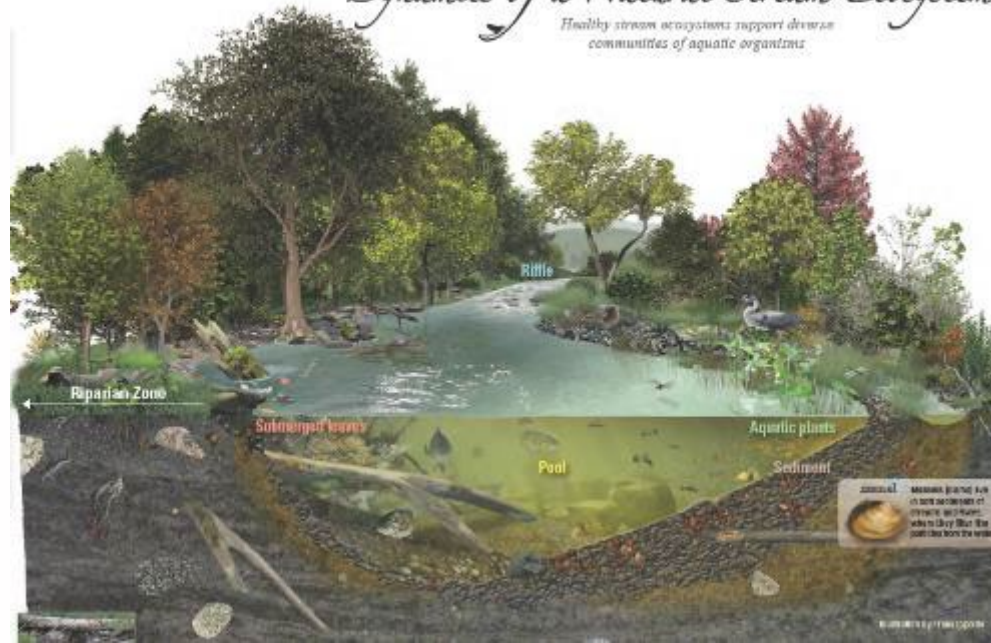
# Dynamics of an Agricultural Stream Ecosystem

*Agricultural practices are diverse, and thus the impacts to stream ecosystems from agriculture are highly variable.*



# Dynamics of a Natural Stream Ecosystem

*Healthy stream ecosystems support diverse communities of aquatic organisms.*





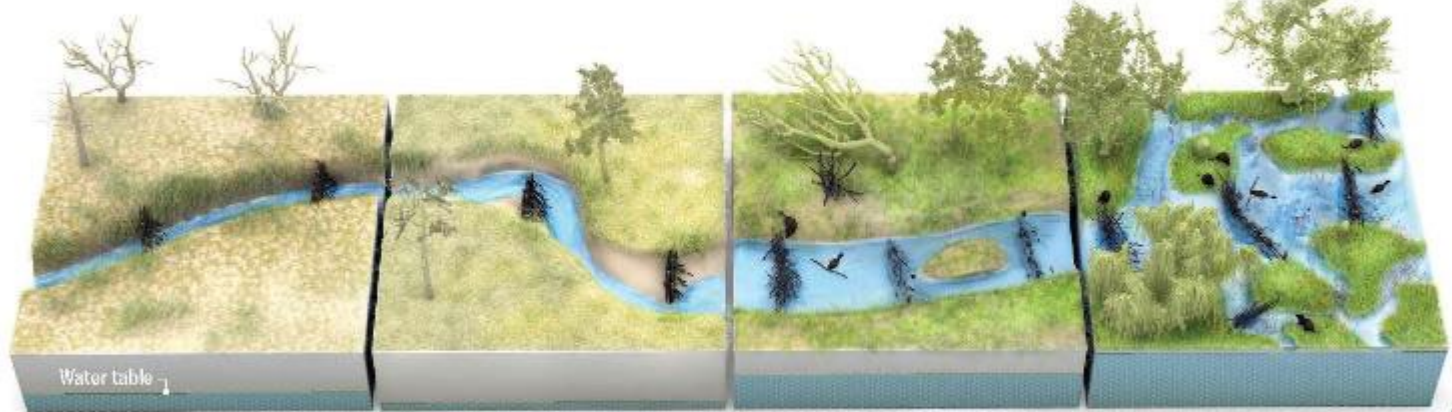
Incised stream

### A stream comes back to life

Across the U.S. West, scientists and land managers are using beaver dam analogs (BDAs) to heal damaged streams, re-establish beaver populations, and aid wildlife. In some cases, researchers have seen positive changes in just 1 to 3 years.



Restored stream



#### Adding dams

Beaver trapping and overgrazing have caused countless creeks to cut deep trenches and water tables to drop, drying floodplains. Installing BDAs can help.

#### Widening the trench

BDAs divert flows, causing streams to cut into banks, widening the incised channel, and creating a supply of sediment that helps raise the stream bed.

#### Beavers return

As BDAs trap sediment, the stream bed rebuilds and forces water onto the floodplain, recharging groundwater. Slower flows allow beavers to recolonize.

#### A complex haven

Re-established beavers raise water tables, irrigate new stands of willow and alder, and create a maze of pools and side channels for fish and wildlife.

# Ecosystem Engineers

---







08/30/2021 04:36 PM 82°F

SPYPOINT LINK-S



09/22/2021 10:20 PM 37°F

SPYPOINT LINK-S

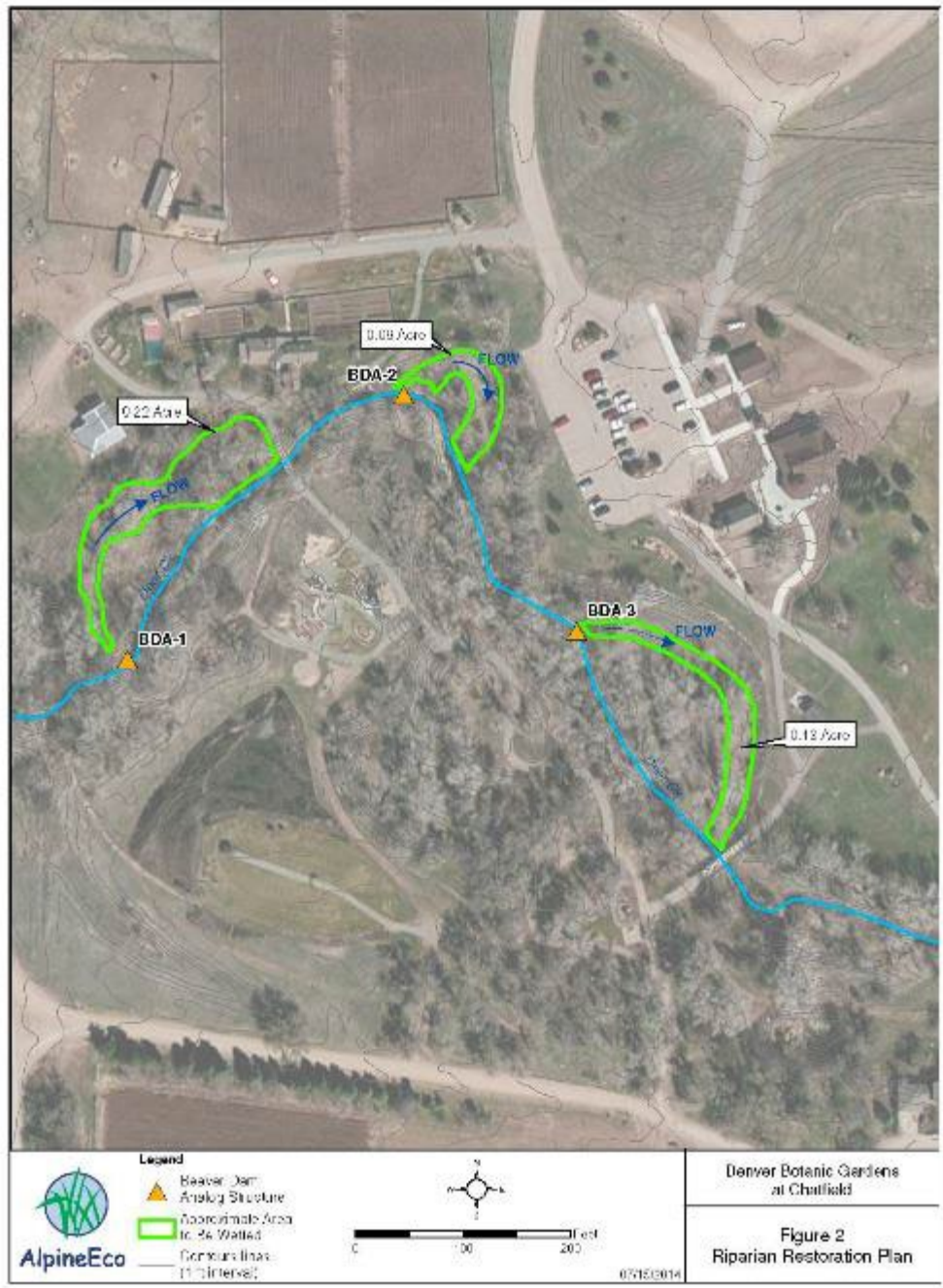


AM 09°F

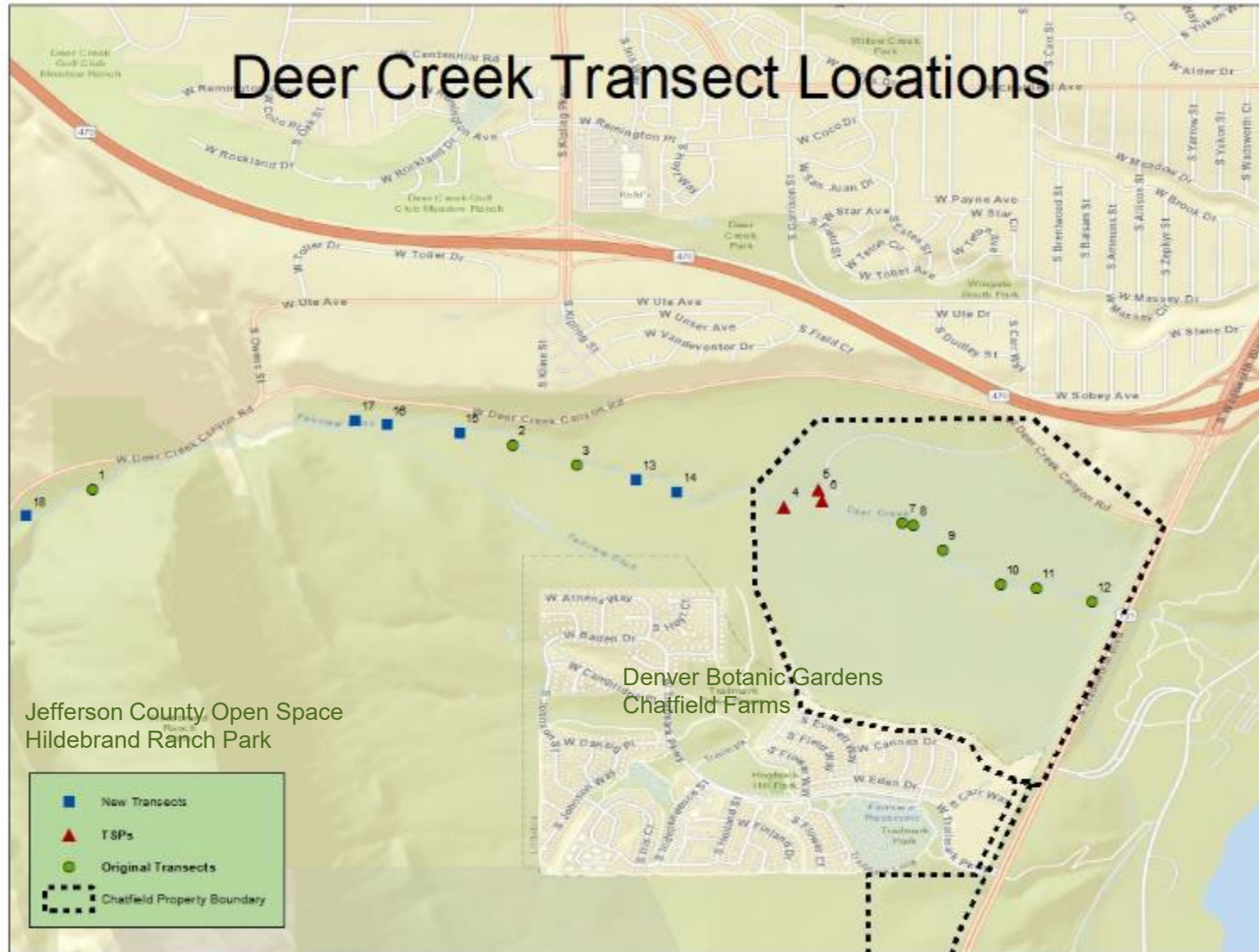
SPYPOINT LINK-S





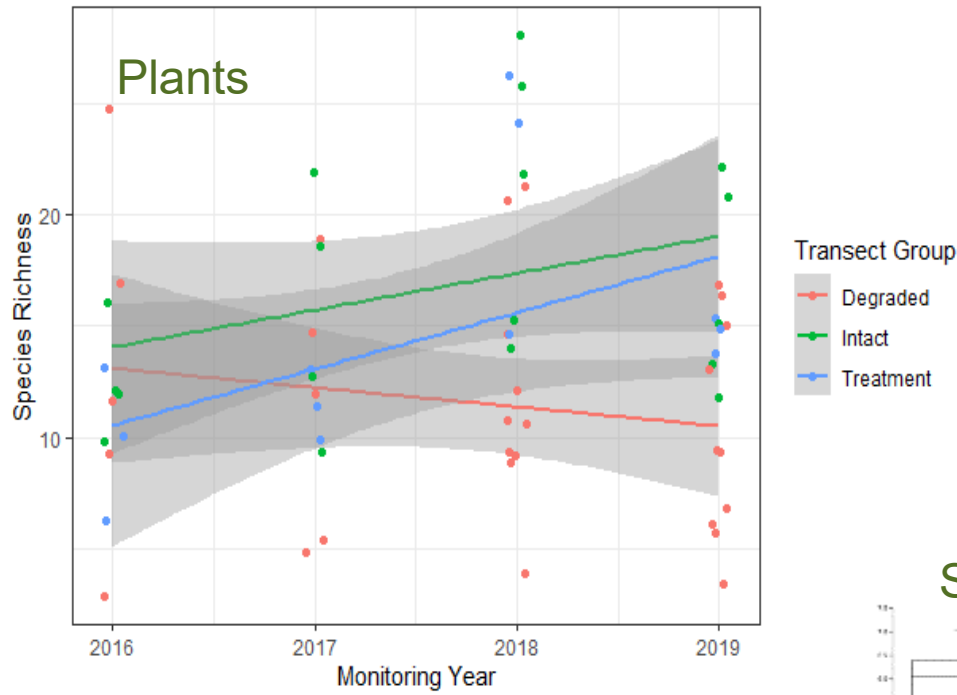




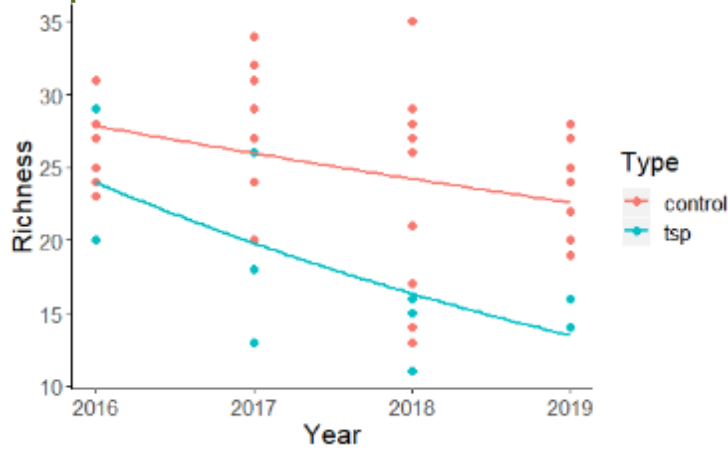


Plants: diversity, abundance, canopy cover  
 Water quality: pH, temp, N, *E. coli*  
 Aquatic macroinvertebrate diversity

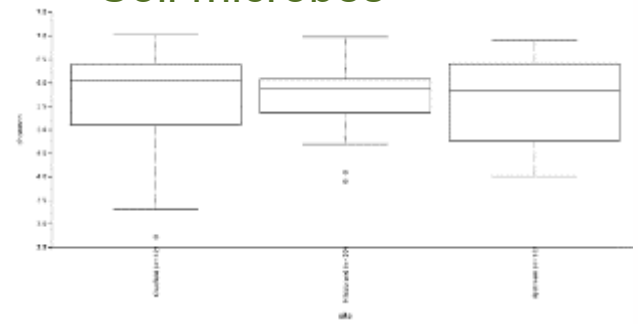
Species Richness Over Time



### Aquatic macroinvertebrates



### Soil microbes





**June 2017**



**June 2018**



**April 2024**

## To Our Funders: Thank You

Borgen Family Foundation

National Fish and Wildlife Foundation Five Star and Urban Waters  
Program

CO Department of Agriculture Noxious Weed Fund

Jefferson County Open Space

Colorado Water Conservation Board

Gladys Cheesman Evans Endowment

Bureau of Land Management

USDA National Institute of Food and Agriculture