

intro

In this study, the conventional focus on grassland restoration, which is challenged around recreating plant communities aligned with ideal conditions. This study dives in complexities of ecosystem recovery after oil and gas extraction in the northern U.S. Great Plains rangelands. Through a multi-trophic analysis that comprises a chrono sequence of two to 33 years since reclamation, this study contrasts the reclaims that did not match to the undeveloped rangeland after 33 years have gone by. However, nematode trophic structuring has seemed to be recovered. Intriguingly, despite the long periods of time, the reclaimed soil is still persistent in salinity and pH compared to undeveloped soils. While nematode communities were able to recover, plant communities still seem to struggle against restoration efforts, unveiling the lasting impact of high soil salinity which is holding back the entire ecosystem recovery. This study shows the challenges of getting to where the ecosystems need to be. The hypothesis of this study will be nematode communities will be able to recover compared soil and plant communities will not be able to recover after reclamation.

The objective of this final project in R Studio is to conduct a comprehensive analysis on the given data of the ecological damages that have arisen from oil and gas extraction. This project will be done by using data visualizations, statistical models, and markdown documentation. This project aims to contribute insights from the data tables to become charts and show how the field of grassland restoration and sustainable land management practices are occurring. Overall, reclamation practices can recover nematode communities but not soil conditions or plant communities.

Nematodes

Nematodes, commonly known as roundworms, constitute a diverse and ubiquitous group of microscopic, non-segmented worms found in a myriad of terrestrial and aquatic environments. Despite their diminutive size, nematodes play pivotal roles in ecosystems as they interact with various organisms and influence nutrient cycling. With an estimated one million species, nematodes exhibit remarkable diversity in morphology, behavior, and ecological functions. Their adaptability allows them to inhabit virtually every habitat on Earth, from soil and freshwater to extreme environments like deep-sea sediments. As crucial components of soil ecosystems, nematodes contribute significantly to nutrient dynamics, plant health, and serve as valuable indicators of environmental conditions and ecosystem health.

methods

The method for this project involves utilization of R Studio to conduct in-depth analyses of ecological data related to impacts that occurred due to the oil and gas extraction. The work will be done by RStudio with provided data and methods such as coding. After all code and images have been collected, they will be transferred to github to create an interactive website to show off the write up, coding, and images. Within the experiment itself, I was given a data set already to work with. The researchers in this experiment must have been able to study the soil composition such as pH and salt concentrations after reclamation. The same goes for the plant communities and the nematode communities. Within the experiment itself, they conducted a comprehensive multi-trophic study focusing on soil factors, plant species composition, and nematode trophic structuring. The investigation targeted reclaimed oil and gas well sites ("reclaims") across a chronosequence spanning two to 33 years since reclamation. Through the

study, the researchers were able to collect the total amount of nematodes with respect of their feeding techniques.

Expected results

Nematodes are a parasite which can be found all over the world within plants and animals. These animals would be expected to be able to stabilize after reclamation rather than the soil and plant communities are. "The reasons for the success of the Nematoda as parasites probably include the presence of an environmentally protective cuticle, facultative diapause (like the dauer stage of *Caenorhabditis elegans*), biochemical adaptations to existence in extreme conditions, and the use of a variety of reproductive strategies." (Riddle Blumenthal, et al.) Nematodes can withstand a wide variety of extreme conditions, even of course after an attempt at stabilization of a plant community. This is not the same case for plants and soil. "Oil and gas development and reclamation change the physical structure and biological function of soil, often decreasing water filtration and increasing erosion, which affects the establishment and persistence of plant communities" (Sean Stéfano, et al.) Even after the 33 years from this study, the entire function and biological structure will alter due to these stresses. Although nematodes live in these plant communities, The plants and soil are not meant to be able to deal with these extreme conditions such as nematodes are. These results would be useful in planning future projects around plant communities since we can see there will be an impact on them. This will be another environmental issue that needs to be discussed in which policy makers may need to consider how these processes move forward.

Results

The nematode abundance and feeding habits were assessed across multiple sites, transects, and sampling points within the reclaimed oil and gas well sites ("reclaims") and adjacent undeveloped rangeland. The total nematode counts varied across sites and transects, with abundances generally higher in the 150 m transects compared to the 50 m transects. Notably, the nematode communities were categorized into different trophic groups, including Unknown, Bacterivorous, Frugivorous, Herbivorous, Omnivorous, and Predatory.

After looking at the data charts created, it is notable that bacterivorous nematodes had a greater frequency at each of the sites being followed by herbivorous nematodes. Then the predatory nematodes were third being followed by the frugivorous nematodes. However, there was a good amount of frequency of unknown nematodes as well.

Conclusion.1

In conclusion, this final project represents an effort to display the ecological setbacks associated with energy development for oil and gas extraction. This will be done through combining data visualizations, statistical modeling in R, and Markdown documentation. The goal is to show the long-term impacts of ecosystem recovery. The findings of this study could help provide information on future projects that may include this type of human-made impact. This project contributes valuable insights to all such as the scientific community all the way up to the policy makers. "Oil and gas development and reclamation change the physical structure and biological function of soil, often decreasing water filtration and increasing erosion, which affects the establishment and persistence of plant communities.

Conclusion.2

In conclusion, the analysis of the nematode data set reveals intriguing patterns in trophic structuring across the surveyed sites and transects. Bacterivorous nematodes emerged as the most abundant trophic group, underscoring their pivotal role in nutrient cycling and soil ecology. Following closely were herbivorous nematodes, emphasizing their impact on plant-microbe interactions and ecosystem dynamics. Notably, predatory nematodes exhibited substantial representation, reflecting their crucial role in controlling other soil organisms. Fungivorous nematodes, while present, demonstrated a comparatively lower abundance. Intriguingly, the category labeled as "Unknown" also exhibited a high count, suggesting that a significant portion of the nematode community remains to be characterized or may encompass novel trophic strategies. This comprehensive trophic analysis provides valuable insights into the complexity of nematode communities, contributing to a deeper understanding of soil ecosystem dynamics and emphasizing the need for continued research to unravel the intricacies of these microscopic yet ecologically significant organisms.

Importance

Nematodes play a pivotal role in ecological communities due to their diverse and influential contributions. As decomposers, they facilitate nutrient cycling by breaking down organic matter, enriching soil and promoting plant growth. Additionally, nematodes serve as key indicators of soil health and ecosystem functioning, reflecting the overall balance and stability of the environment. In agricultural settings, certain nematode species act as biological control agents, helping to manage pest populations. Their interactions with plants, fungi, and other microorganisms contribute to the intricate web of relationships that sustains biodiversity and ensures the resilience of terrestrial and aquatic ecosystems. Overall, the ecological significance of nematodes extends far beyond their microscopic size, making them essential components of diverse biological communities.

GLM

The key results are visualized on the response scale, providing an interpretable depiction of the impact of each trophic group on the overall nematode abundance. The visualization likely shows the estimated effects of each trophic group on the response variable, allowing for an intuitive understanding of how changes in these predictors influence the total nematode count. Interpretation of the specific plot is needed to discern the magnitude and direction of these effects, which will help in gaining insights into the relative contributions of different trophic groups to the observed variation in nematode abundance within the given data set.