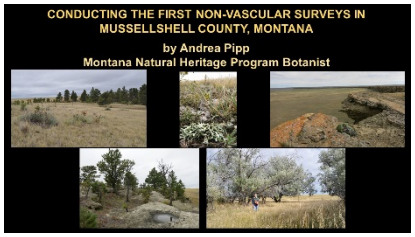
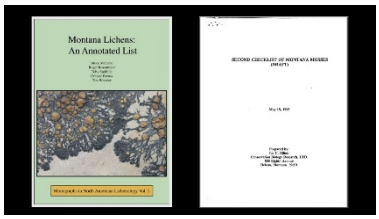


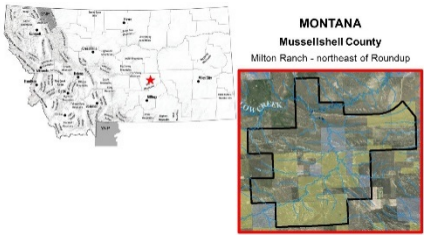
- In 2014 the monograph, Montana Lichens: An Annotated List was published.
- This publication not only listed the lichen taxa in MT, but it based the work on verified specimens, provided the location of these specimens, addressed synonymy, provided habitat information, and highlighted the counties where no lichens had been collected.



- **A bit later in 2015** Montana's Moss Expert Joe Elliott decided it was time to revise his 1993 Montana Moss Checklist.

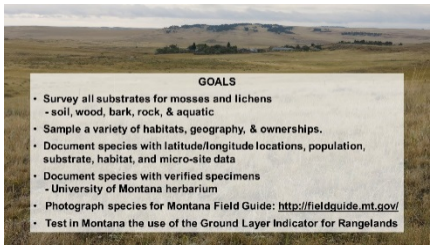
- In 2015 I was also approached by Bill Milton, a rancher who for 30 years has worked to maintain a profitable livestock ranching operation that was ecologically healthy for both land and family.
- Bill wanted his land surveyed for mosses and lichens.
- His ranch is located in Mussellshell County, where only 1 lichen and no mosses had ever been documented.

- With an invitation from the Milton Family who provided lodging and meals,
- transportation funding from the Montana Native Plant Society,
- funding from the Bureau of Land Management
- funding from the Montana Natural Heritage Program,
- and expertise from members of Northwest Lichenologists - the first documented moss and lichen surveys for Mussellshell County took place on the Milton Ranch.

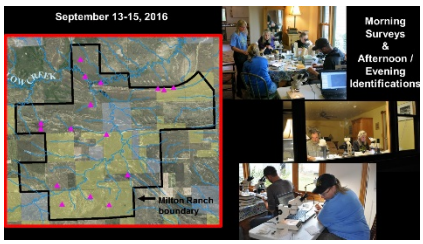


- Milton Ranch is located about 9 miles northeast of Roundup, Montana in Mussellshell County – shown by the red star.
- The ranch, which is outlined in black, raises cattle and occupies about 15,000 acres, consisting of
  - privately-owned land shown here with no color coding,
  - leased land from the Bureau of Land Management, color coded in yellow,
  - and leased land from the State of Montana, color coded in blue.

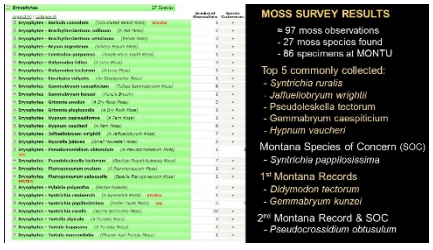
The ranch consists of rolling grassland, open ponderosa pine stands, and sandstone rock outcrops dissected by mostly ephermal and intermittent streams with some perennial waters streams.



The goals were
* to survey all terrestrial and aquatic substrates for all mosses and lichens: soil, wood, bark, and rock
* to sample from a variety of habitats, geography, and ownerships.
* to document observations by collecting specimens, mapping their location, and recording population and other data.
* to photograph species to put onto the Montana Field Guide
* to test in Montana the use of the Ground Layer Indicator for Rangelands



- The project took place from September 13-15 of 2016.
- Mornings were spent surveying and afternoons into evenings were spent identifying our collections.
- In the mornings teams of two were dispersed across the ranch to capture as much habitat and geographic variability as possible.
- The pink triangles show where teams surveyed.
- Each person was equipped with a GPS, camera, and collection packets.
- By the time we left on September 16th, most of the collected specimens had been identified.
- A few folks took specimens home to further examine.
- All of the moss specimens were sent to Joe Elliott for verification.
- A few specimens were sent other experts such as Caleb Morse, Patricia Eckel, and John Spence.



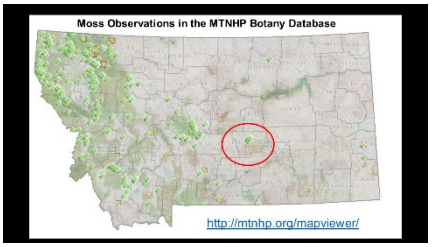
What did we find?

- We made about 97 moss observations representing 27 species.
- Of these 86 specimens were curated and deposited at the University of Montana herbarium.
- The 5 most commonly collected mosses are listed on the slide
- A few noteworthy specimens were found:

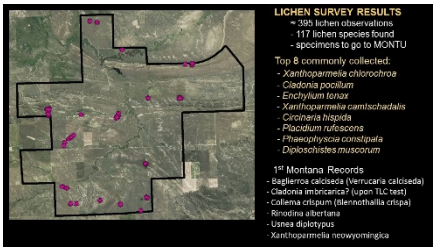
- Syntrichia pappilosissima, a Montana Species of Concern

- Didymodon tectorum and Gemmabryum kunzei which are Montana's 1st records, and

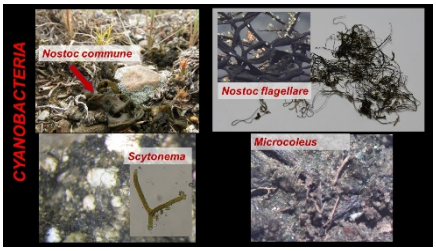
- Pseudocrossidium obtusulum which is a Species of Concern and the 2nd record for Montana.



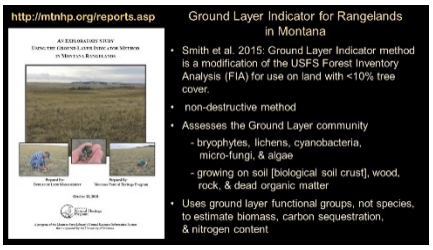
The moss data is in the botany database, and is available on our website through the Map Viewer Application and by request.



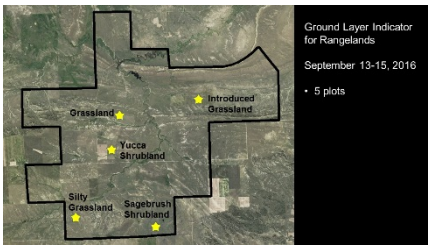
- We collected about 395 lichen specimens representing about 117 species.
- This fall many of them will be curated and deposited at the University of Montana herbarium.
- The 8 mostly commonly found lichens are listed on the slide.
- We found no Species of Concern based on our current list.
- However, we found about 6 species that are new records for Montana
- The lichen data will soon be in our database and available on Map Viewer.



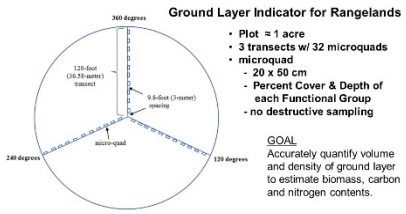
We made about 23 observations of cyanobacteria representing 4 taxa:
- Nostoc commune
- Nostoc flagellare
- Microcoleus
- Scytonema



- During this time we implemented an exploratory study of the Ground Layer Indicator for Rangelands (GLIR).
- This was a modification of the original Ground Layer Indicator method developed by Rob Smith.
- It quantifies the ecological significance that ground-dwelling organisms provide in forests and rangelands by using functional groups - and not species - to estimate biomass, carbon storage, and nitrogen content.
- The Ground Layer Indicator broadens the concept of biological soil crusts which occupy the soil to include the non-vascular species that grow on wood, rock, and dead organic material at the ground surface.
- I'm going to highlight a few results, but you can find the full report on the Montana Natural Heritage Program website.



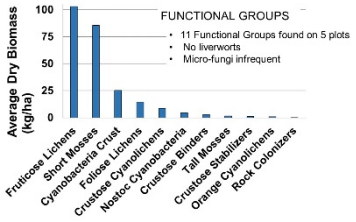
- During September 5 plots were subjectively located in different habitats:
  - Introduced Grassland
  - Grassland
  - Silty Grassland
  - Yucca Shrubland
  - Sagebrush Shrubland
    - Plots were placed near to areas surveyed for mosses and lichens, or near vegetation monitoring transects or near the 2010 plant community plots.



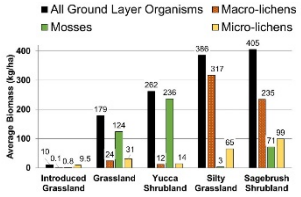
- Each Ground Layer Indicator for Rangeland plot is about 1 acre in size.
- It consists of 3 transects and 32 microquads.
- Each microquad measures 20 x 50 centimeters.
- Within each microquad the percent cover and depth of each functional group is measured.
- The goal is to accurately quantify the volume and density of the ground layer to estimate biomass, carbon and nitrogen contents.
- This is a non-destructive method.

What's a Functional Group?

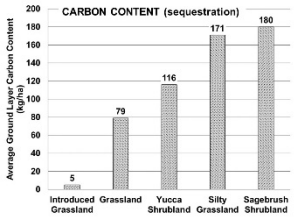
- Functional groups are composed of species that are of the same type of organism, such as a lichen, moss, or cyanobacteria, and share the same primary ecological role and growth form.
- For example, lichen species can be split into functional groups that are best at fixing nitrogen, binding organic material, binding soil particles, providing invertebrate habitat, contributing to rock weathering, or providing forage to ungulates.



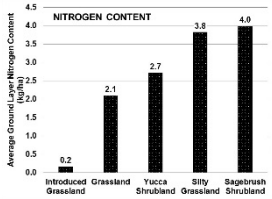
- This graph shows the 11 Functional Groups and their average biomass when all 5 plots were combined.
- I apologize that I don't have time to explain the differences between these Functional Groups.



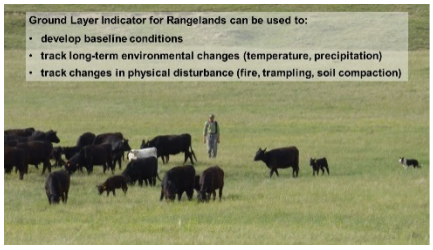
- Now let's look at the average biomass at each of the 5 plots.
- Biomass tells us how much organisms cover the soil.
- Collectively, all functional groups contribute to biomass, as shown by the black bars.
- Across the 5 plots representing different habitats, biomass differs for mosses – in green, macro-lichens – in orange, and micro-lichens – in yellow.
- The introduced grassland had the least average biomass of Ground Layer organisms.
- This land broken by the plow more than 20 years ago and was planted with mostly crested wheatgrass and alfalfa.
- The sagebrush shrubland has the highest biomass and is dominated by Big Sagebrush, grasses, and forbs.



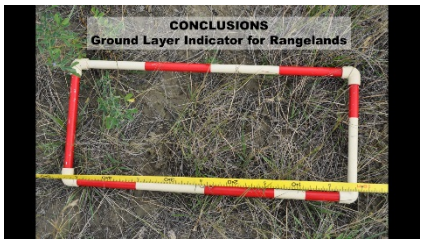
- Vascular plants and biological soil crusts contribute to rangeland carbon uptake, storage (sequestration), and release.
- Ground Layer Organisms grow in the open spaces between individual vascular plants
- It is in these interspaces between plants that ground layer organisms provide the primary source of carbon, improves soil fertility, and provides energy for soil microbial populations.
- This graph shows the amount of carbon that is stored in the Ground Layer at the 5 plots.
- The pattern in carbon content mirrors the pattern seen for biomass.
- This is expected because carbon is proportional to biomass.



- While nitrogen is abundant in the atmosphere, its form is not useable by plants.
- Cyanobacteria and cyanolichens are best at converting nitrogen into 'rangeland fertilizer' that can be used by plants.
- This graph shows the amount of nitrogen in the Ground Layer at the five plots.
- The pattern mirrors that of biomass.
- Cyanobacteria and cyanolichens were present in all plots, but were least prevalent in the introduced grassland and most abundant in the Sagebrush Grassland.

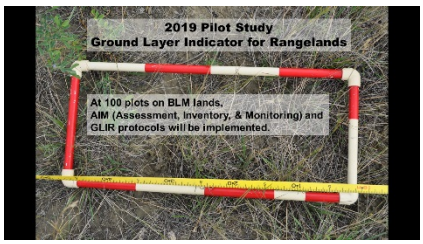


- The purpose of the Ground Layer Indicator for Rangelands is to quantify their ecological contributions, such as
- biomass which indicates how much is present to affect soil erosion or to store carbon or nitrogen.
- A well-designed study can use this method to develop baseline conditions to quantify functional groups, biomass, carbon and nitrogen storage, and other variables.
- From the baseline conditions long-term changes in the environment could be tracked to help determine a trend, either declining, increasing, or stable.
- Likewise, changes in physical conditions or particular changes from a management action can be tracked to determine a declining, increasing, or stable trend.

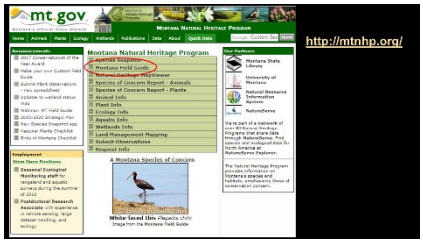


This exploratory study demonstrated that:

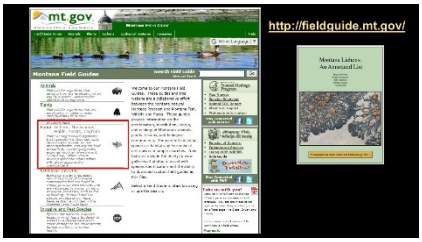
- the method is appropriate for use in Montana, particularly for ranch or statewide scales.
- We collected data from 5 subjectively placed plots.
- We found that Ground Layer Organisms are patchily distribution. This meant that our 5 plots were insufficient to accurately estimate biomass and nutrient content.
- As you all know plots cannot be subjectively placed if you want to make accurate inferences with the data.



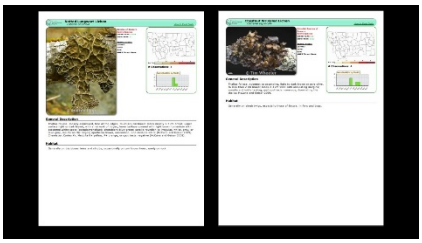
- This summer we are implementing a pilot study in north-central Montana that is well-designed.
- The BLM is putting in 100 plots where both the AIM and Ground Layer Indicator for Rangelands will be implemented.



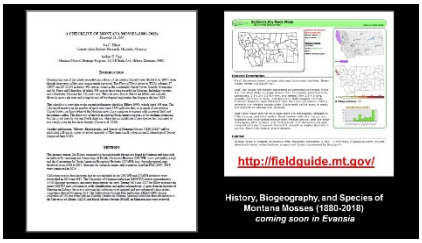
- Lastly, I want to share with you some updates from the Montana Natural Heritage Program's website.
- For the first time Montana has a Lichen Checklist.
- You can find it on the Montana Field Guide



- Specifically, on the Fungi Field Guide.
- At its core, the checklist brings in information from Montana Lichens: An Annotated List.
- With help from one of its co-authors, Tim Wheeler and others, Montana's Lichen Checklist brings in more recent literature, standardized common names, synonymy and misapplied names, and classification.



- On the Montana Field Guide each species has its own profile with photos, identification, habitat, Montana location data, and other information.
- It is a work in progress.
- You will find profiles for rare lichens more developed than for others.



- Montana has a revised Moss Checklist completed by Joe Elliott.
- It uses current taxonomy based on the Flora of North America and has county distribution maps.
- The Moss checklist is available on the Plant Field Guide or as a downloadable PDF.
- This spring, Evansia will be publishing The History, Biogeography, and Species of Montana Mosses from 1880-2018.

That's it – thanks for listening!