Insect response to reclamation efforts on an abandoned road in Wyoming's Powder River Basin

Michael Curran & Zachary Farmer, Abnova Ecological Solutions

Miles Milbrath & Lusha Tronstad, University of Wyoming

LB Myers, EOG Resources, Inc.

American Society of Reclamation Sciences

Laramie, WY

8 June 2026

In collaboration with:

Focused efforts to advance reclamation in the Powder River Basin

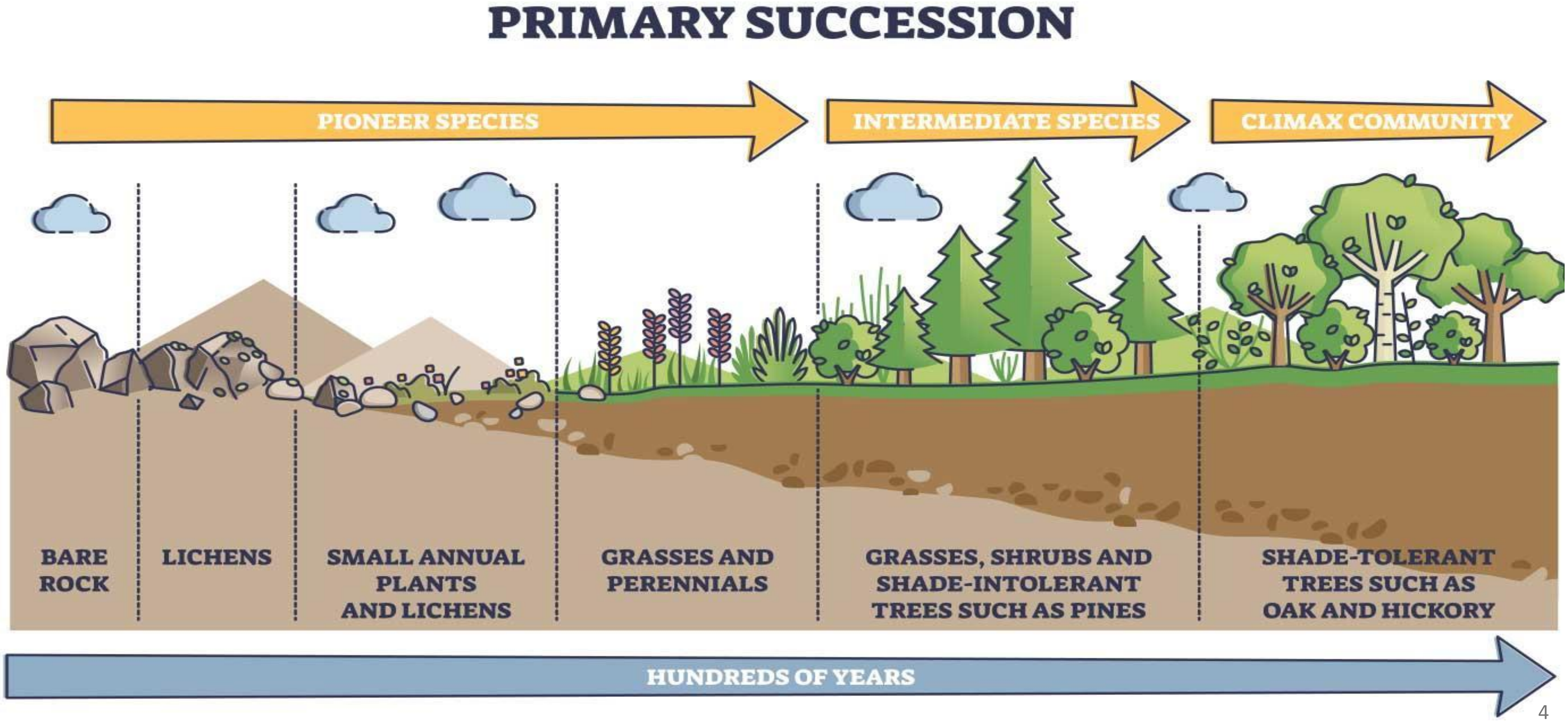
- Utilize data-driven approach and innovative practices to improve reclamation outcomes.

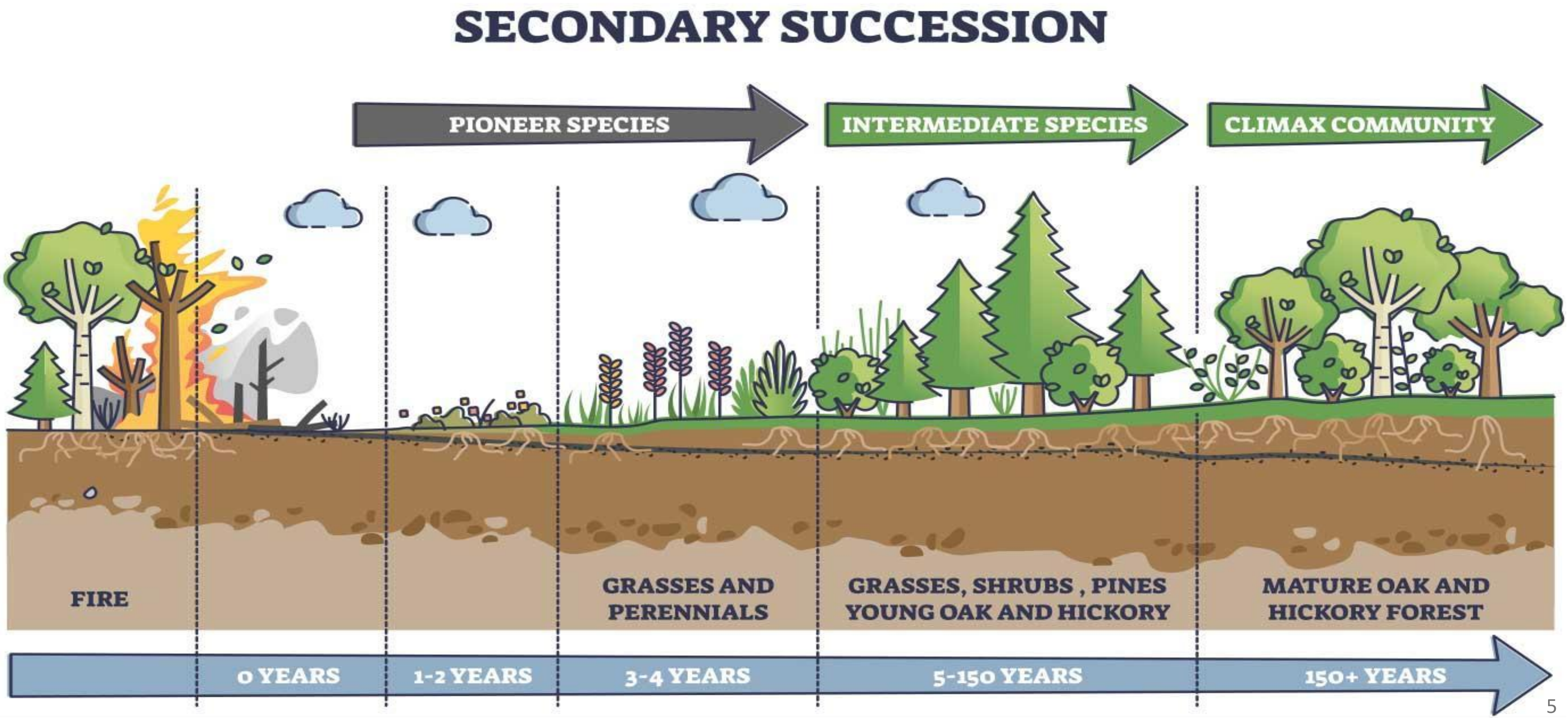
Collaborated on two-year Abnova study (2024-2025) to assess ecosystem services and reclamation on abandoned wells and roads.

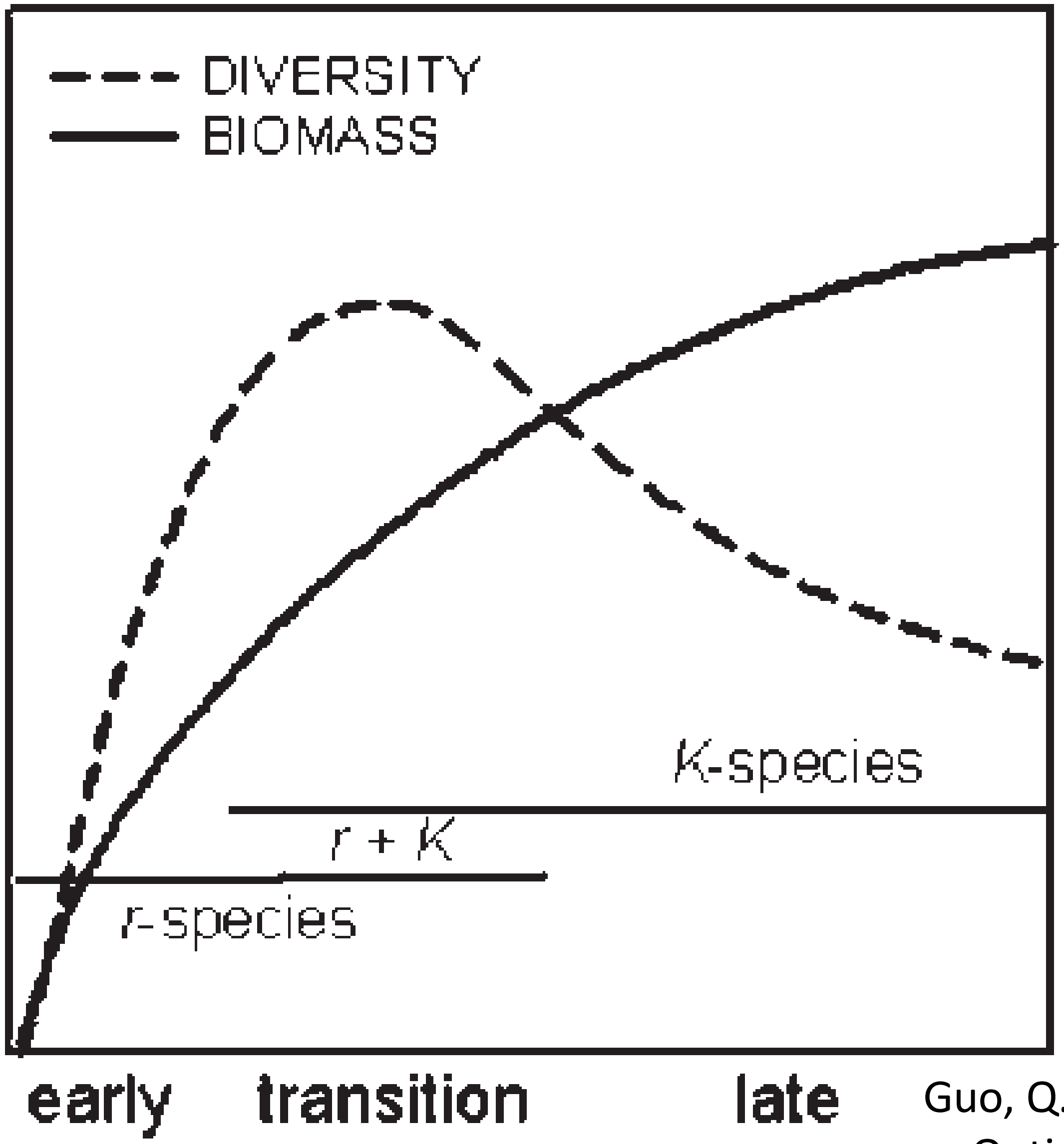
- Partnered with University of Wyoming Natural Diversity Database (WYNDD)

Definitions of Ecological Restoration, Ecological Reclamation, Ecological Succession

- Ecological Restoration – "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER Primer 2004)
- Reclamation – "main objectives include stabilization of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose" (SER Primer 2004); also"the process of making severely degraded land fit for cultivation or a state suitable for some human use" (SER 2019)
- Ecological Reclamation – "the process of assisting the recovery of severely degraded ecosystems to benefit native biota through the establishment of habitats, populations, communities, or ecosystems that are similar, but not necessarily identical to surrounding and naturally occurring ecosystems" (Gerwing et al. 2022)
- Ecological Succession – "the process by which the mix of species and habitat in an area changes over time" (U. Chicago 2021)


PRIMARY SUCCESSION
PIONEER SPECIES
INTERMEDIATE SPECIES
CLIMAX COMMUNITY
BARE ROCK
LICHENS
SMALL ANNUAL PLANTS AND LICHENS
GRASSES AND PERENNIALS
GRASSES, SHRUBS AND SHADE-INTOLERANT TREES SUCH AS PINES
SHADE-TOLERANT TREES SUCH AS OAK AND HICKORY
HUNDREDS OF YEARS

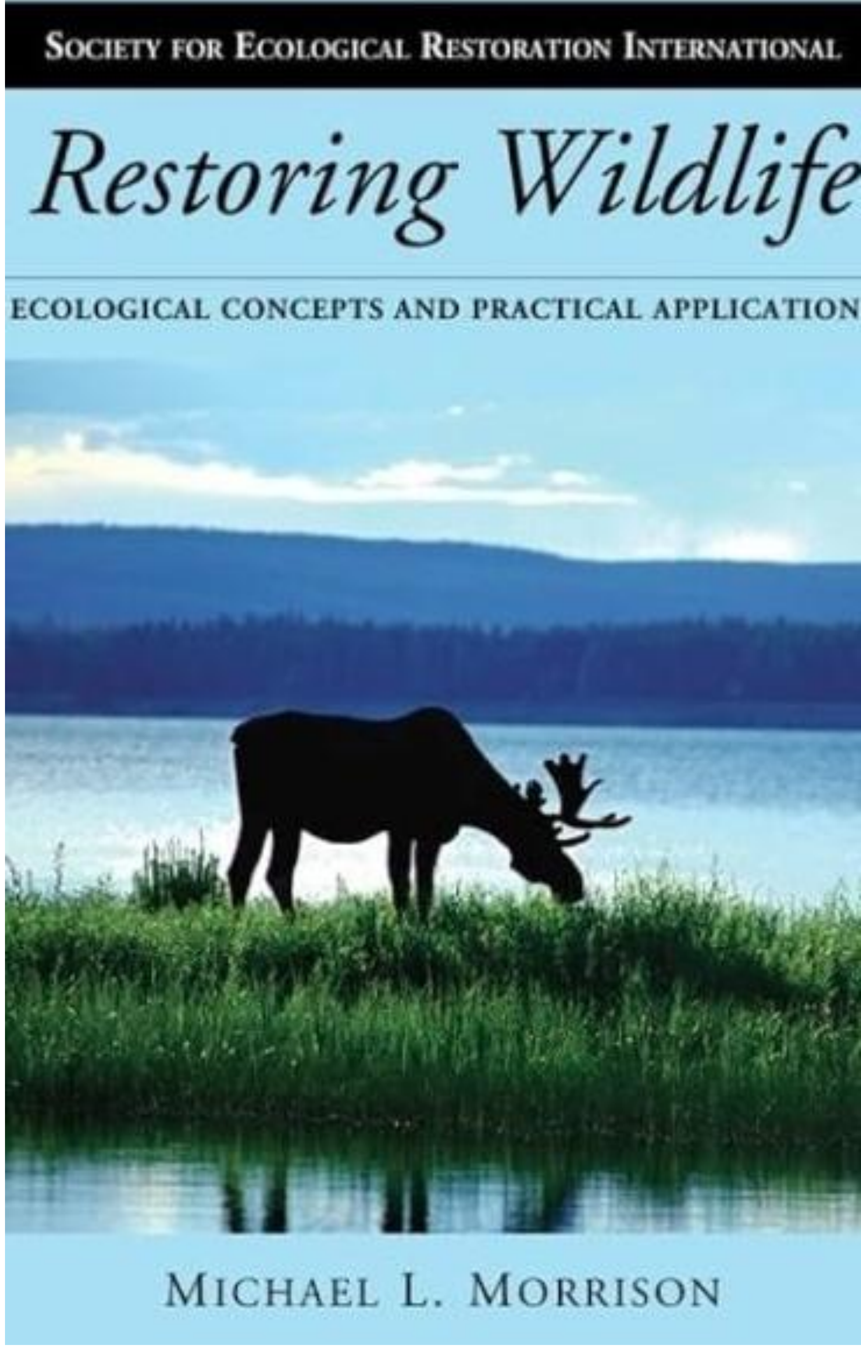

SECONDARY SUCCESSION
PIONEER SPECIES
INTERMEDIATE SPECIES
CLIMAX COMMUNITY
FIRE
GRASSES AND PERENNIALS
GRASSES, SHRUBS , PINES YOUNG OAK AND HICKORY
MATURE OAK AND HICKORY FOREST
0 YEARS
1-2 YEARS
3-4 YEARS
5-150 YEARS
150+ YEARS



Guo, Q. 2019. Disturbance, Life History and Optimal Management for Biodiversity. *AMBIO A Journal of the Human Environment.*

Defining Habitat

- "The resources and conditions present in an area that produce occupancy (for any reason) by an organism. Habitat is organism specific and relates to the presence of a species, population, or individual (animal or plant) to an area's abiotic and biotic features. Habitat is thus the sum of the specific resources needed by an organism. Therefore, migration and dispersal corridors, and the land animals occupy during breeding and nonbreeding seasons, are habitat. An organism-based understanding of habitat is needed to determine appropriate restoration goals."
- 'habitat use', 'habitat selection', 'habitat preference', 'habitat availability', 'habitat quality' have unique meanings with quality referring to the ability of the environment to provide conditions appropriate for population persistence – ranging from low to high quality based on resources for survival, reproduction, and population persistence
- Habitat inherently refers to the vegetation occurring in an area



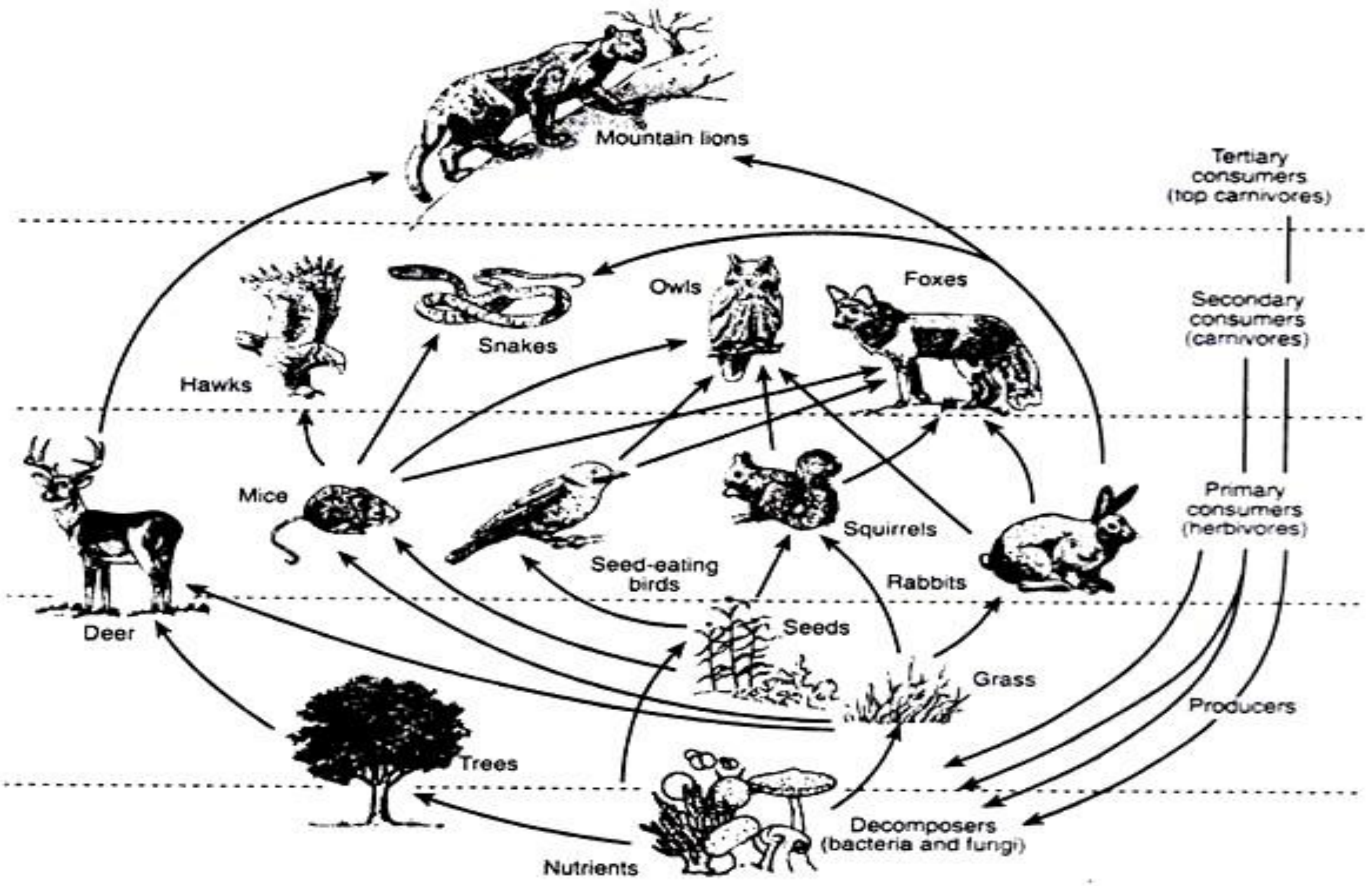
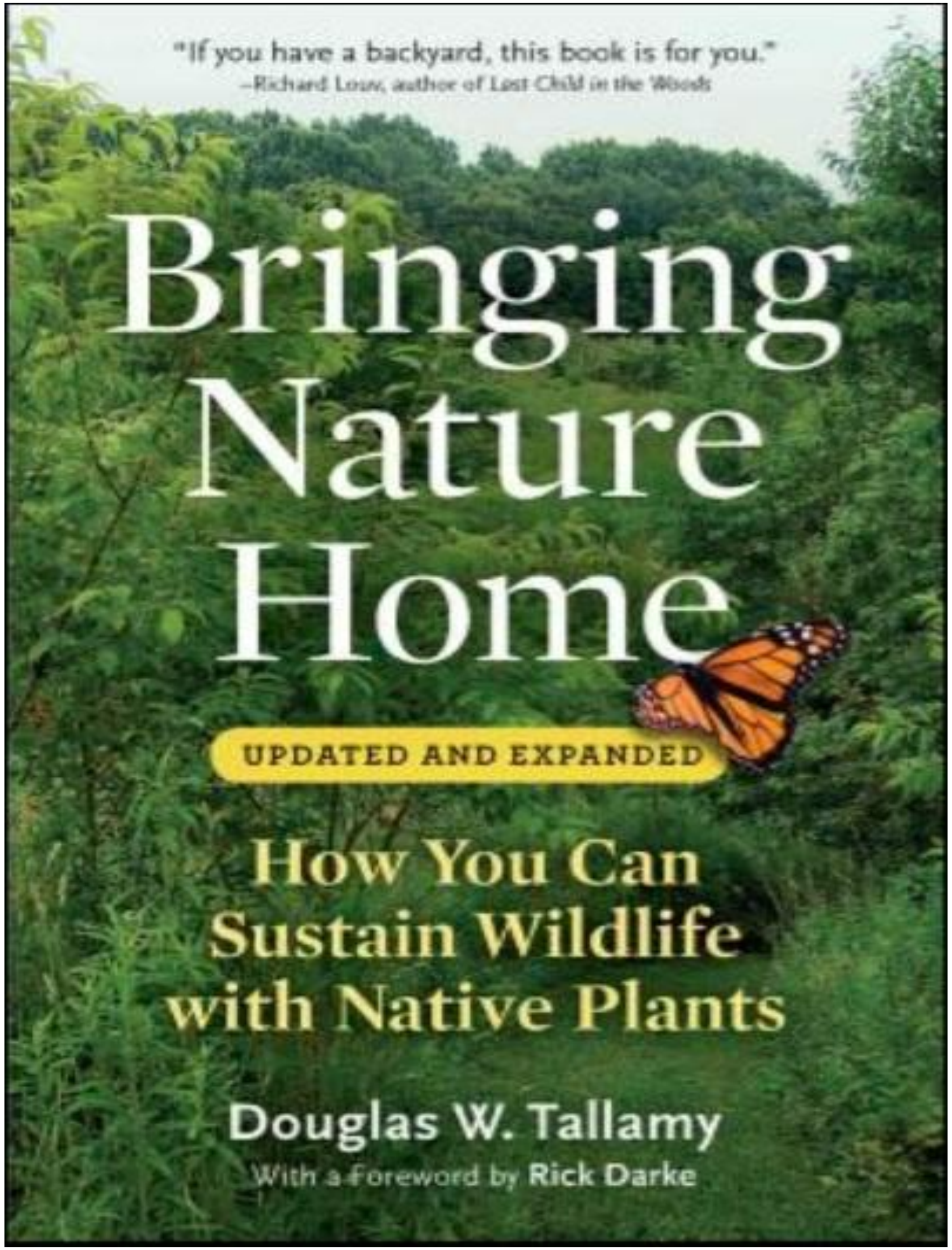


Fig. 4.9 : Food web of a terrestrial ecosystem

Mukherjee, 1999



Douglas W. Tallamy

FOLLOW

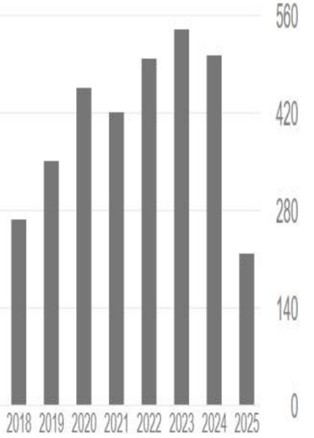
Professor of Entomology and Wildlife Ecology
Verified email at udel.edu - Homepage

insect ecology

TITLE	CITED BY	YEAR
Impact of native plants on bird and butterfly biodiversity in suburban landscapes KT Burghardt, DW Tallamy, W Gregory Shriver Conservation biology 23 (1), 219-224	565	2009
Convergence patterns in subsocial insects DW Tallamy, TK Wood Annual review of entomology 31 (1), 369-390	369	1986
Bringing nature home: how you can sustain wildlife with native plants, updated and expanded DW Tallamy Timber Press	366 *	2009
Phytochemical induction by herbivores. DW Tallamy, MJ Raupp	335	1991
Do alien plants reduce insect biomass? DW Tallamy Conservation biology 18 (6), 1689-1692	315	2004
Ranking lepidopteran use of native versus introduced plants DW Tallamy, KJ Shropshire Conservation Biology 23 (4), 941-947	279	2009

Cited by — VIEW ALL

	All	Since 2020
Citations	7959	2646
h-index	49	27
i10-index	93	51

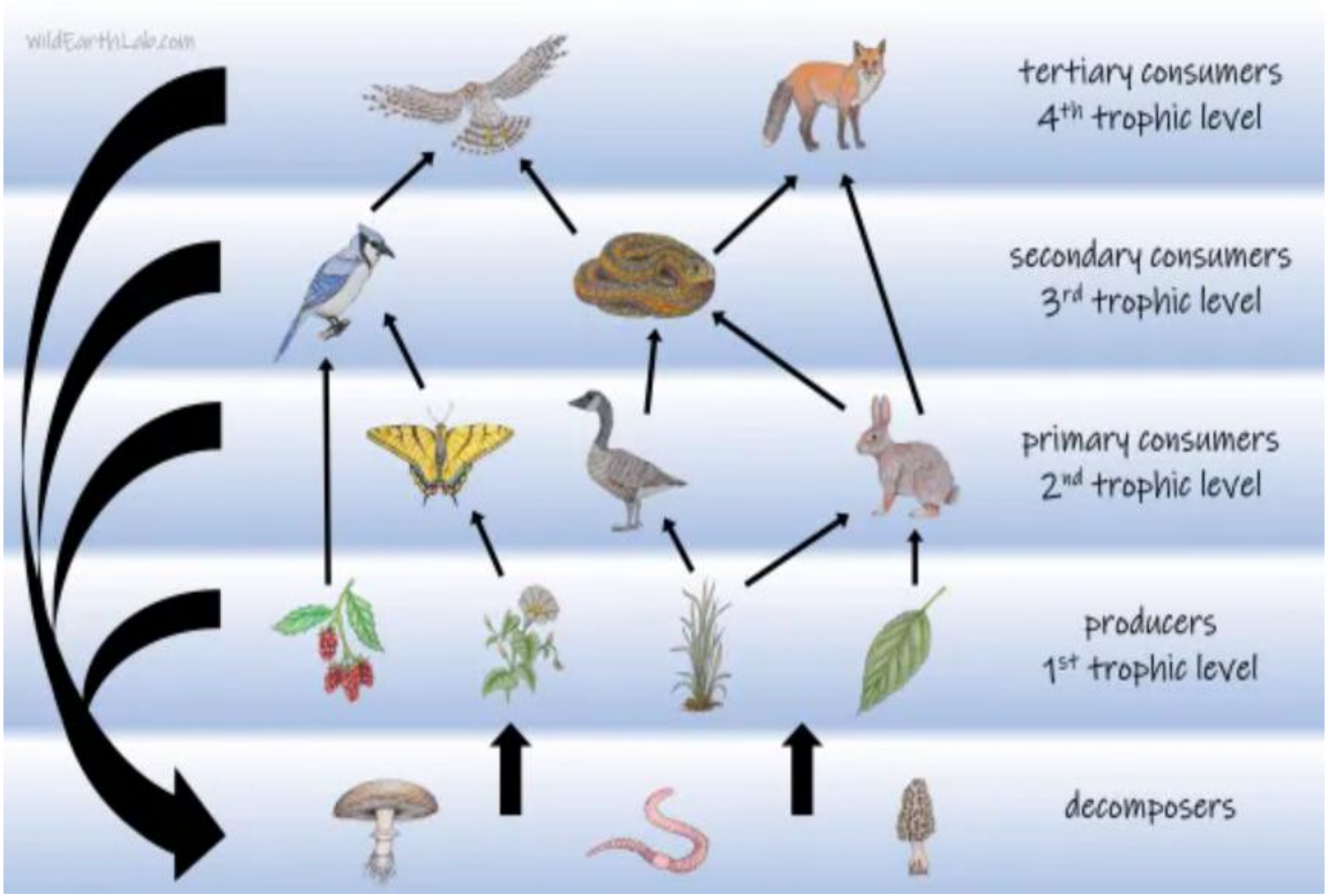


Public access — VIEW ALL

1 article — 9 articles

not available — available

Based on funding mandates



Wild Earth Lab, 2021

Insect diversity and abundance

Insects are useful indicators of ecosystem functionality (Longcore 2003)

Primary source of protein for ~96% of terrestrial birds and critical in the diet of other wildlife (Tallamy 2009)

Insects provide more pollinator services than any other group of animals (Harmon et al. 2011)

Assist with nutrient cycling and other ecosystem services (Belovsky & Slade 2001)

Ecosystem Services and Insects

Provisioning Services

Food, raw materials, fresh water, **medicinal resources**

Regulating Services

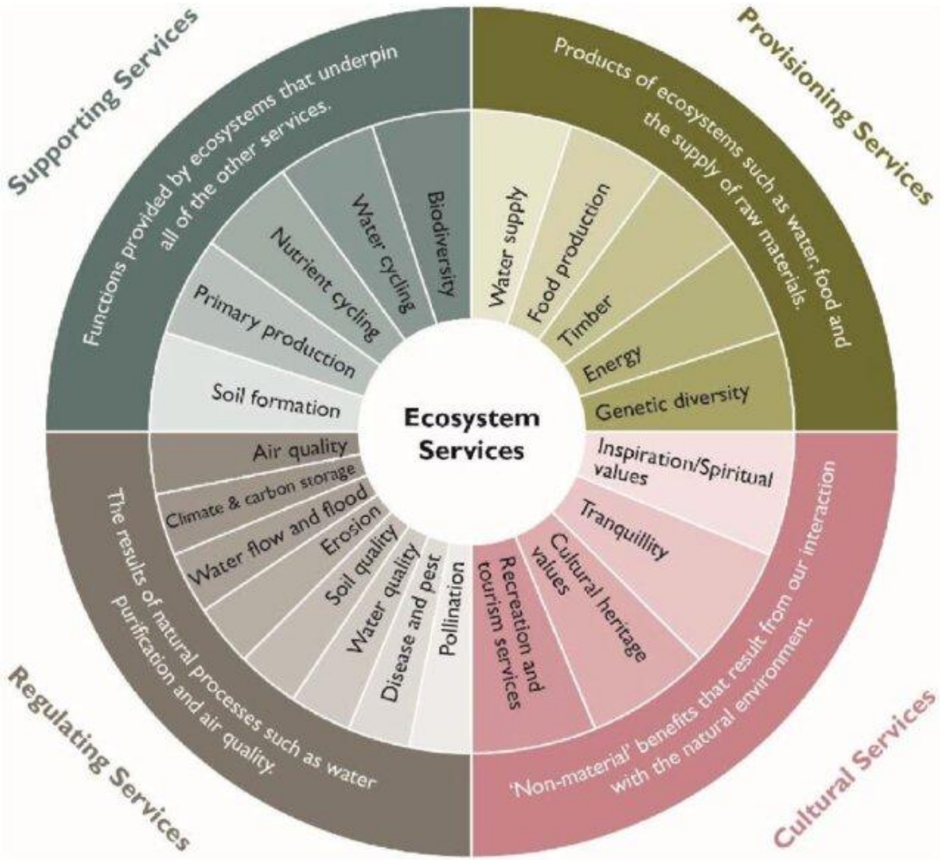
Local climate and air quality, **carbon sequestration and storage**, moderation of extreme events, waste-water treatment, **erosion control/soil fertility, pollination, biological control**

Habitat or Supporting Services

Habitat for species (food, shelter, water), maintenance of genetic diversity (high species diversity often means high genetic diversity), nutrient cycling

Cultural Services

Recreation (mental & physical health), tourism, aesthetic appreciation and **inspiration for culture, art, and design**, spiritual experience



www.teebweb.org

land

MDPI

Article

Insect Abundance and Diversity Respond Favorably to Vegetation Communities on Interim Reclamation Sites in a Semi-Arid Natural Gas Field

Michael F. Curran [1,2,3,*], Timothy J. Robinson [4], Pete Guernsey [5], Joshua Sorenson [6], Taylor M. Crow [7], Douglas I. Smith [1] and Peter D. Stahl [1,2,3]

animals

MDPI

https://www.mdpi.com/journal/animals

Article

Ecological Restoration Practices within a Semi-arid Natural Gas Field Improve Insect Abundance and Diversity during Early and Late Growing Season

Michael F. Curran [1,2,3,*], Joshua R. Sorenson [4], Zoe A. Craft [1], Taylor M. Crow [5], Timothy J. Robinson [6] and Peter D. Stahl [1,2,3]

diversity

MDPI

Article

Insect Abundance and Richness Response to Ecological Reclamation on Well Pads 5–12 Years into Succession in a Semi-Arid Natural Gas Field

Michael F. Curran [1,*], Jasmine Allison [2], Timothy J. Robinson [3], Blair L. Robertson [4], Alexander H. Knudson [5], Bee M. M. Bott [1,6], Steven Bower [1] and Bobby M. Saleh [2]

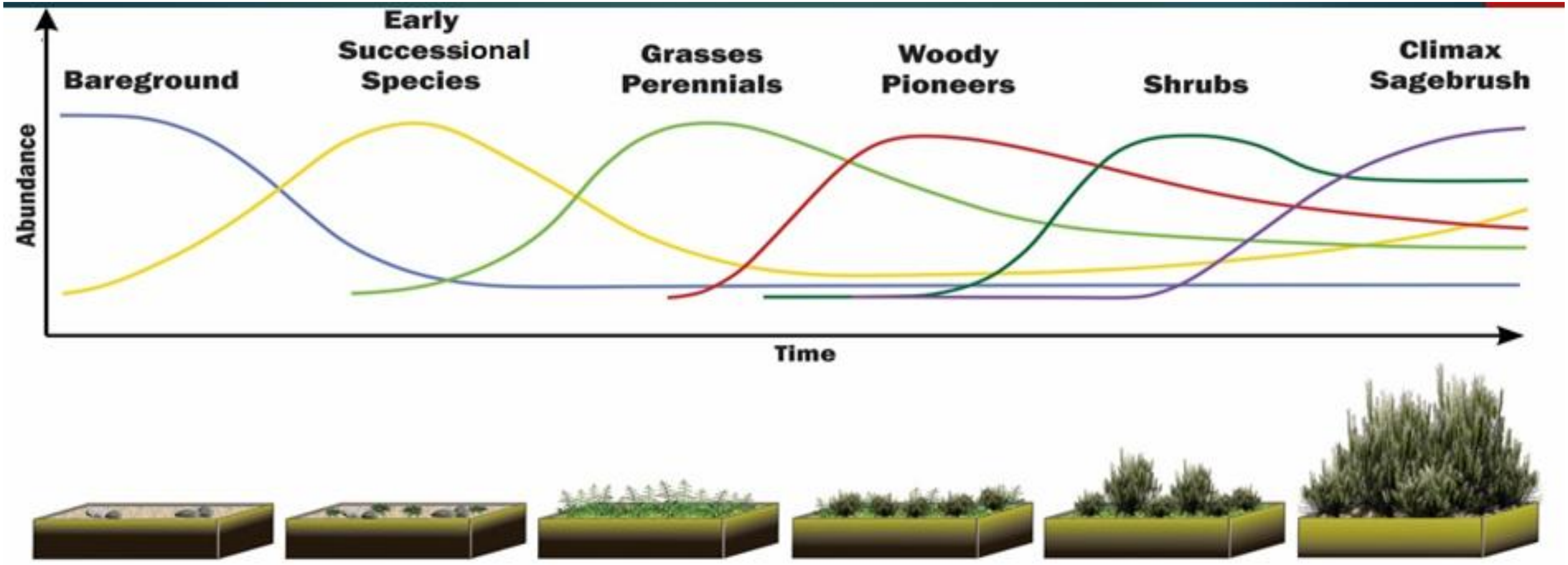
Purpose of studying insects on road reclamation sites.

- Linear features may serve as ecological corridors, as opposed to well pads which are arranged in a patchy matrix
- Research on road reclamation associated with oil and gas development is lacking (Mann et al. 2024)
- Insects are critical sources of protein for birds and other wildlife and ecosystems

Study design

- Three sampling periods over two years (2024-2025) on ~3 mile reclaimed road in Powder River Basin (3 and 4 years post reclamation initiation)
  - August 2024
  - June 2025
  - September 2025
- Road broken into 60 sections based on methods from Curran et al. 2025
- Every 5th section was sweep netted to account for 20% of area
- A match pair design was used to sample with equal intensity on adjacent reference areas
- Vegetation measured with high resolution smartphone camera and analyzed in SamplePoint (Booth et al. 2006, Curran et al. 2019)
- Insects captured with sweep netting technique (Curran and Farmer) and analyzed at U. Wyoming by Milbrath

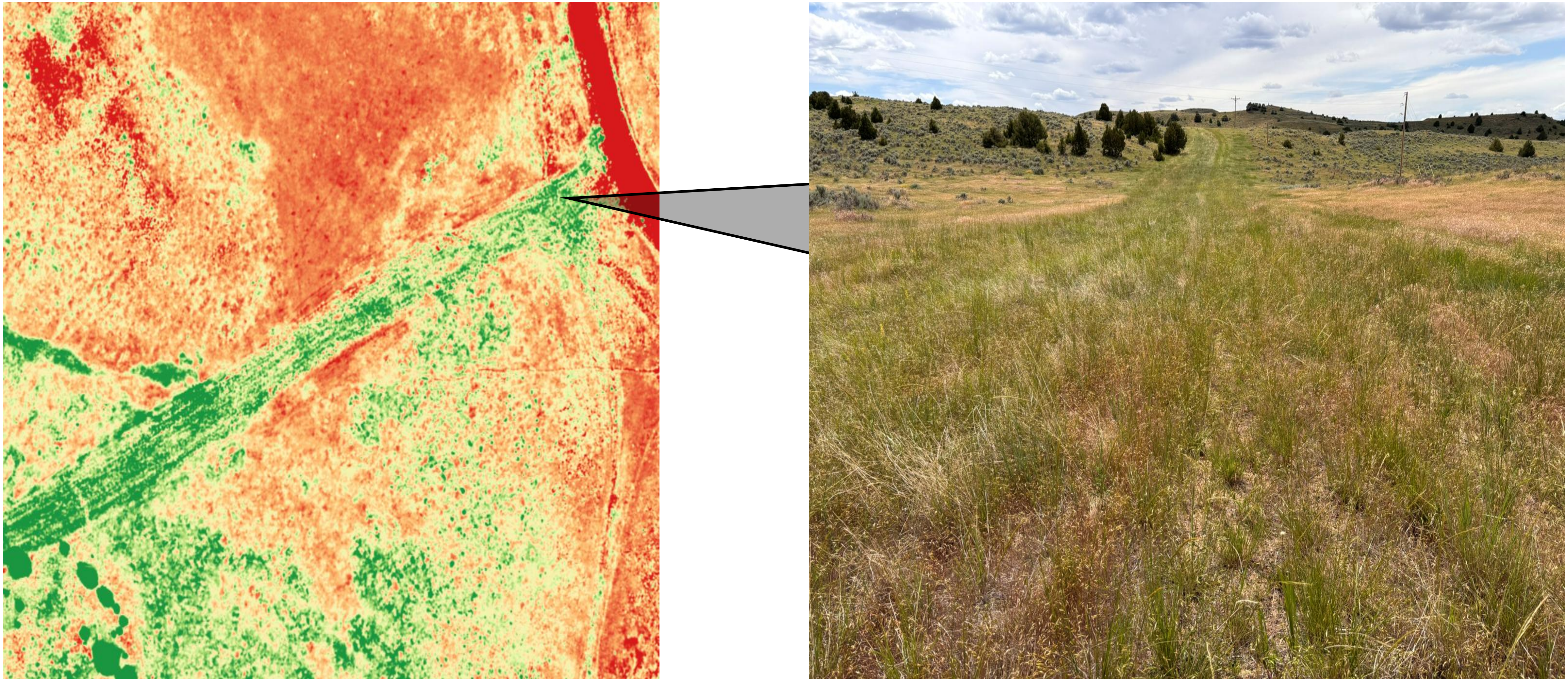
Succession in the Sagebrush Steppe



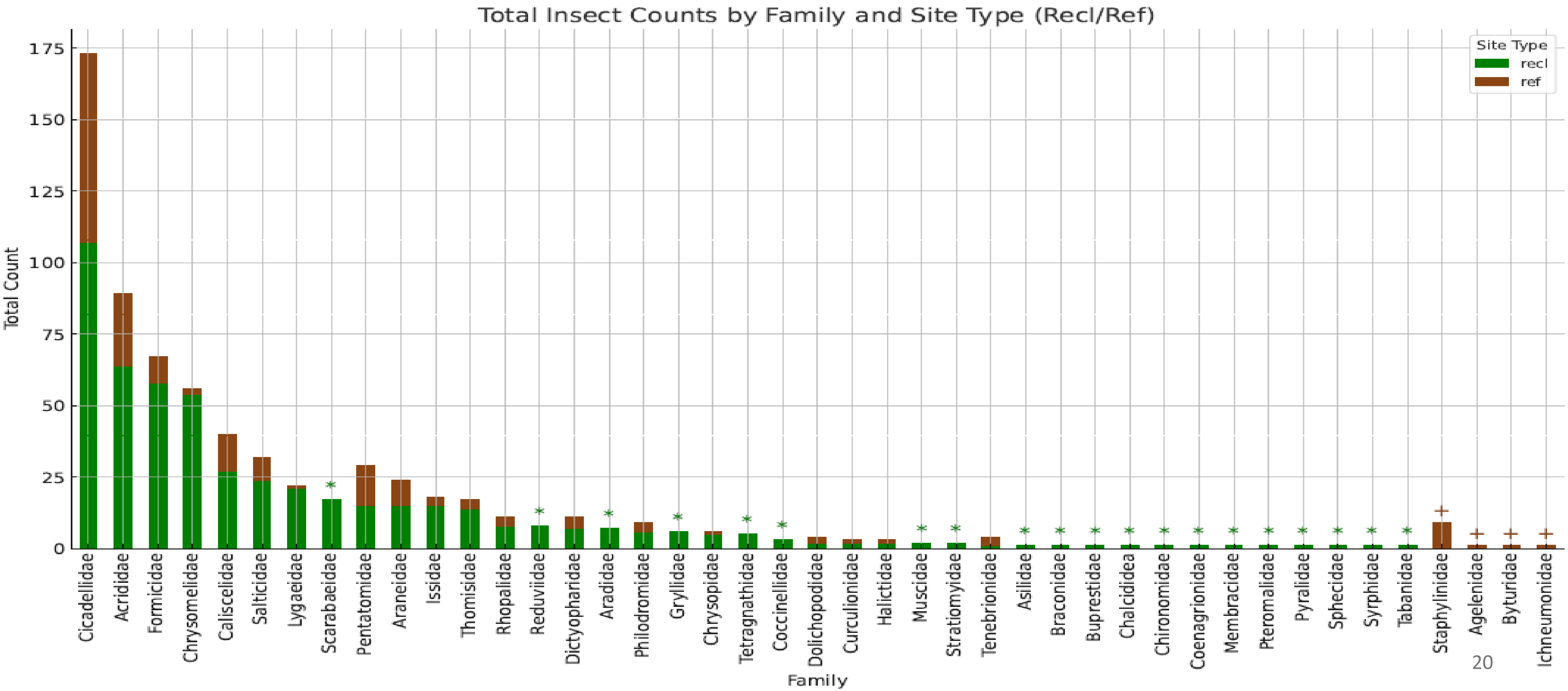
Vegetation Analysis

- Road reclamation area contained more overall cover than reference
- More grasses and forbs found on reclamation than reference
- Less weeds on reclamation than reference
- More shrubs on reference than reclamation

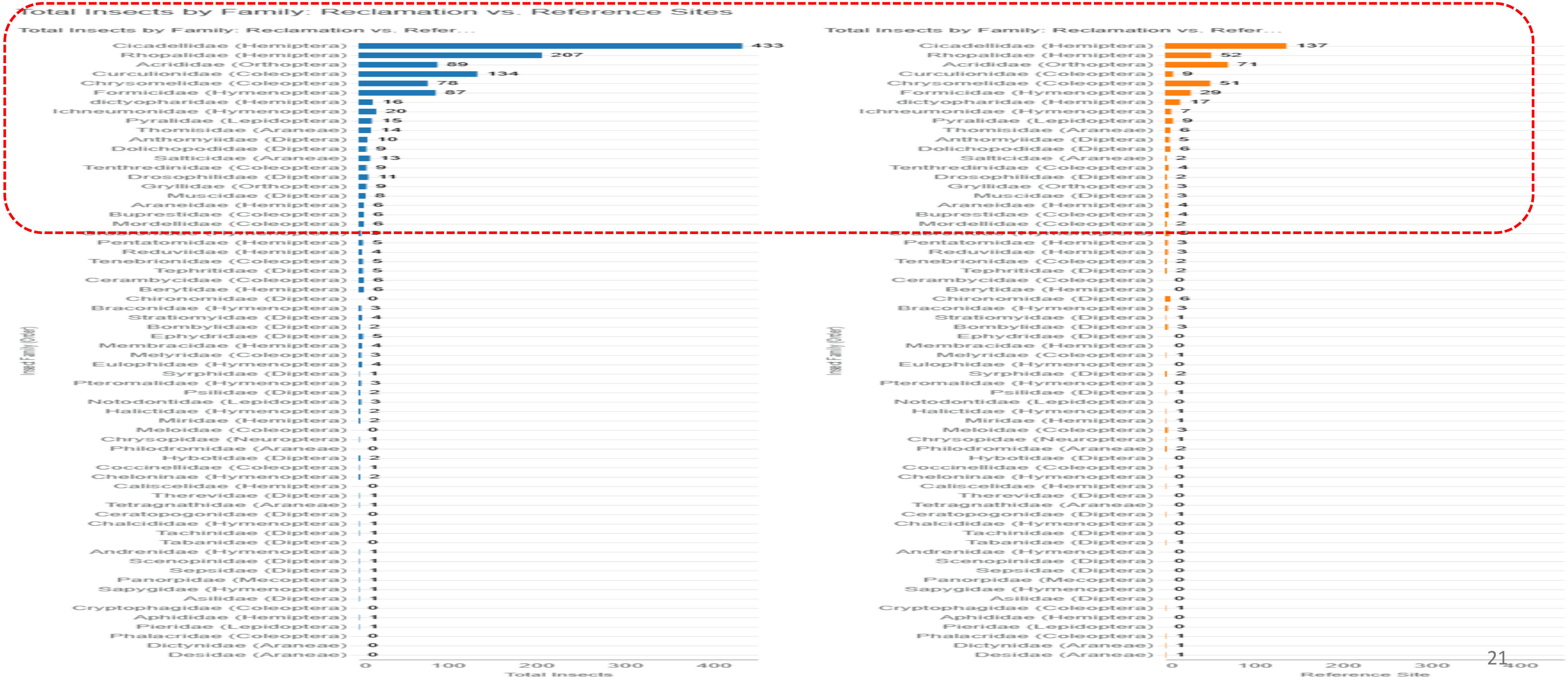
Weed supression



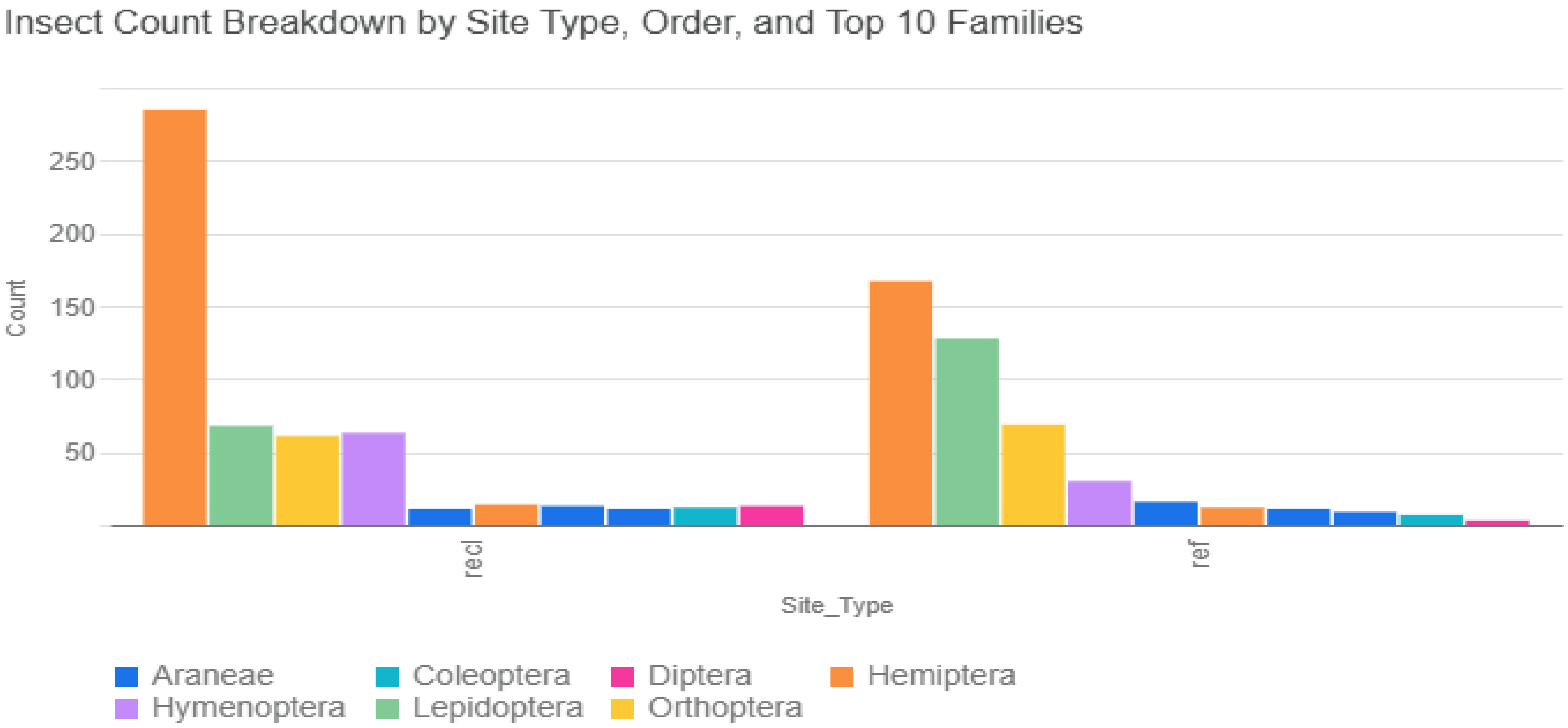
August 2024 Data



June 2025 Data



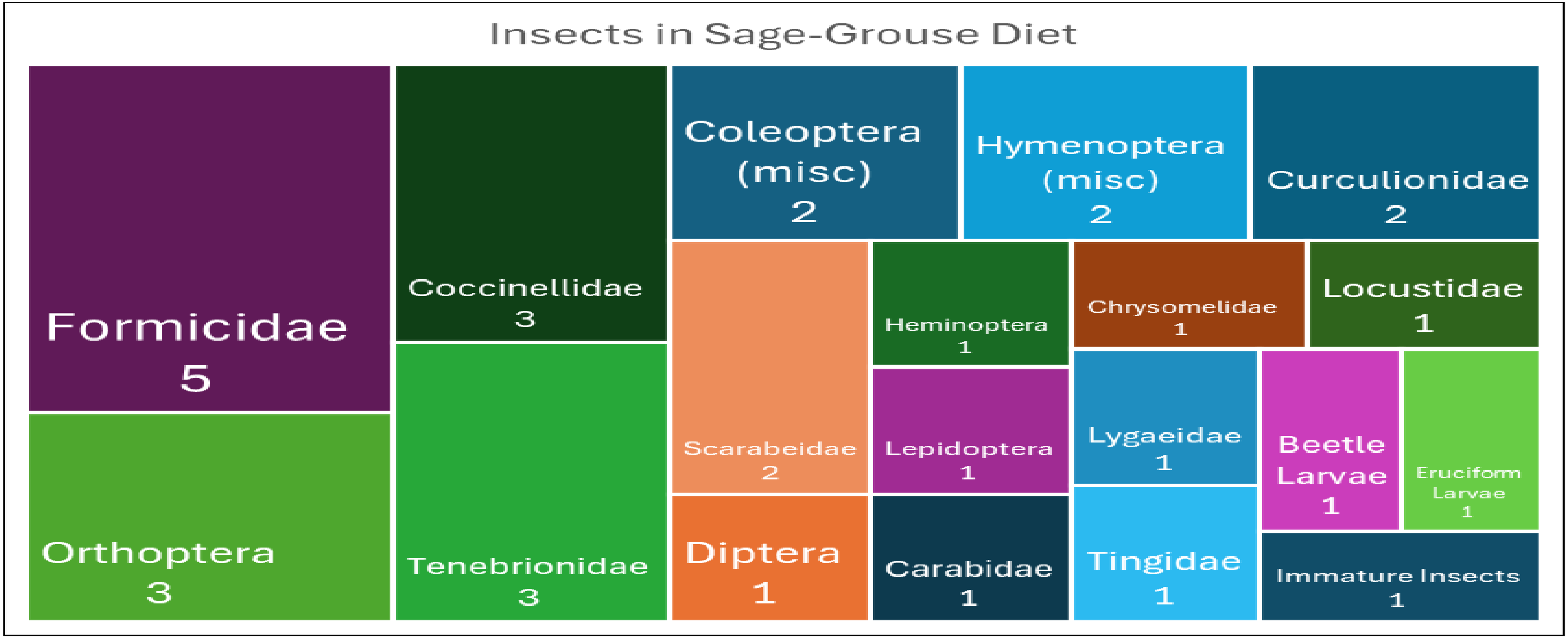
September 2025 Data



Conclusions & Study Limitations

- Insects higher on reclamation than reference in all three years, with statistical significance observer in August 2024 and June 2025
- Insect diversity significantly higher on reclamation than reference across all three sampling periods
- Insect sampling conducted on one road (though other vegetation and net primary productivity data across multiple roads in the area show similar vegetation trends)
  - Road seeded with mix of native grasses, shrubs, and forbs
- Only conducted late season in 2024, though early and late season covered in 2025

Ties to sage-grouse diet



Bott et al. *In review*

Future Directions

- Collaborate with various stakeholders
- Expand study area and move study timing to peak bloom periods
- Build on research questions
- Understand long-term trends

References

- Losey, J.E.; Vaughan, M. The economic value of ecological services provided by insects. *Bioscience* **2006**, *56*, 311–323.
- Noreiga, J.A.; Hortal, J.; Azcarate, F.M.; Berg, M.P.; Bonada, N.; Briones, M.J.; Del Toro, I.; Goulson, D.; Ibanez, S.; Landis, D.A.; et al. Research trends in ecosystem services provided by insects. *Basic Appl. Ecol.* **2018**, *26*, 8–23.
- Lavelle, P. Soil function in a changing world: The role of invertebrate ecosystem engineers. *Eur. J. Soil Biol.* **1997**, *33*, 159–193.
- Belovsky, G.E.; Slade, J.B. Insect herbivory accelerates nutrient cycling and increases plant production. *Proc. Natl. Acad. Sci. USA* **2000**, *97*, 14412–14417.
- Tallamy, D. *Bringing Nature Home: How Native Plants Sustain Wildlife in Our Gardens*; Timber Press: Portland, OR, USA, 2009.
- Archer, S.; Pyke, D.A. Plant-animal interactions affecting plant establishment and persistence on revegetated rangeland. *Rangel. Ecol. Manag.* **1991**, *44*, 558–565.
- Dixon, K.W. Pollination and restoration. *Science* **2009**, *325*, 571–573.
- Curran, M.F., Sorenson, J.R., Craft, Z.A., Crow, T.M., Robinson, T.J. and Stahl, P.D., 2022. Ecological restoration practices within a semi-arid natural gas field improve insect abundance and diversity during early and late growing season. *Animals*, *13*(1), p.134.
- Curran, M.F., Robinson, T.J., Guernsey, P., Sorenson, J., Crow, T.M., Smith, D.I. and Stahl, P.D., 2022. Insect abundance and diversity respond favorably to vegetation communities on interim reclamation sites in a semi-arid natural gas field. *Land*, *11*(4), p.527.
- Curran, M.F., Allison, J., Robinson, T.J., Robertson, B.L., Knudson, A.H., Bott, B.M., Bower, S. and Saleh, B.M., 2024. Insect Abundance and Richness Response to Ecological Reclamation on Well Pads 5–12 Years into Succession in a Semi-Arid Natural Gas Field. *Diversity*, *16*(6), p.324.
- Curran, M.F., Cox, S.E., Robinson, T.J., Robertson, B.L., Rogers, K.J., Sherman, Z.A., Adams, T.A., Strom, C.F. and Stahl, P.D., 2019. Spatially balanced sampling and ground-level imagery for vegetation monitoring on reclaimed well pads. *Restoration ecology*, *27*(5), pp.974-980.