

# Vegetation Change Along a Post-mining Reclamation Chronosequence in Central Wyoming

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Carolyn Johnson

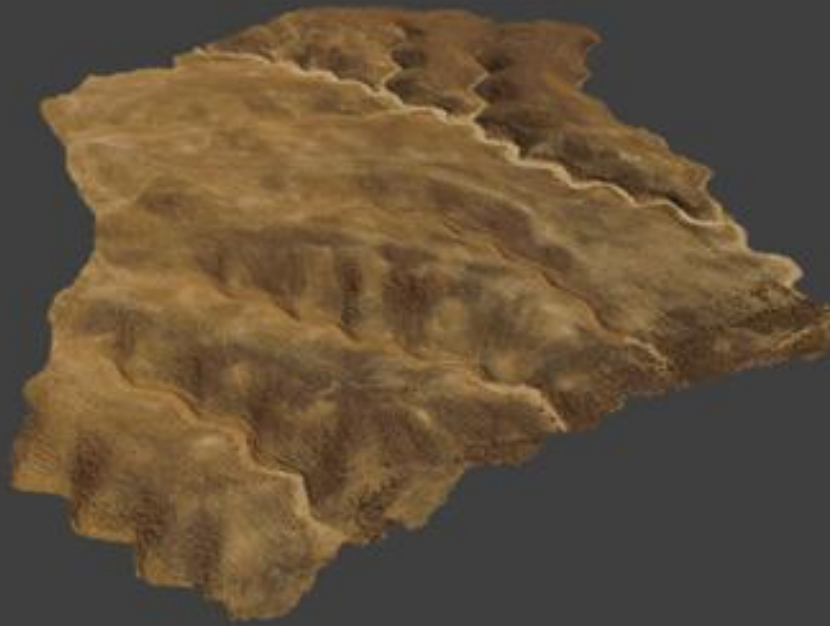


# History of Reclamation

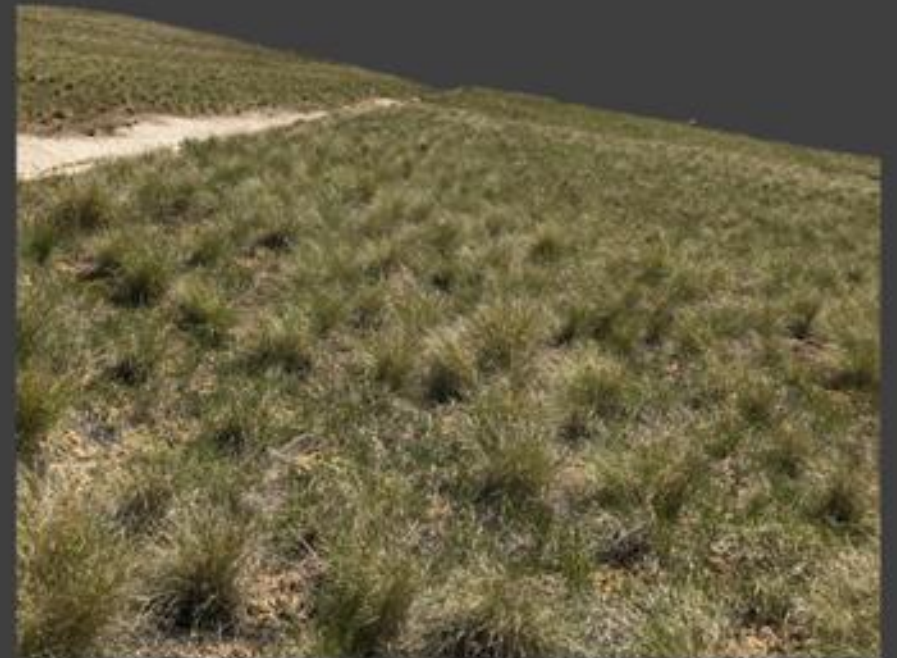
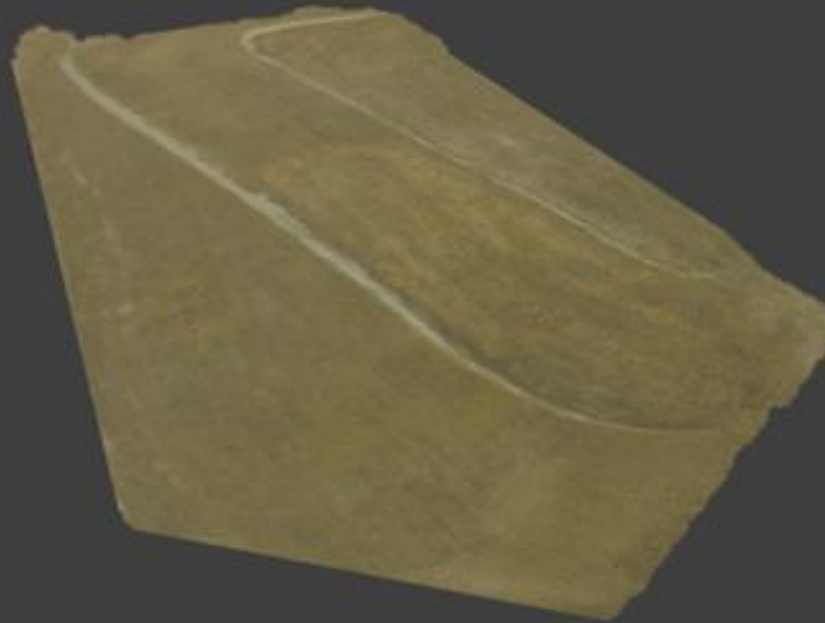
- Uranium mining altered soils, hydrology, and vegetation
- Reclamation aims to restore ecosystem function
- Long-term vegetation recovery remains poorly understood



# Geomorphic



# Traditional



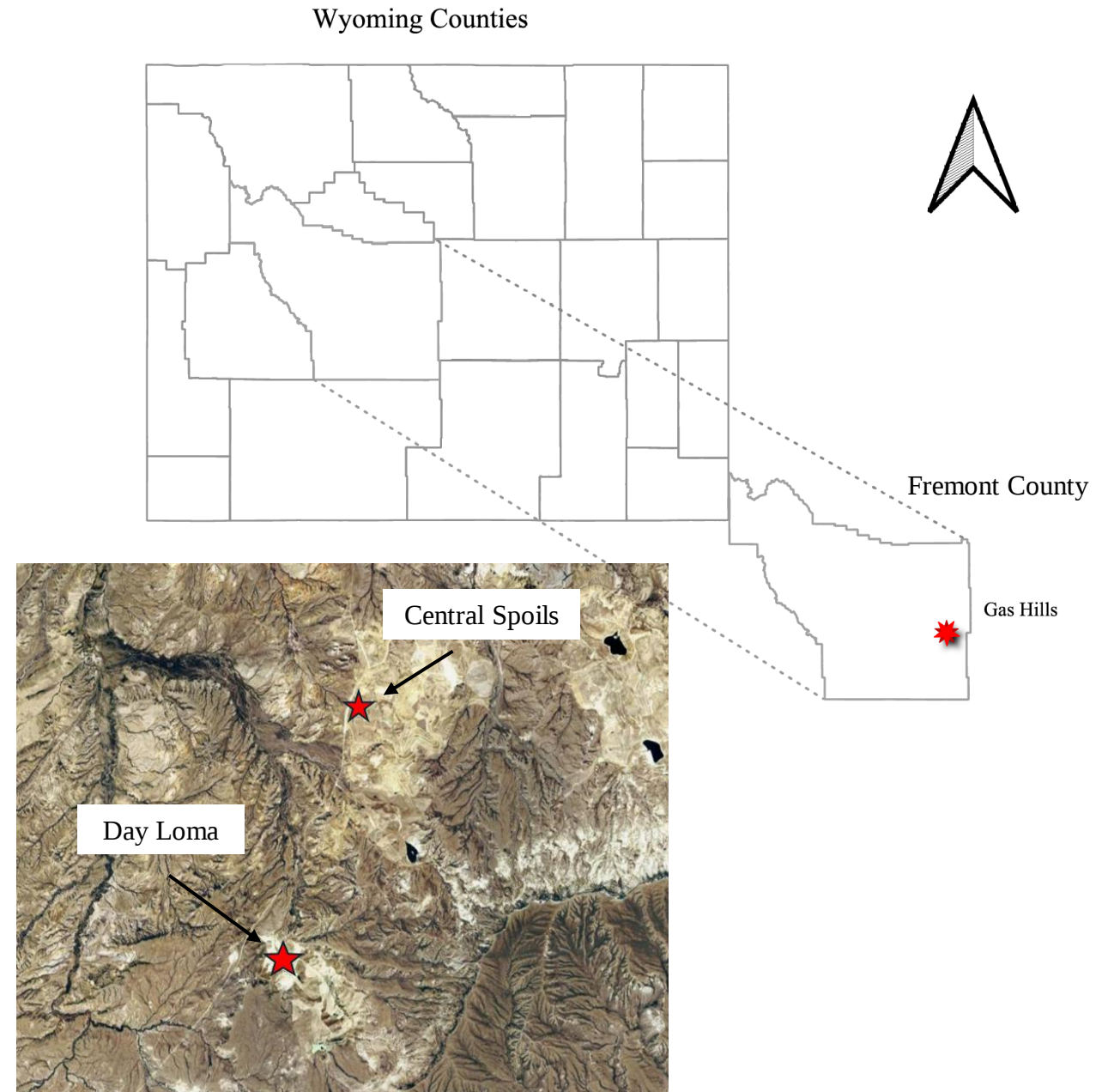
# Objectives



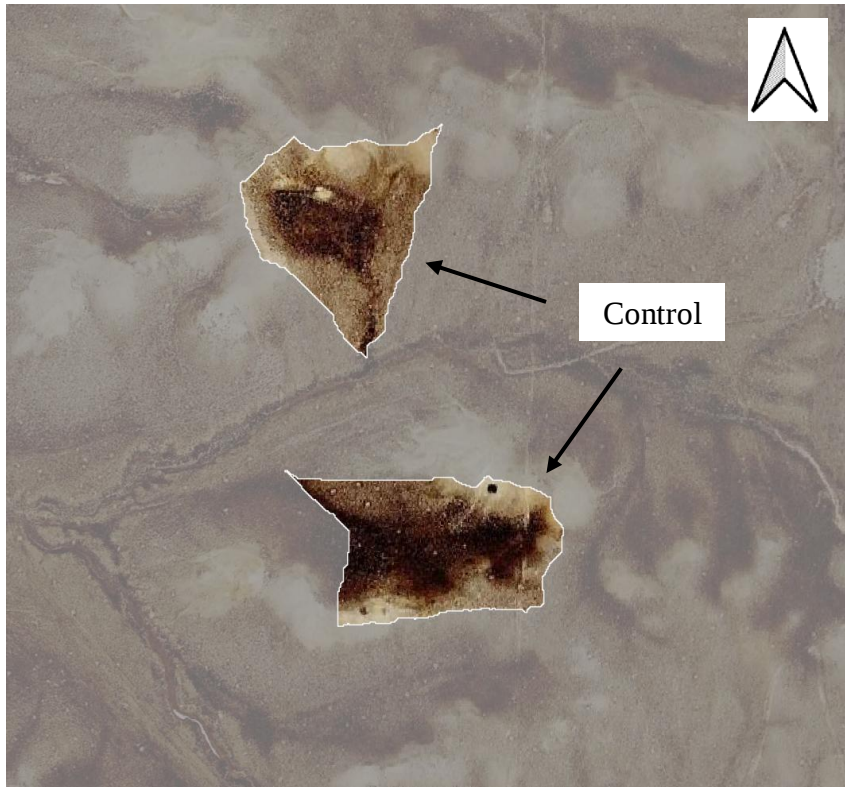
- Quantify vegetation recovery across a 15-year chronological sequence
- Compare reclaimed and unmined sagebrush sites
- Evaluate the influence of seed mixes on recovery

# Study Area

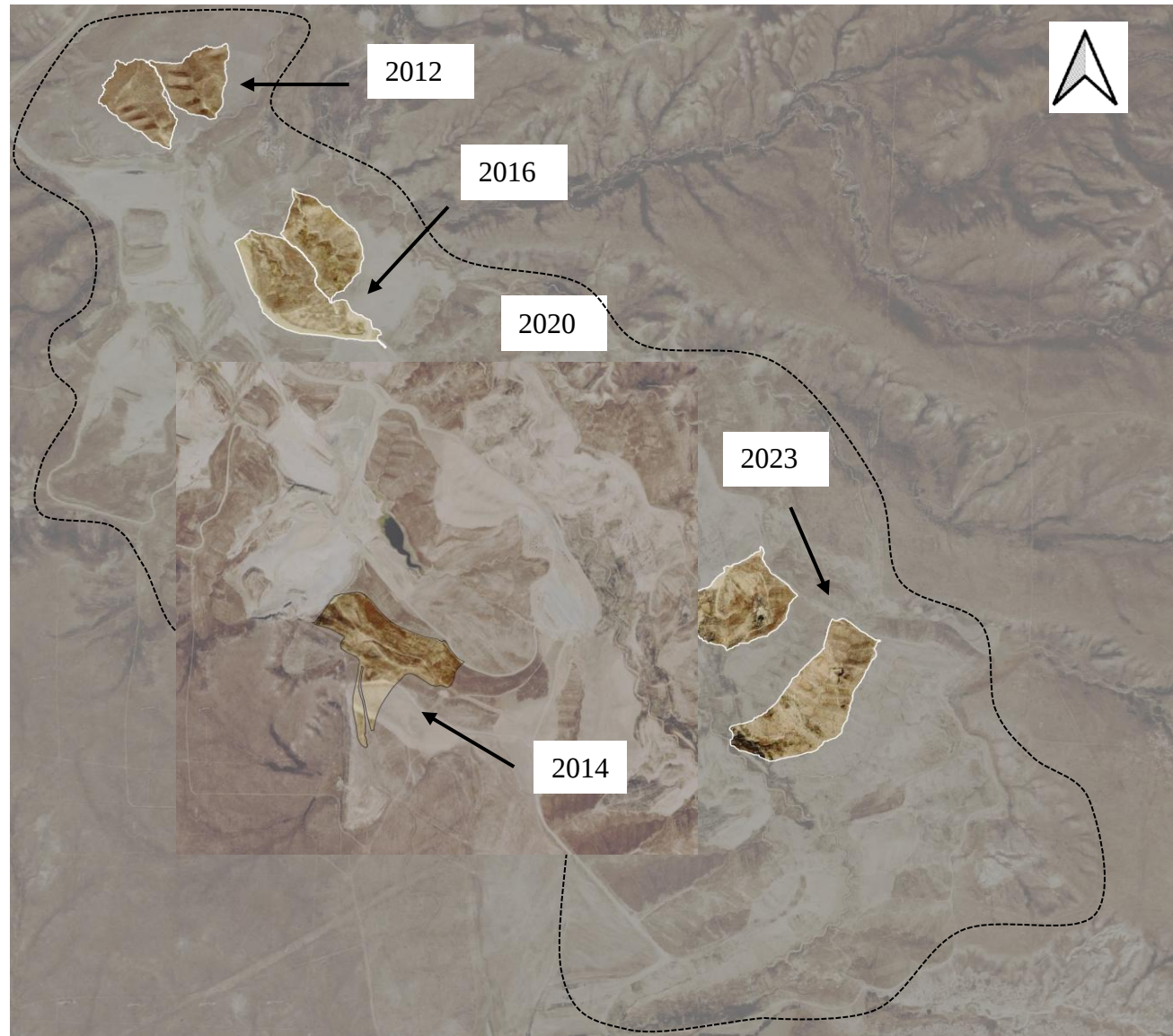
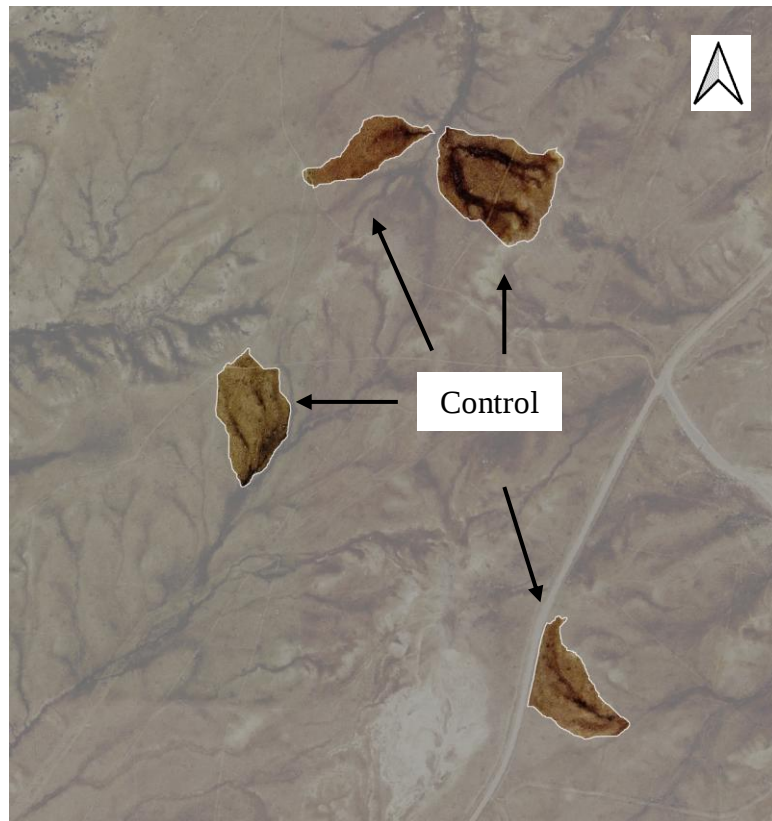
- Gas Hills Uranium Mining District, Wyoming
- Geomorphic reclamation drainages
- Sagebrush-steppe unmined sites
- Gas Hills represents one of the earliest large-scale geomorphic reclamation efforts in the western United States



# Central Spoils - Selected Sites



# Day Loma - Selected Sites



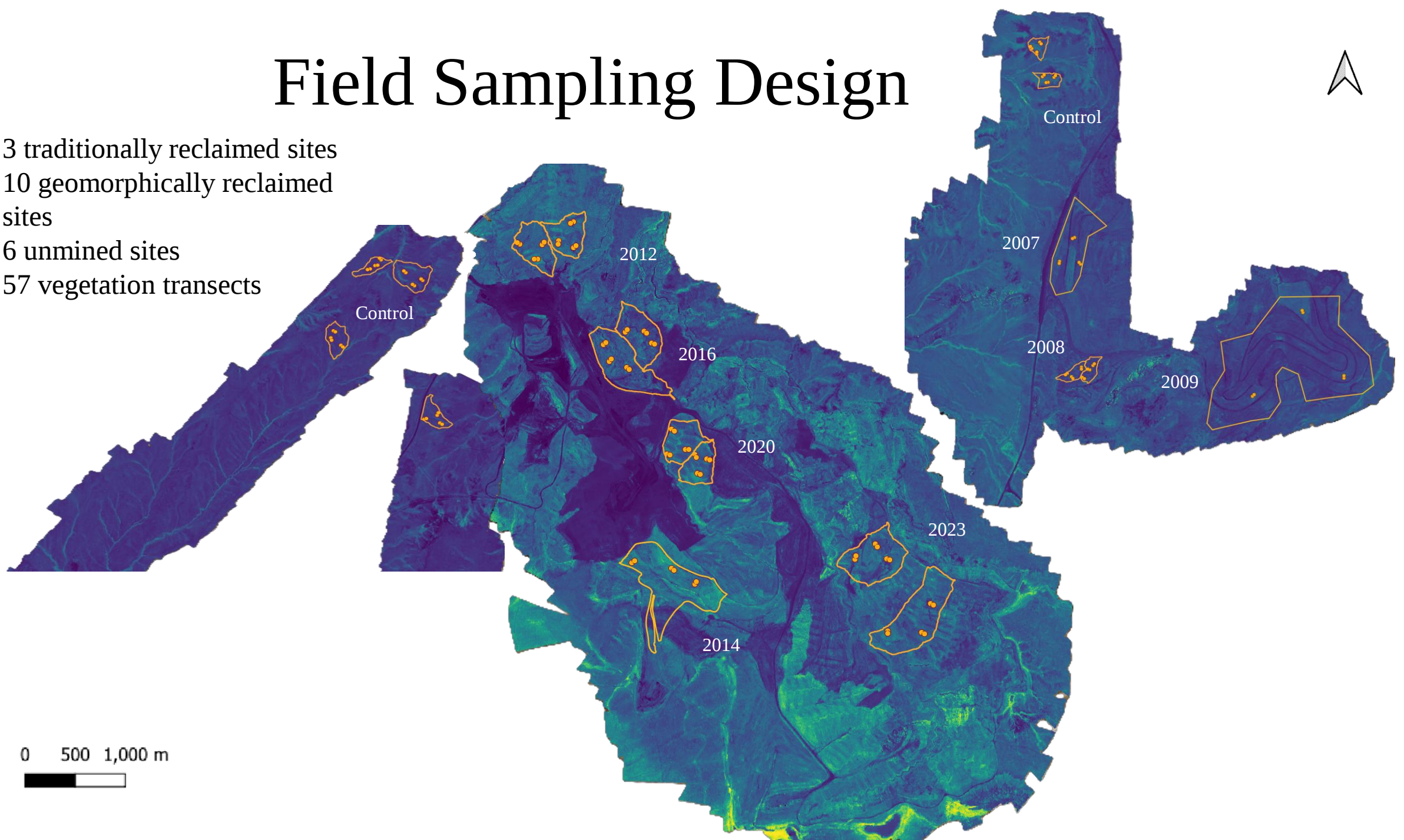
# Outline

- Field Sampling Design
- Chronological Sequence



# Field Sampling Design

- 3 traditionally reclaimed sites
- 10 geomorphically reclaimed sites
- 6 unmined sites
- 57 vegetation transects

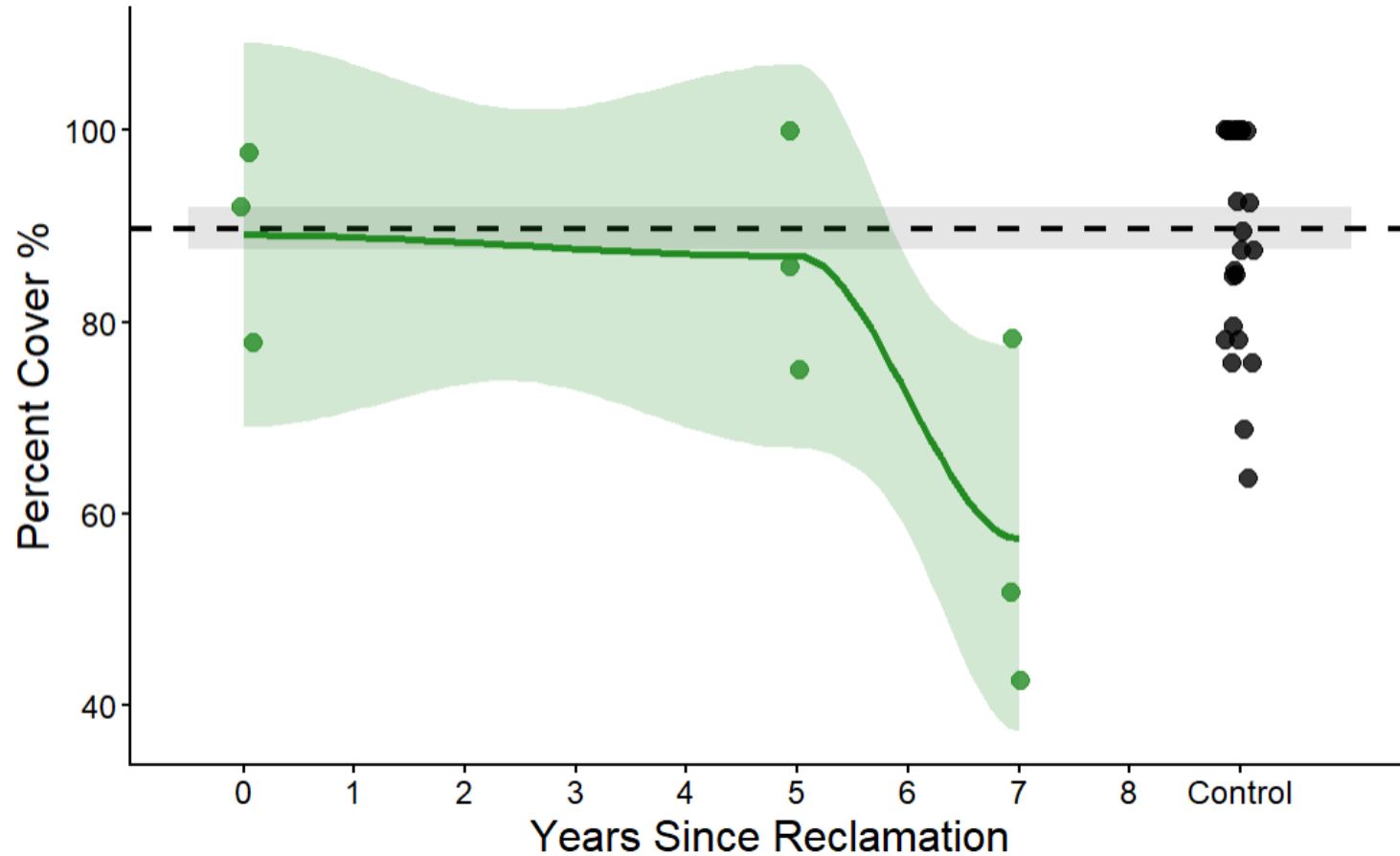


# Outline

- Field Sampling Design
- Chronological Sequence
- Vegetation Data
  - Recovery Curve
  - Total Vegetation Cover
  - Species Richness
  - Functional Group Composition
  - Sagebrush Density
  - Native Species Composition
  - Seed Mix Contribution



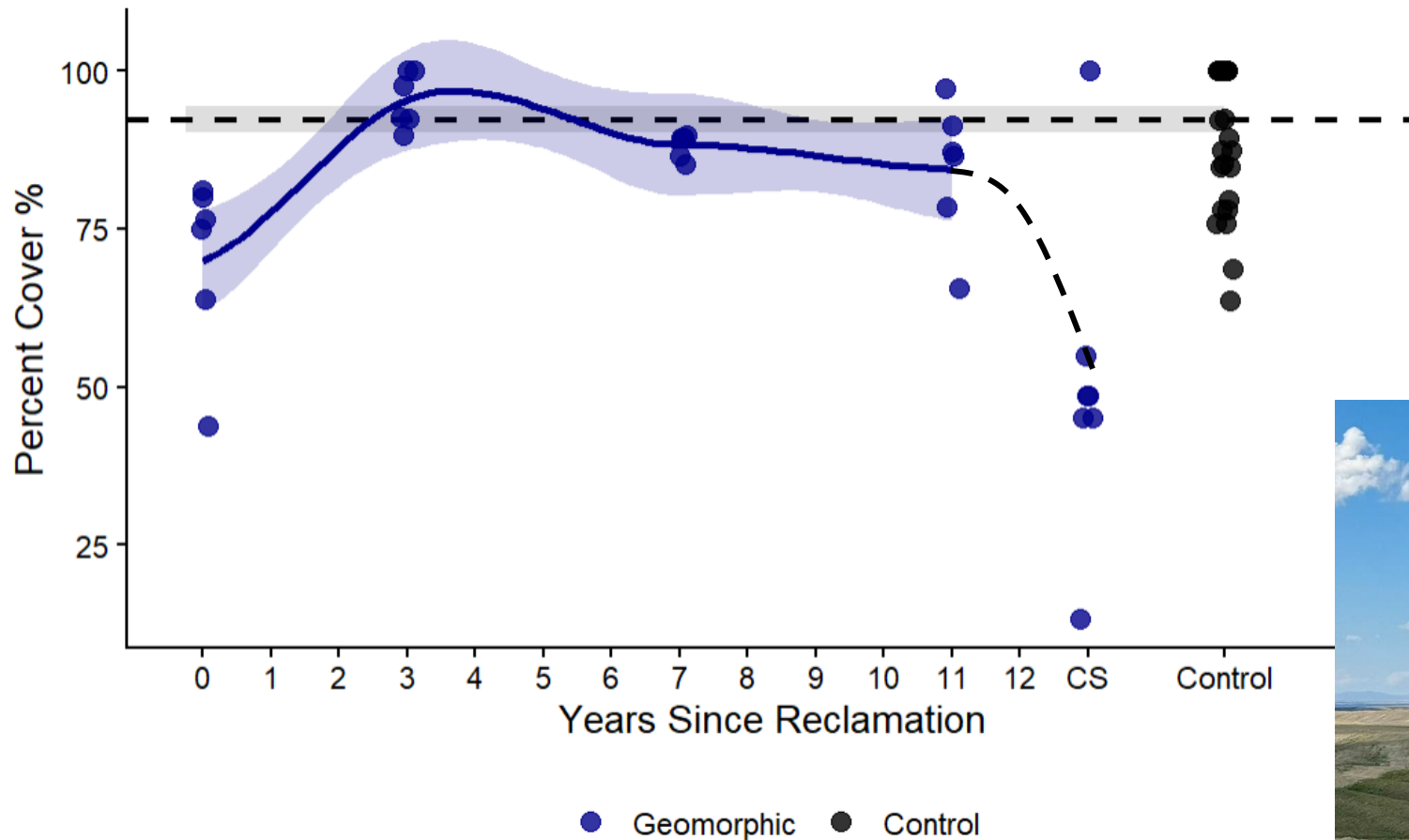
# Traditional Reclamation Recovery Curve



- Most traditional reclamation sites achieved vegetation cover comparable to controls
- The oldest site showed low cover, indicating possible long-term recovery limitations



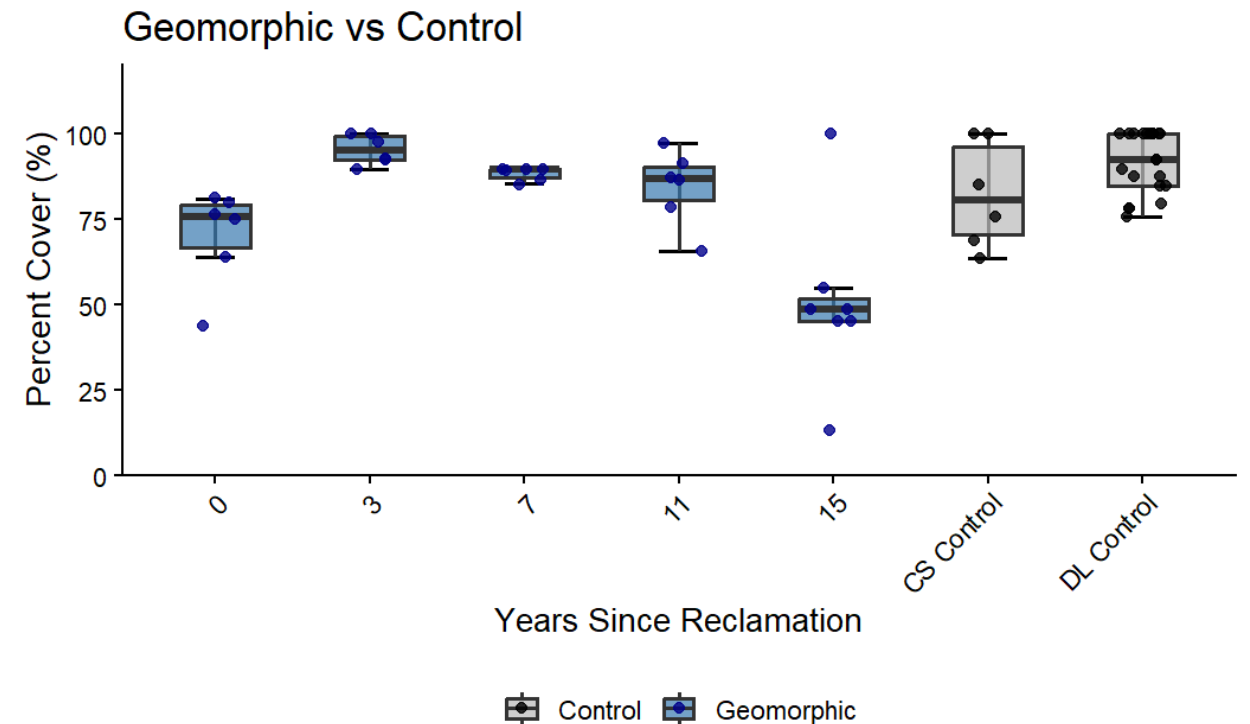
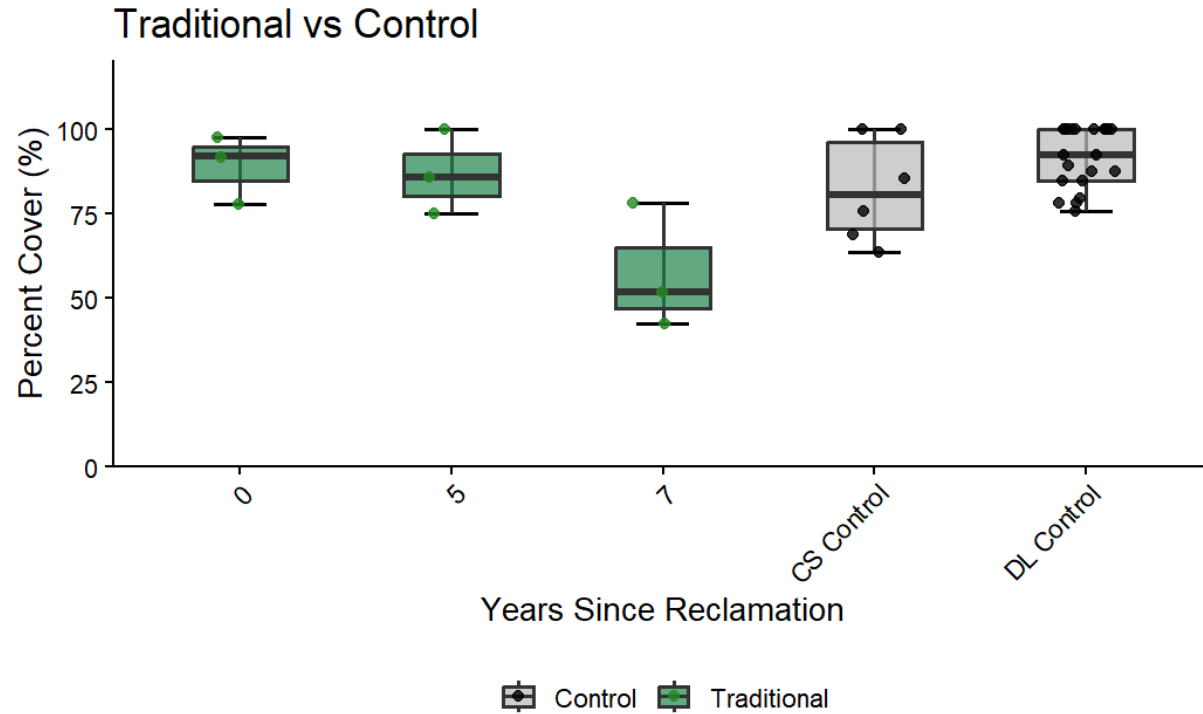
# Geomorphic Reclamation Recovery Curve



- The Day Loma site sustains vegetation cover close to the control site
- The Central Spoils site is under further investigation



# Recovery versus Nearby Controls



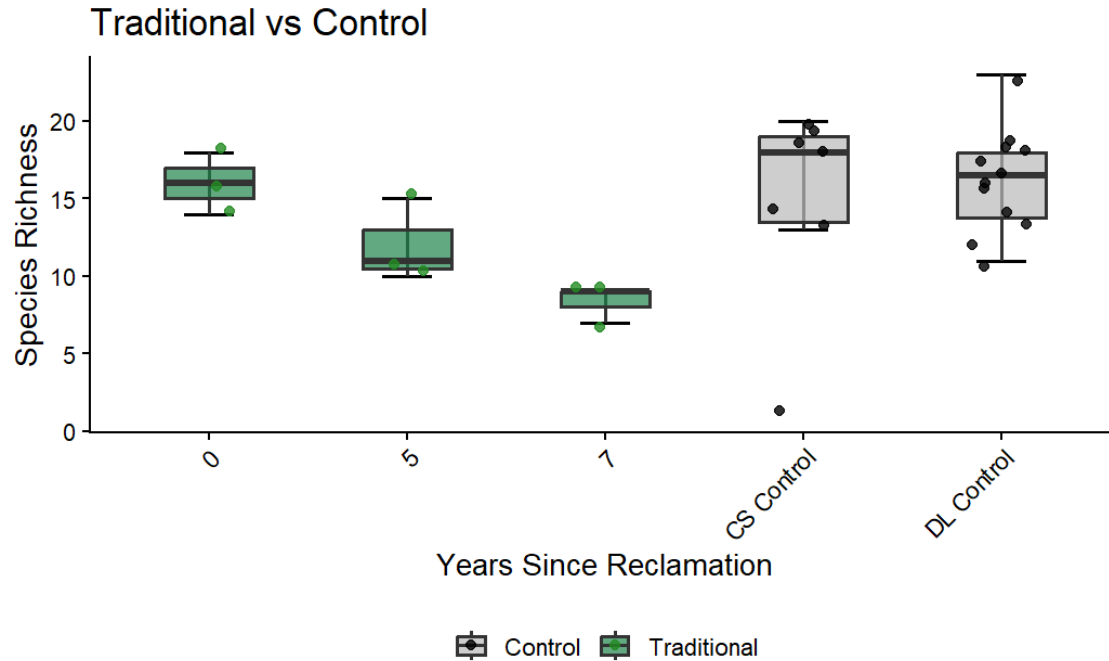
- The Day Loma geomorphic reclamation sites in close proximity to the Day Loma control sites have similar variation trends

# Outline

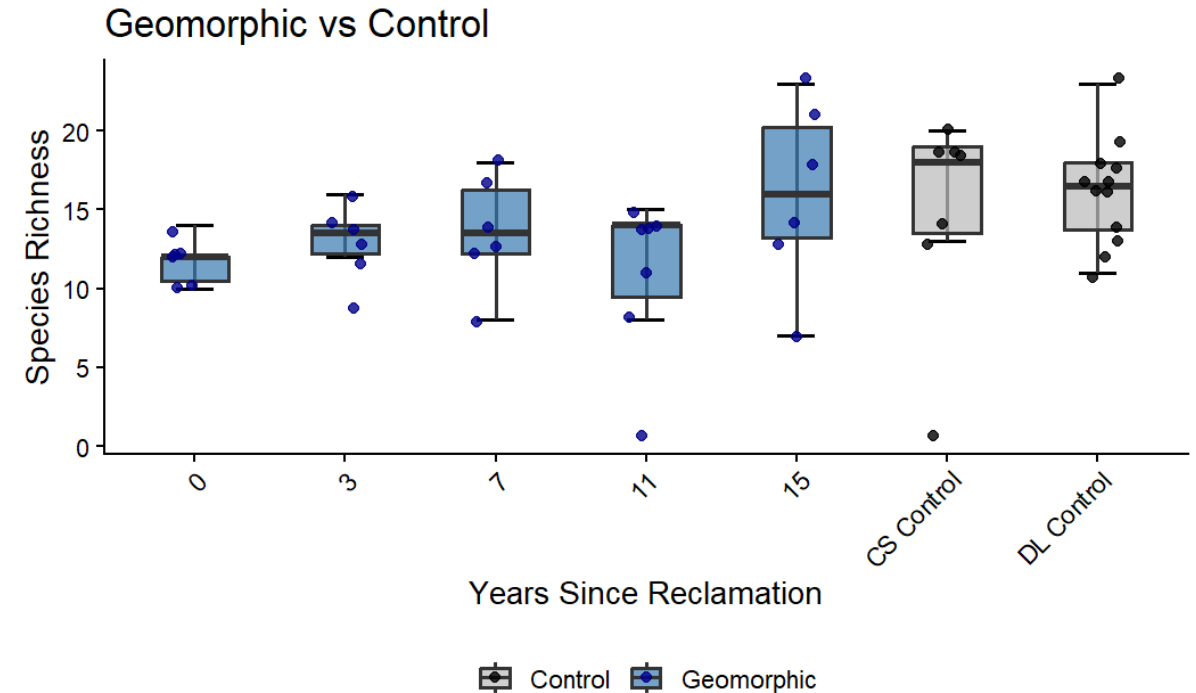
- Vegetation Data:
  - Total Vegetation Cover
  - **Species Richness**
  - Functional Group Composition
  - Sagebrush Density
  - Native Species Composition
  - Seed Mix Contribution



# Total Species Richness



- Species richness declines over time in traditional reclamation



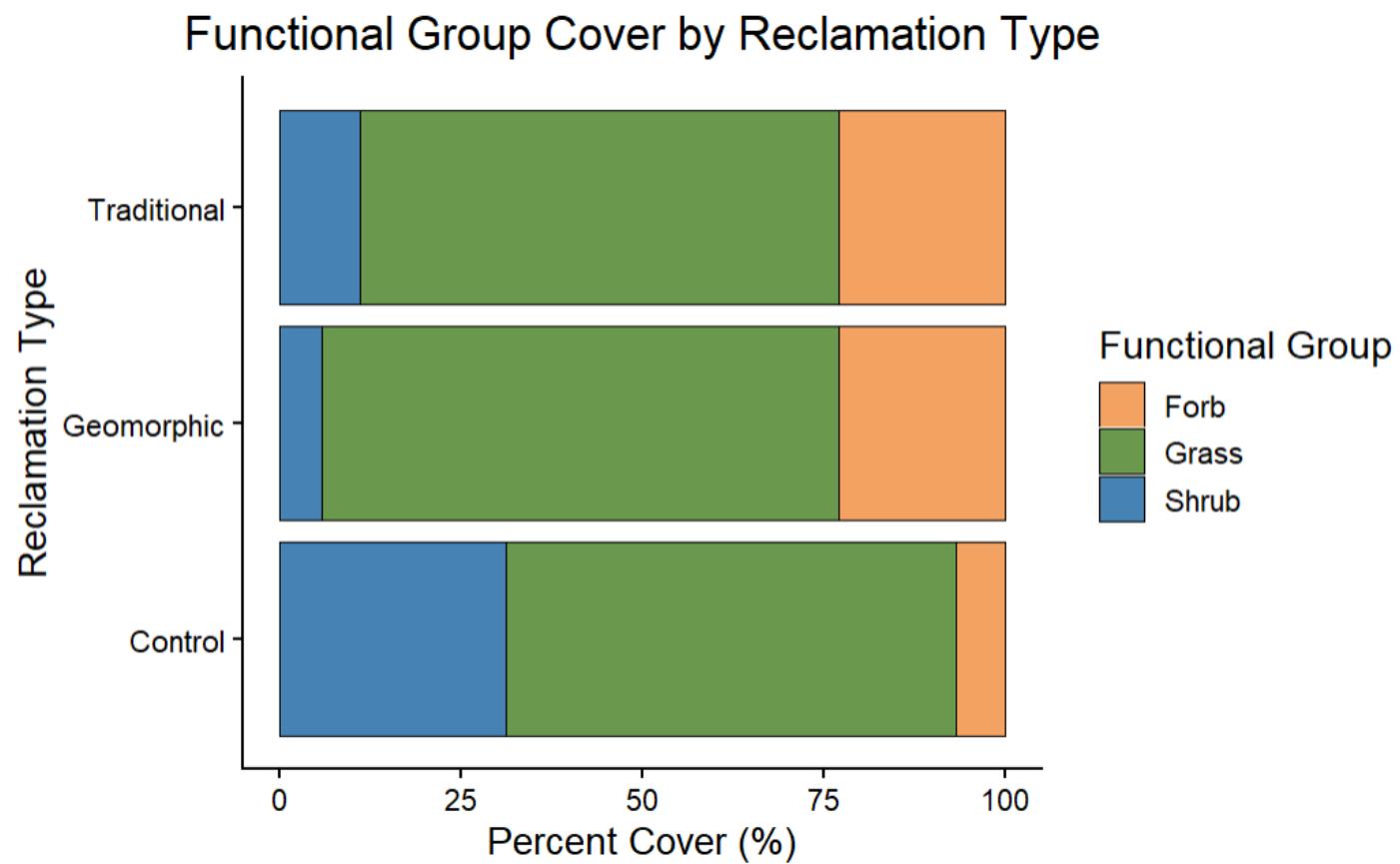
- Species richness increases over time in geomorphic reclamation

# Outline

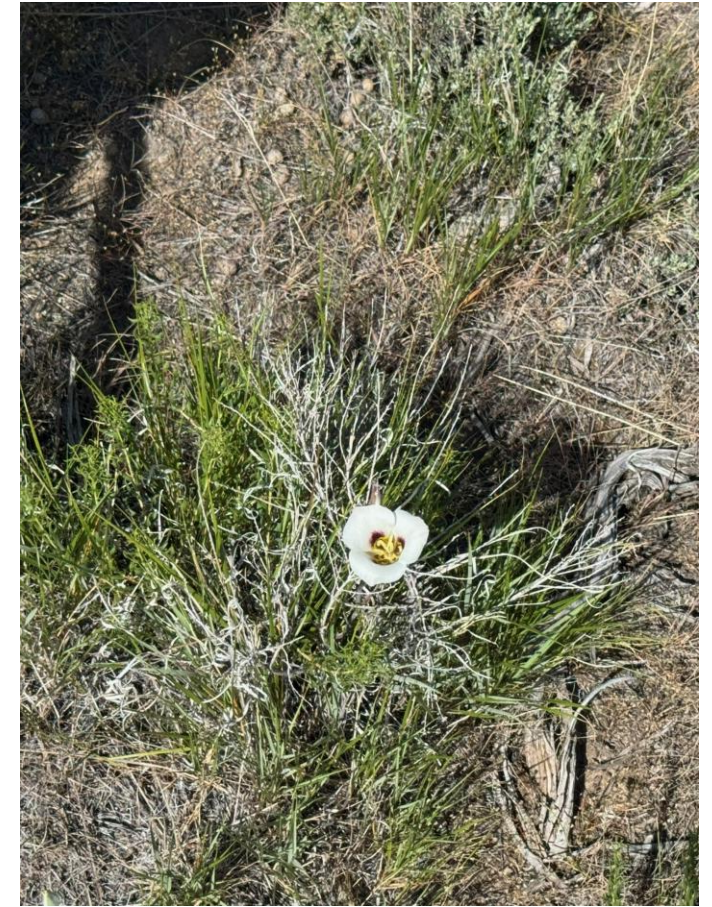
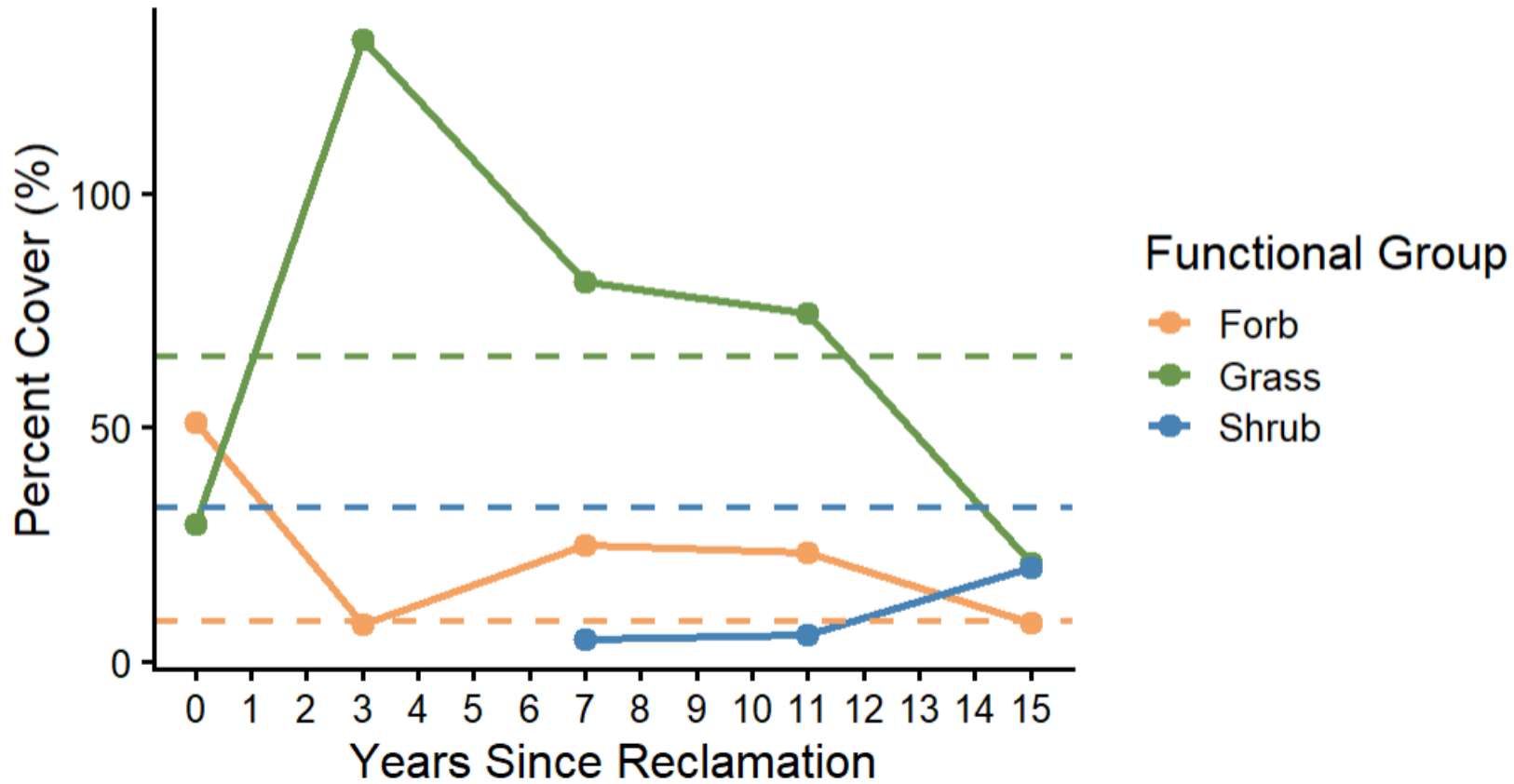
- Vegetation Data:
  - Total Vegetation Cover
  - Species Richness
  - **Functional Group Composition**
  - Sagebrush Density
  - Native Species Composition
  - Seed Mix Contribution



# Functional Group Composition



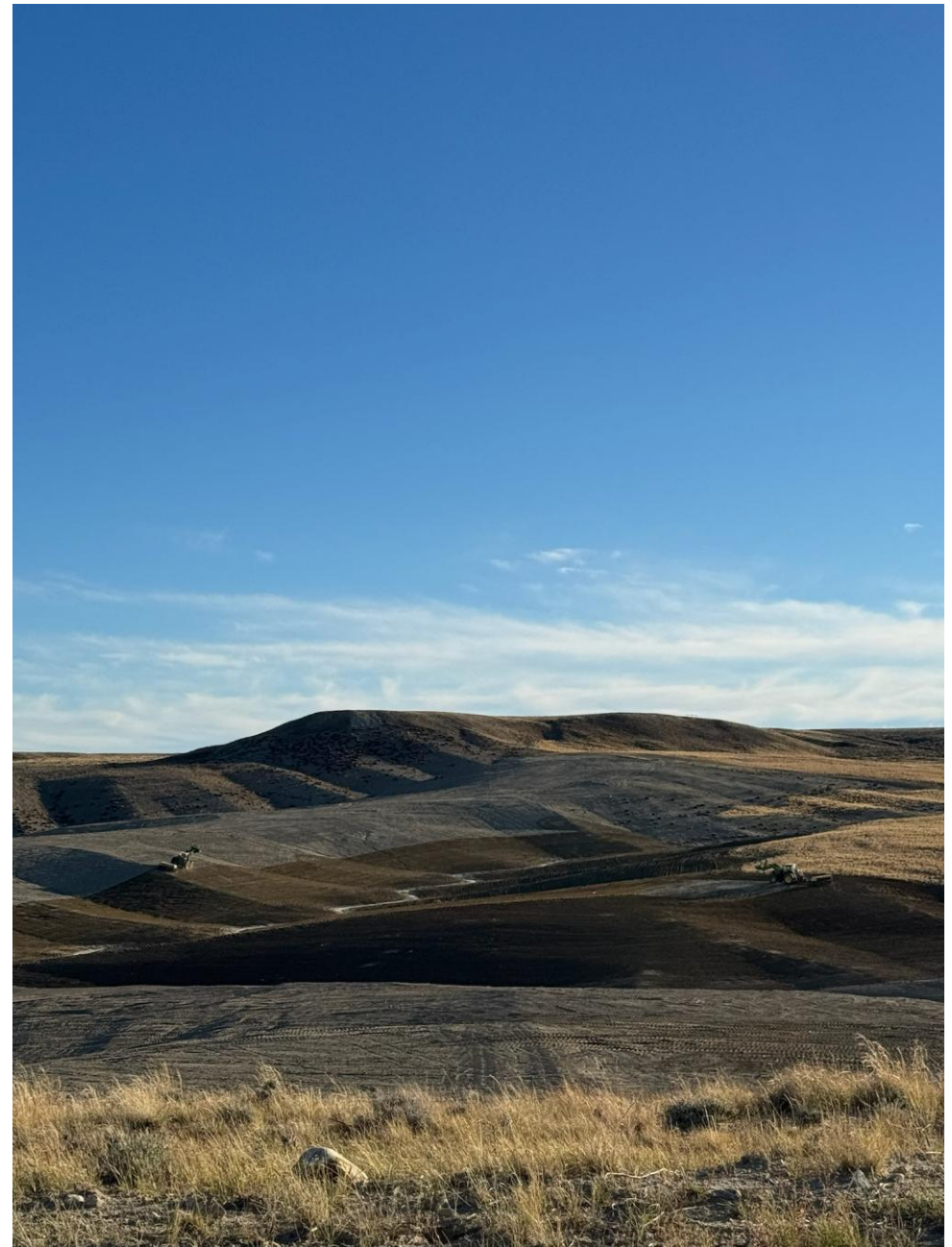
# Functional Groups – Geomorphic Chronosequence



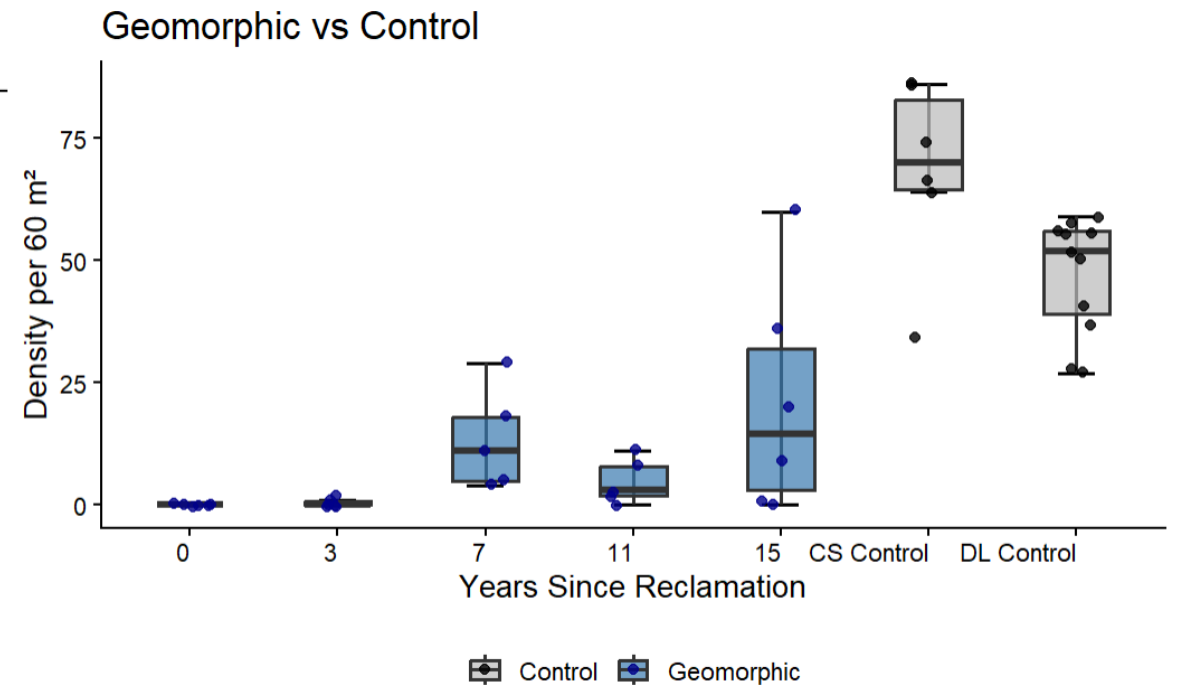
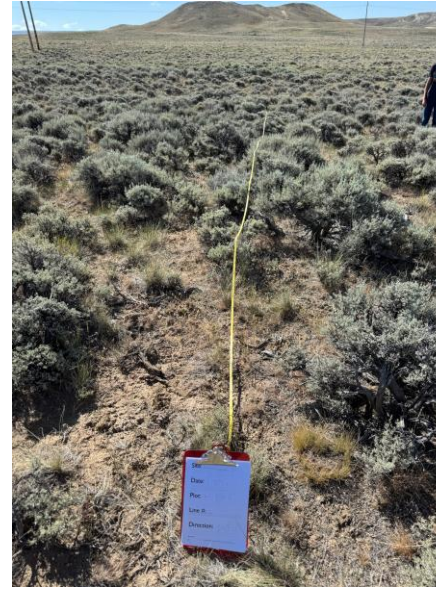
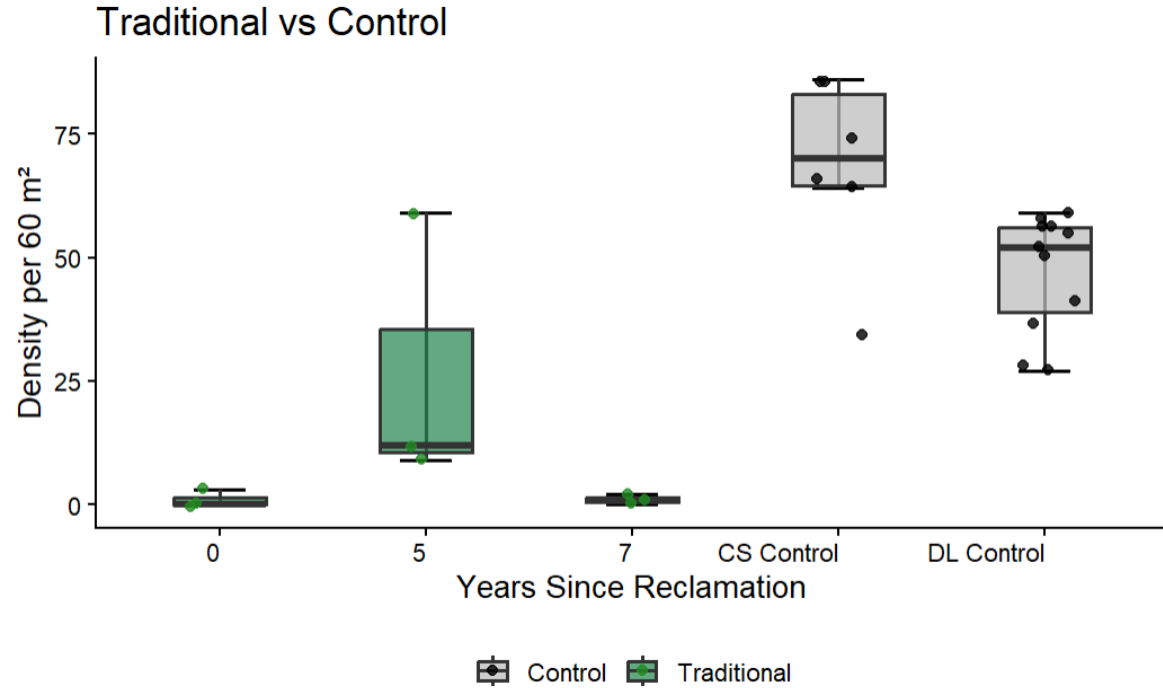
Solid lines = geomorphic sites; dashed lines = control mean cover

# Outline

- Vegetation Data:
  - Total Vegetation Cover
  - Species Richness
  - Functional Group Composition
  - **Sagebrush Density**
  - Native Species Composition
  - Seed Mix Contribution



# Sagebrush Density

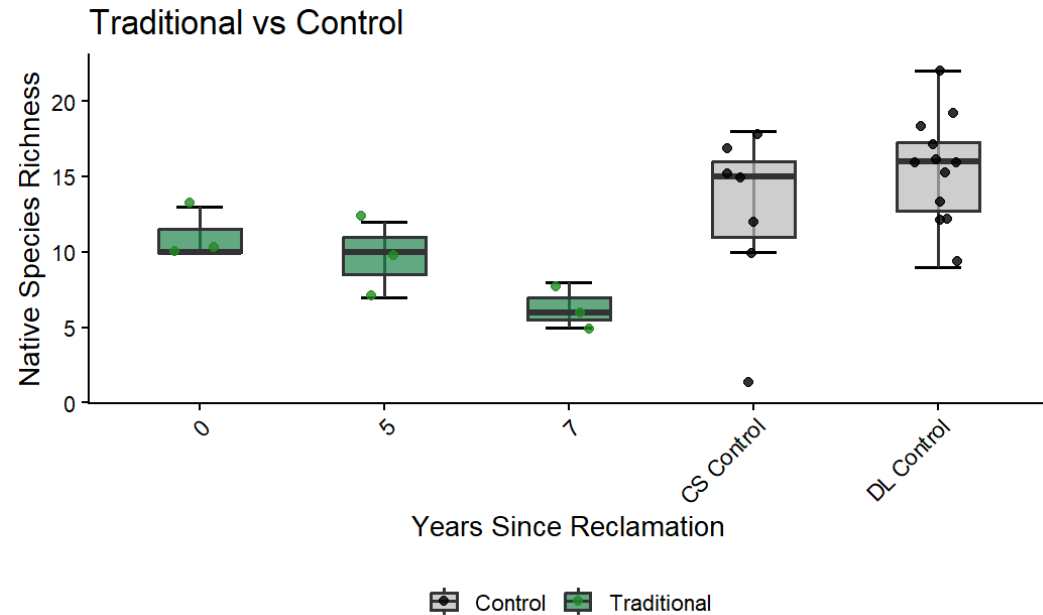


# Outline

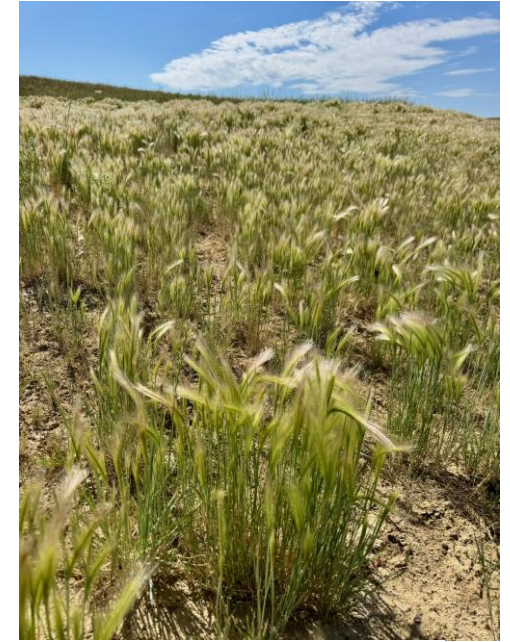
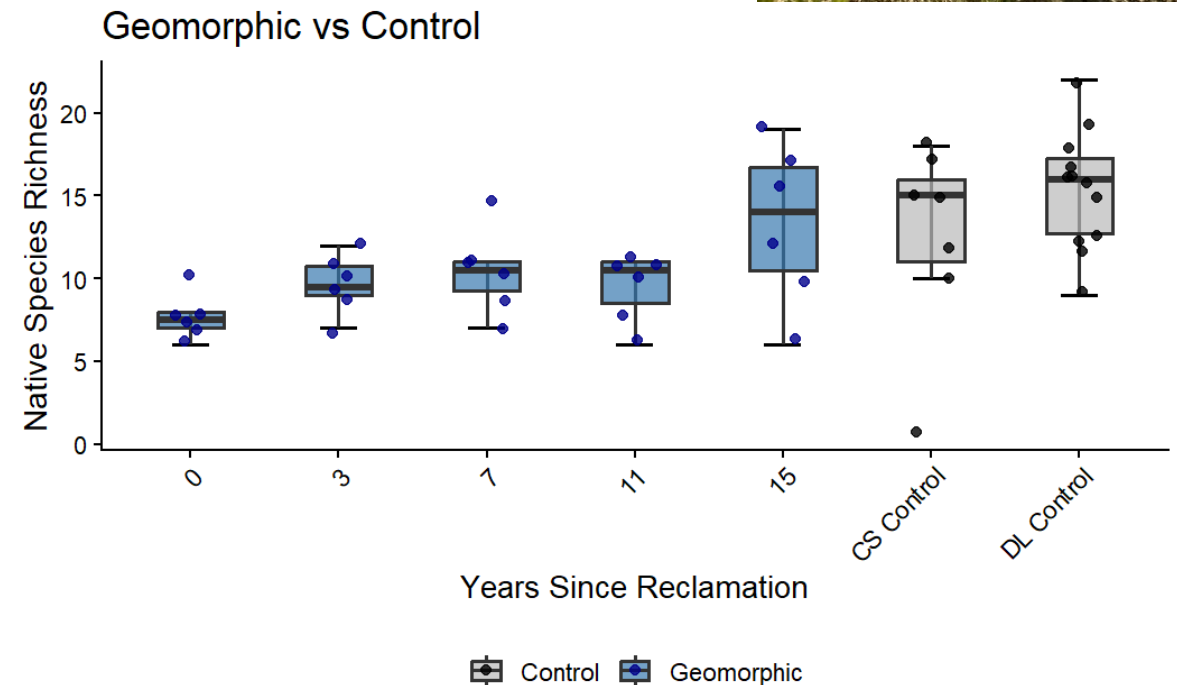
- Vegetation Data:
  - Total Vegetation Cover
  - Species Richness
  - Functional Group Composition
  - Sagebrush Density
  - **Native Species Composition**
  - Seed Mix Contribution



# Native Species Composition



- Traditional reclamation shows a decrease in native species richness over time
- Geomorphic reclamation shows an increase in native species richness over time



# Outline

- Vegetation Data:
  - Total Vegetation Cover
  - Species Richness
  - Functional Group Composition
  - Sagebrush Density
  - Native Species Composition
  - **Seed Mix Contribution**



# Influence of Seed Mixes

AML 16J, 16L, and 16N “Standard” Seed Mix 1997-2008

| Species Count | COMMON NAME             |
|---------------|-------------------------|
| 1             | Thickspike Wheatgrass   |
| 2             | Bluebunch               |
| 3             | Western Wheatgrass      |
| 4             | Slender Wheatgrass      |
| 5             | Needle and Thread Grass |
| 6             | Indian Ricegrass        |
| 7             | Sainfoin                |
| 8             | Wyoming Big Sage        |

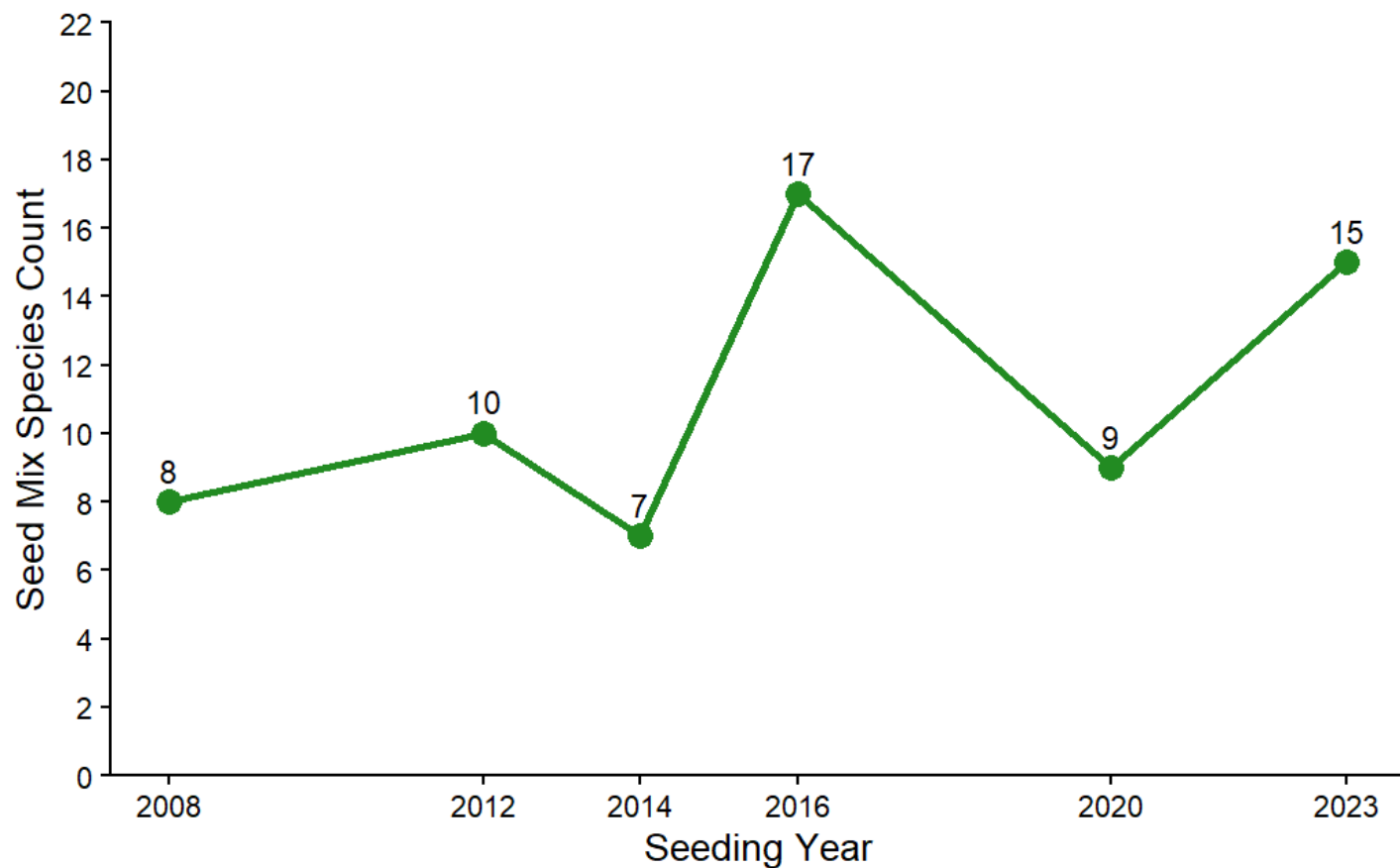
AML 16G-II Day Loma First Seed Mix Modification 2012

| Species Count | COMMON NAME         |
|---------------|---------------------|
| 1             | Bluebunch           |
| 2             | Western Wheatgrass  |
| 3             | Slender Wheatgrass  |
| 4             | Green needlegrass   |
| 5             | Indian Ricegrass    |
| 6             | Winterfat           |
| 7             | Wyoming Big Sage    |
| 8             | American Vetch      |
| 9             | Rocky Mt. Penstemon |
| 10            | Prairie Clover      |

2023 Seed Mixes Upland

| Species Count | COMMON NAME                   |
|---------------|-------------------------------|
| 1             | Wyoming Big Sagebrush         |
| 2             | Bottlebrush Squartail         |
| 3             | Muttongrass                   |
| 4             | Sandburg bluegrass            |
| 5             | Western Yarrow                |
| 6             | Rocky Mountain Beeplant       |
| 7             | Fringed sage                  |
| 8             | Sulfur Flower Buckwheat       |
| 9             | QuickGuard Sterilize Tridecyl |
| 10            | Bluebunch Wheatgrass          |
| 11            | Indian Ricegrass              |
| 12            | Western Wheatgrass            |
| 13            | Green Needlegrass             |
| 14            | Thickspike Wheatgrass         |
| 15            | Fernleaf Biscuitroot          |

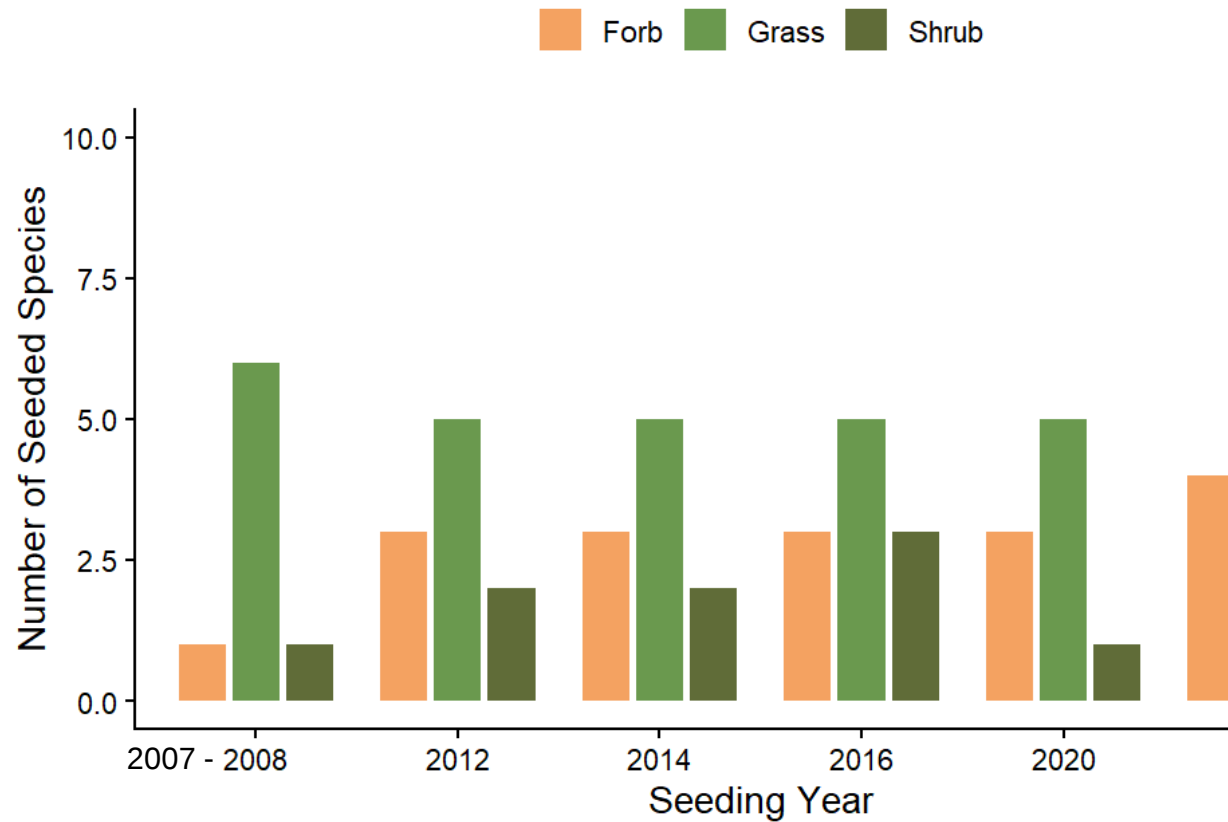
# Seed Mix Count Over Time - Geomorphic



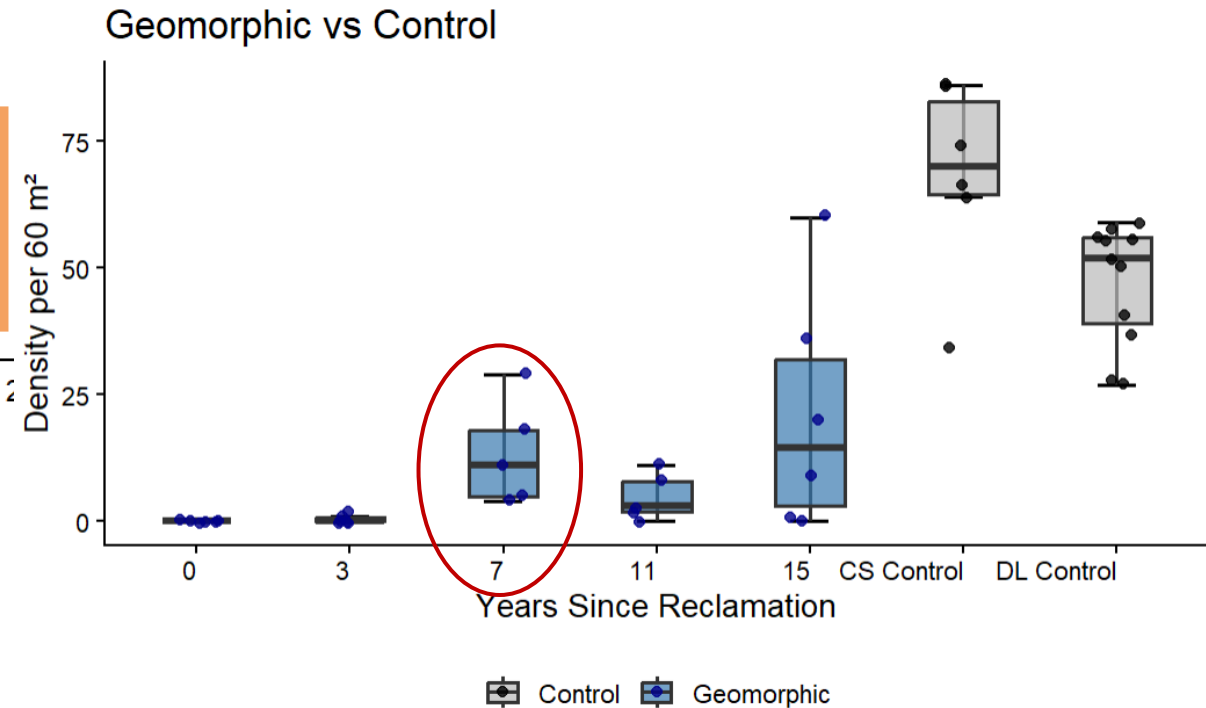
- 2016 seed mix includes upland and lowland (according to the data)
- 2023 seed mix includes only upland application



# Seed Mix (geomorphic and traditional reclamation)



- 2008 high grass count
- 2016 higher shrub count
- 2023 increase in 3 functional groups



# Example: Geomorphic vs Control



# Conclusions

- Vegetation cover recovery trajectories approached conditions observed at unmined reference sites, except at the oldest traditional and geomorphic reclamation sites
- Species richness was highest in the oldest reclaimed geomorphic sites
- Seed mix species counts were greater in recent reclamation, suggesting that seeding contributes to native species cover



# Acknowledgements



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WYOMING DEPARTMENT OF  
ENVIRONMENTAL  
QUALITY



And many others

# Questions?



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