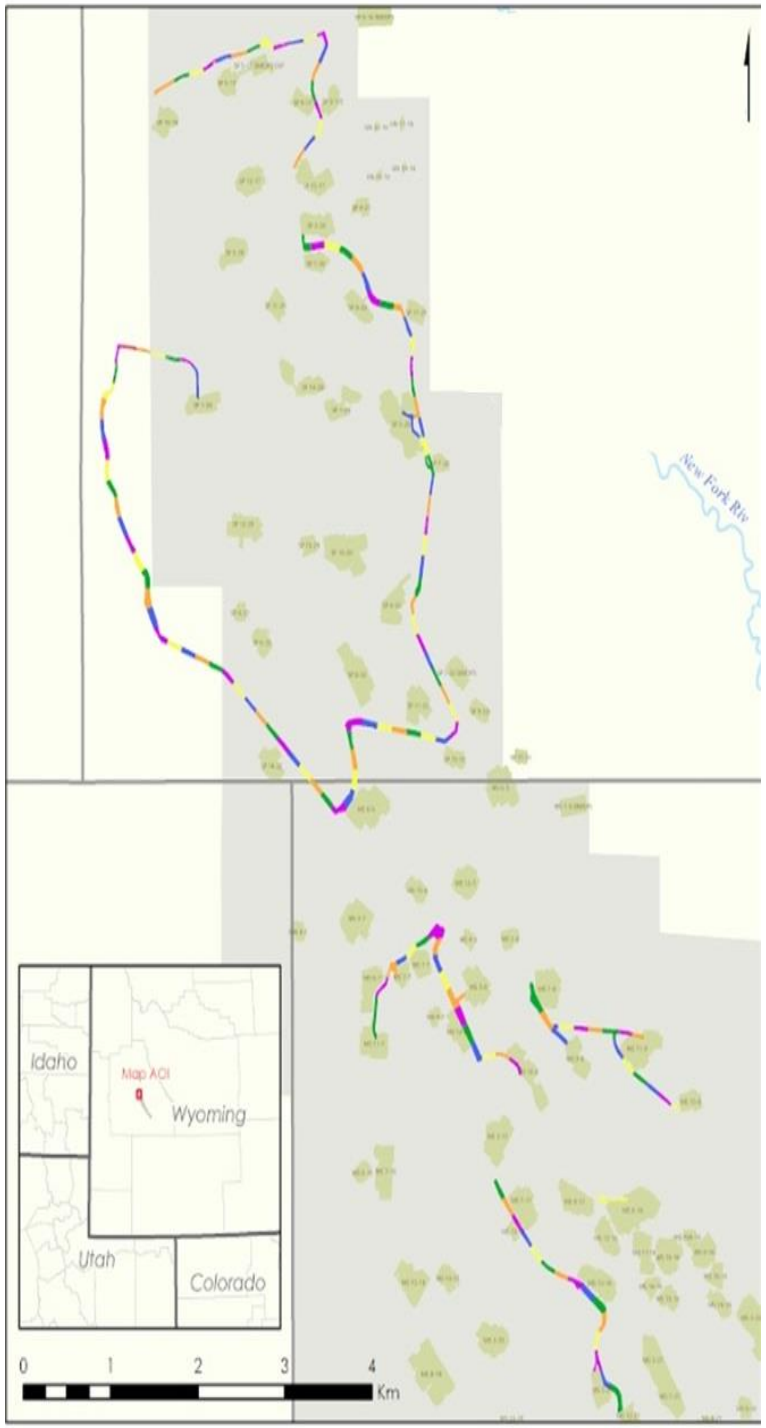
Reclamation of natural gas well pads and pipeline right-of-ways to create biodiversity hotspots and ecological corridors

Michael Curran, PhD, CERP, CWB



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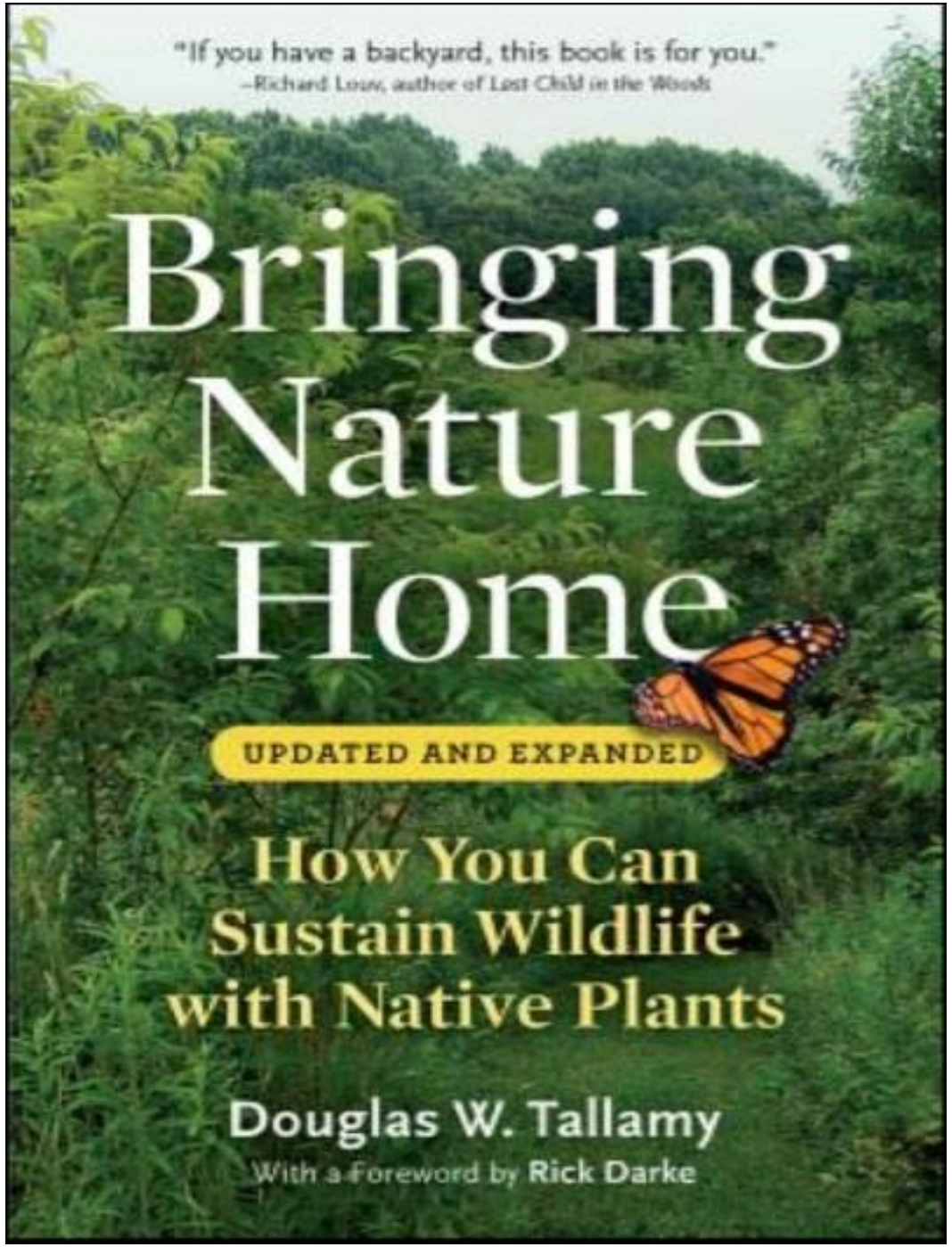

Douglas W. Tallamy

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	436	2009
Convergence patterns in subsocial insects DW Tallamy, TK Wood Annual review of entomology 31 (1), 369-390	330	1986
Phytochemical induction by herbivores DW Tellamy, MJ Raupp	325	1991
Do alien plants reduce insect biomass? DW Tallamy Conservation biology 18 (6), 1689-1692	288	2004
Ranking lepidopteran use of native versus introduced plants DW Tallamy, KJ Shropshire Conservation Biology 23 (4), 941-947	218	2009
Bringing nature home: how you can sustain wildlife with native plants, updated and expanded DW Tallamy	179	2009

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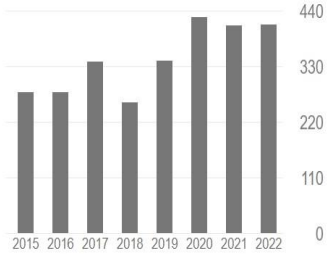

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JOURNAL ARTICLE

Reproductive Success of Chestnut-Collared Longspurs in Native and Exotic Grassland FREE

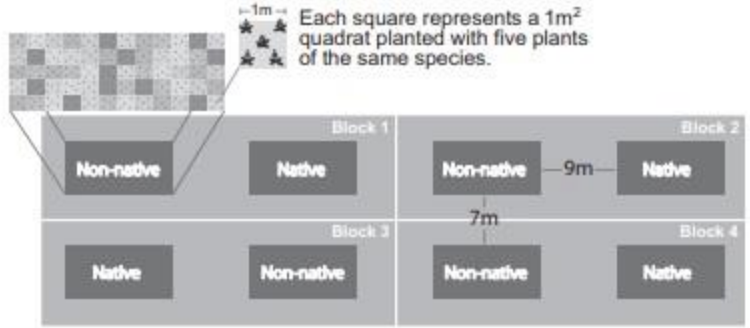
John D. Lloyd, Thomas E. Martin Author Notes

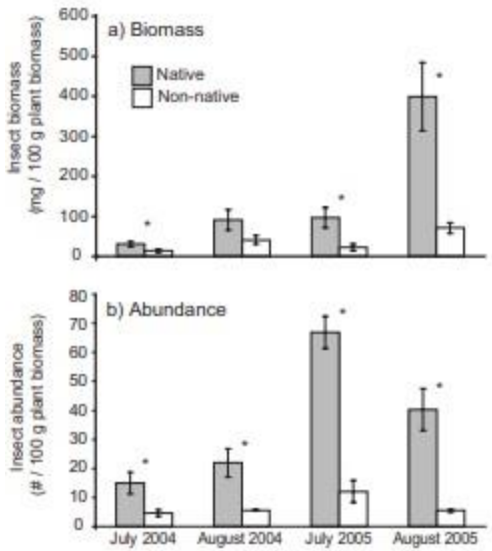
The Condor, Volume 107, Issue 2, 1 May 2005, Pages 363–374,
https://doi.org/10.1093/condor/107.2.363
Published: 01 May 2005 **Article history** ▾

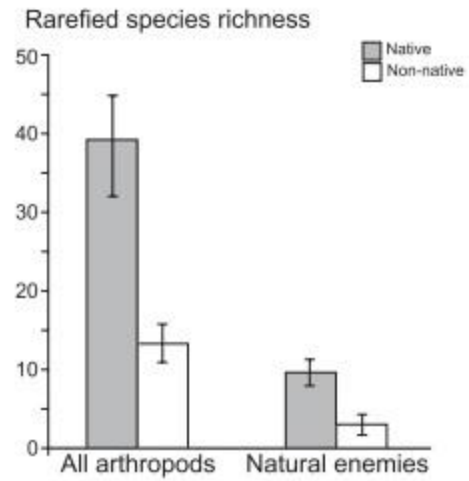
COMMUNITY AND ECOSYSTEM ECOLOGY

Arthropod Communities on Native and Nonnative Early Successional Plants

MEG BALLARD,[1] JUDITH HOUGH-GOLDSTEIN,[1,2] AND DOUGLAS TALLAMY[1]



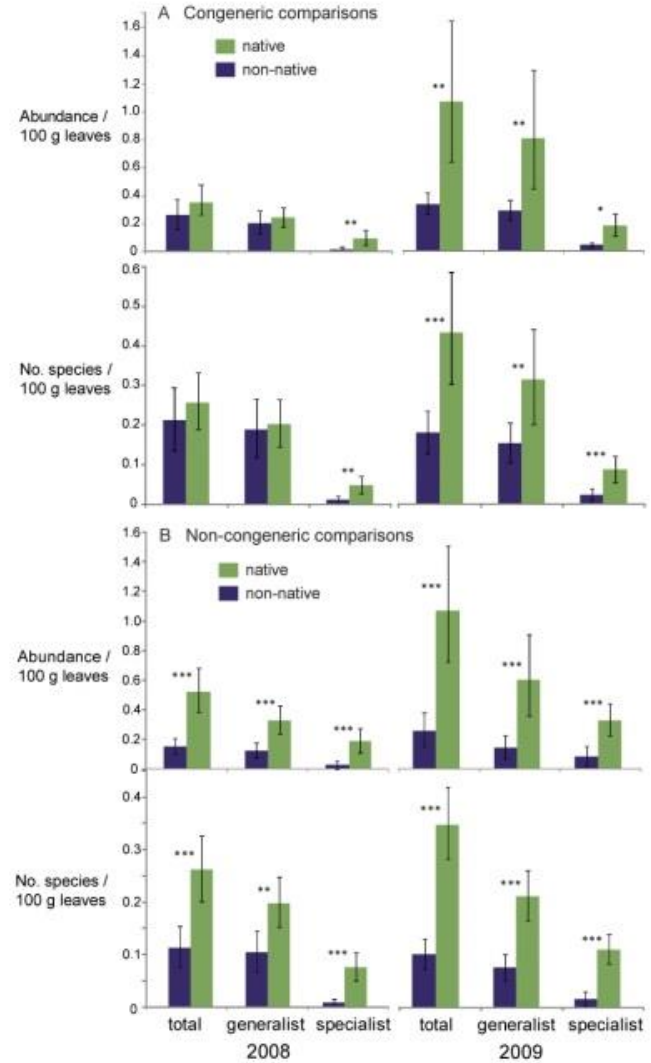




Non-native plants reduce abundance, richness, and host specialization in lepidopteran communities

KARIN T. BURGHARDT,[1,†] DOUGLAS W. TALLAMY, CHRISTOPHER PHILIPS,[2] AND KIMBERLEY J. SHROPSHIRE

Entomology and Wildlife Ecology Department, University of Delaware, Newark, Delaware 19716 USA



Ecosystem Services and Insects

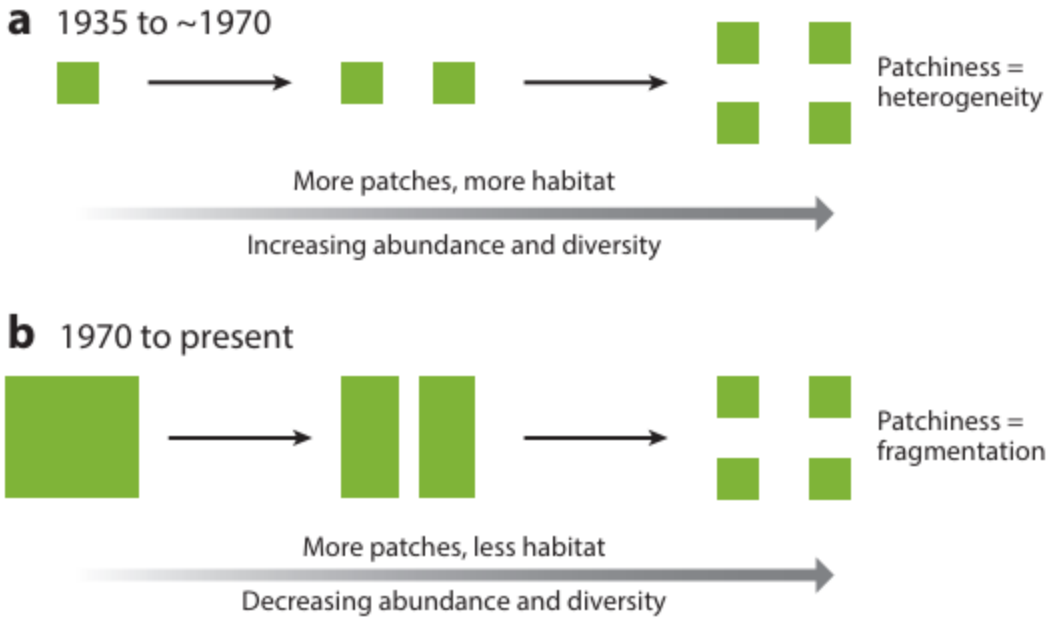
- Provisioning Services
  - Food, raw materials, fresh water, medicinal resources
- Regulating Services
  - Local climate and air quality, **carbon sequestration and storage**, moderation of extreme events, waste-water treatment**, erosion control/soil fertility, pollination**, biological control
- Habitat 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

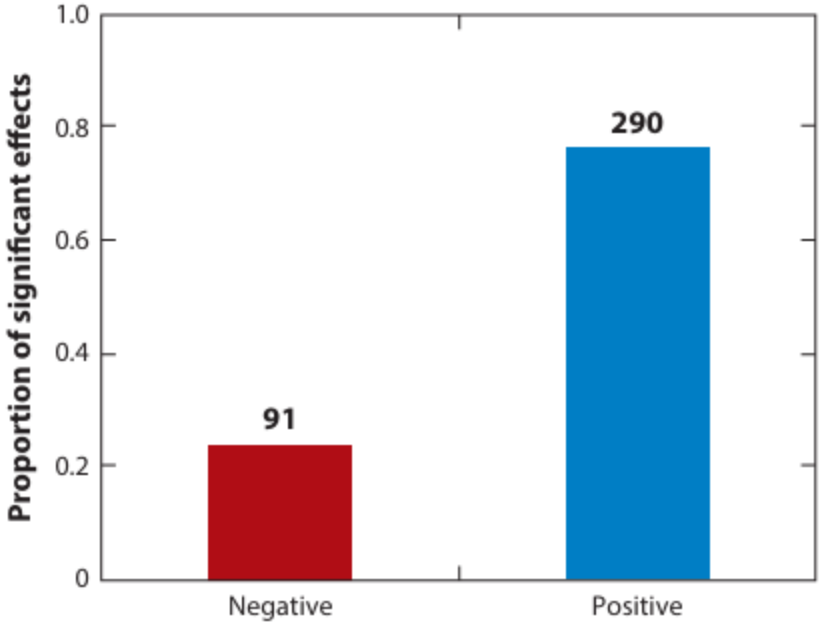
Annual Review of Ecology, Evolution, and Systematics

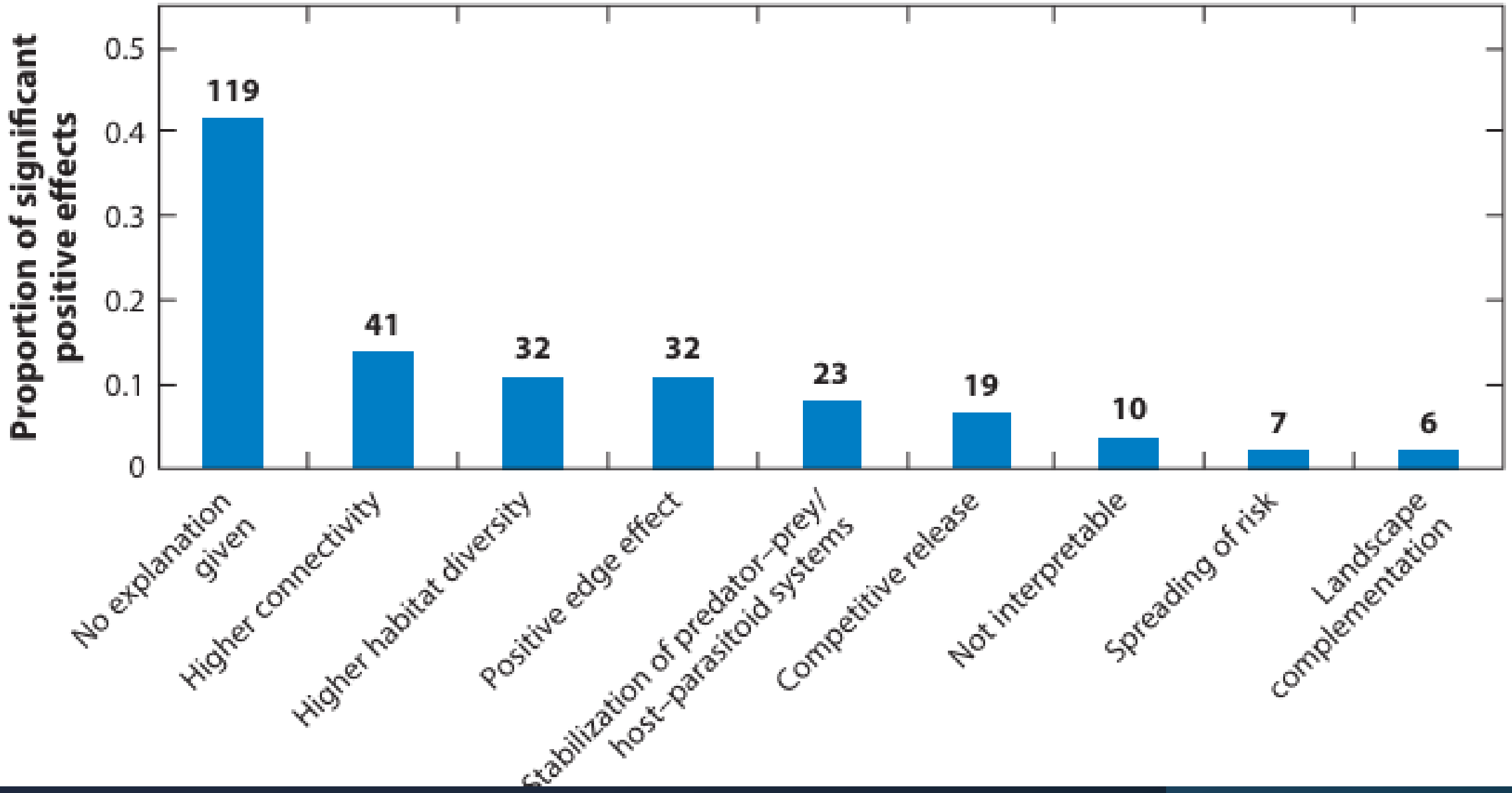
Ecological Responses to Habitat Fragmentation Per Se

Lenore Fahrig

Habitat fragmentation per se – habitat fragmentation independent of habitat loss






Proportion of significant positive effects
0.5
0.4
0.3
0.2
0.1
0
119
41
32
32
23
19
10
7
6
No explanation given
Higher connectivity
Higher habitat diversity
Positive edge effect
Stabilization of predator–prey/host–parasitoid systems
Competitive release
Not interpretable
Spreading of risk
Landscape complementation

ECOLOGY LETTERS

Mass flowering crops enhance pollinator densities at a landscape scale

Catrin Westphal, Ingolf Steffan-Dewenter, Teja Tscharntke

The plant vigor hypothesis and herbivore attack

Peter W. Price

Price, P. W. 1991. The plant vigor hypothesis and herbivore attack. – Oikos 62: 244–251.

ELSEVIER

Rangeland Ecology & Management

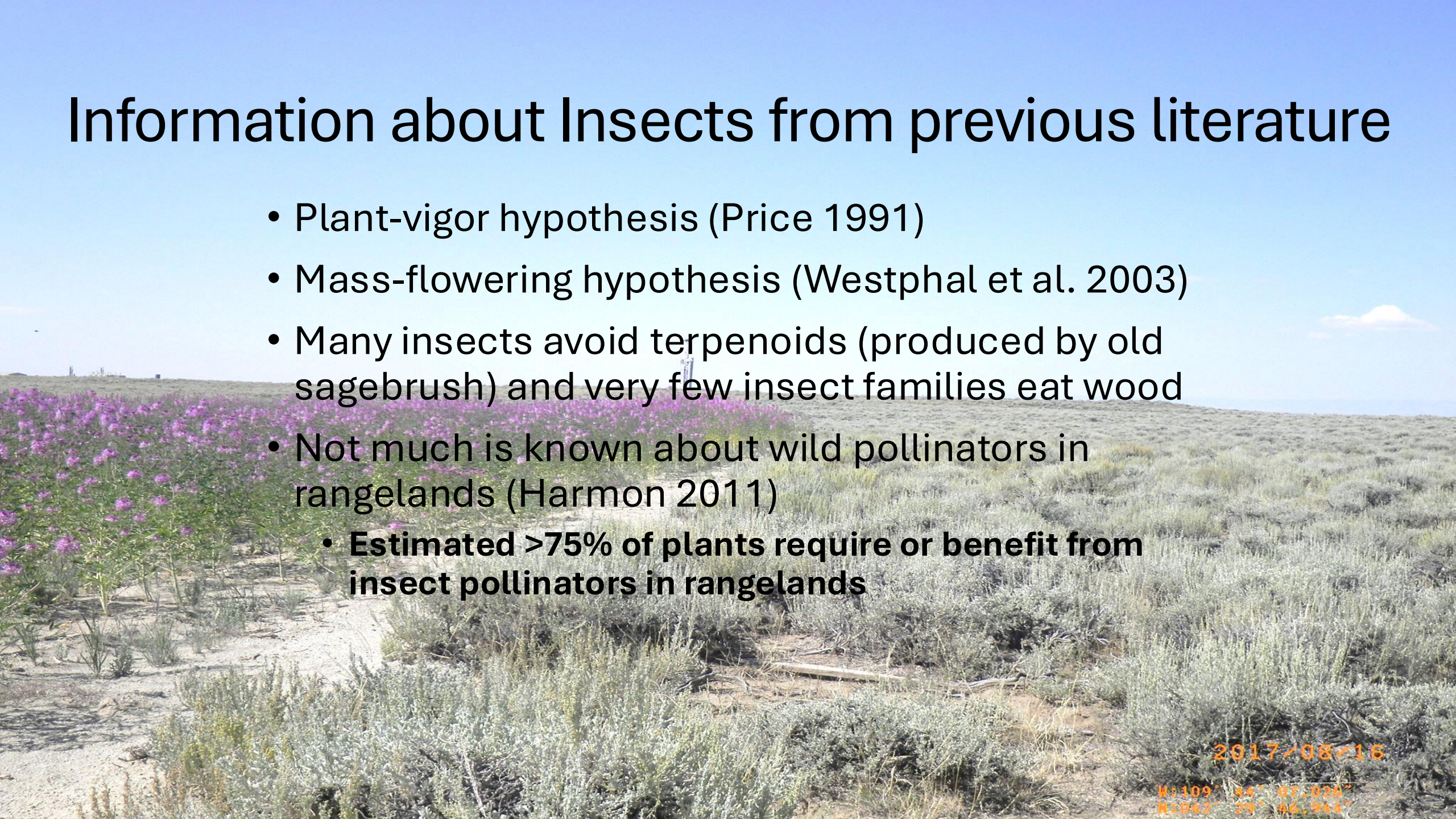
Volume 94, May 2024, Pages 184-194

Sagebrush Ecosystems are More Than *Artemisia:* The Complex Issue of Degraded Understories in the Great Basin

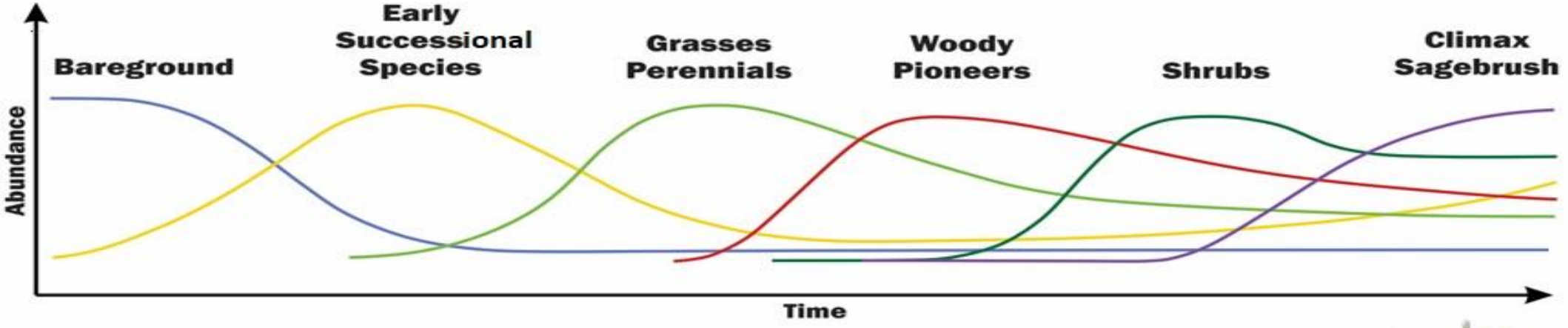
Stella M. Copeland [1], Kirk W. Davies [2], Chad S. Boyd [3]

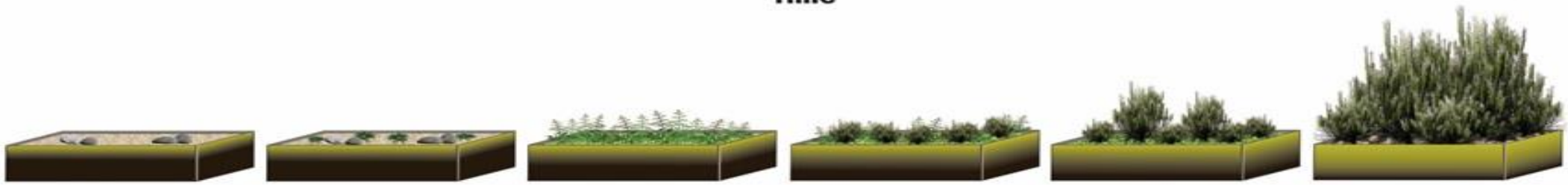
Information about Insects from previous literature

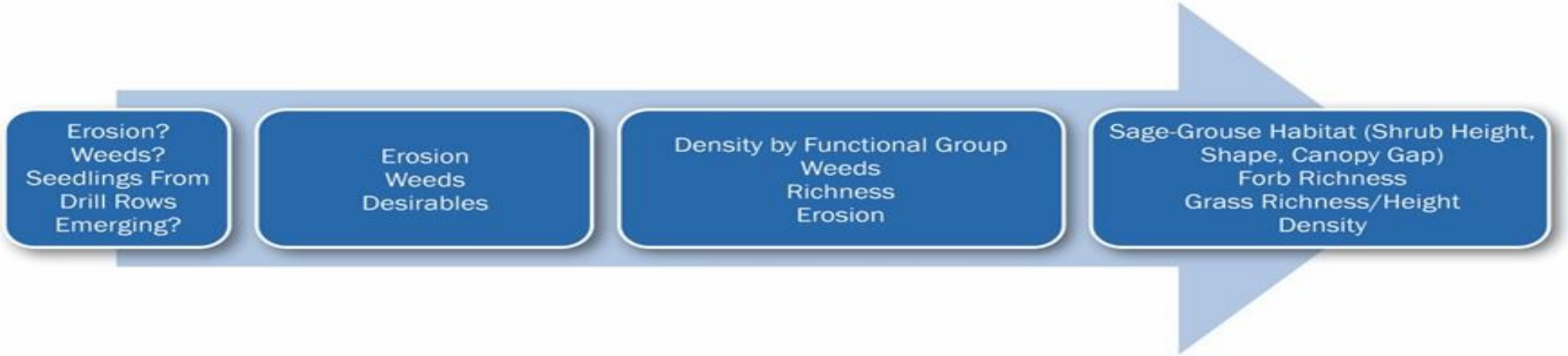
- Plant-vigor hypothesis (Price 1991)
- Mass-flowering hypothesis (Westphal et al. 2003)
- Many insects avoid terpenoids (produced by old sagebrush) and very few insect families eat wood
- Not much is known about wild pollinators in rangelands (Harmon 2011)
  - **Estimated >75% of plants require or benefit from insect pollinators in rangelands**

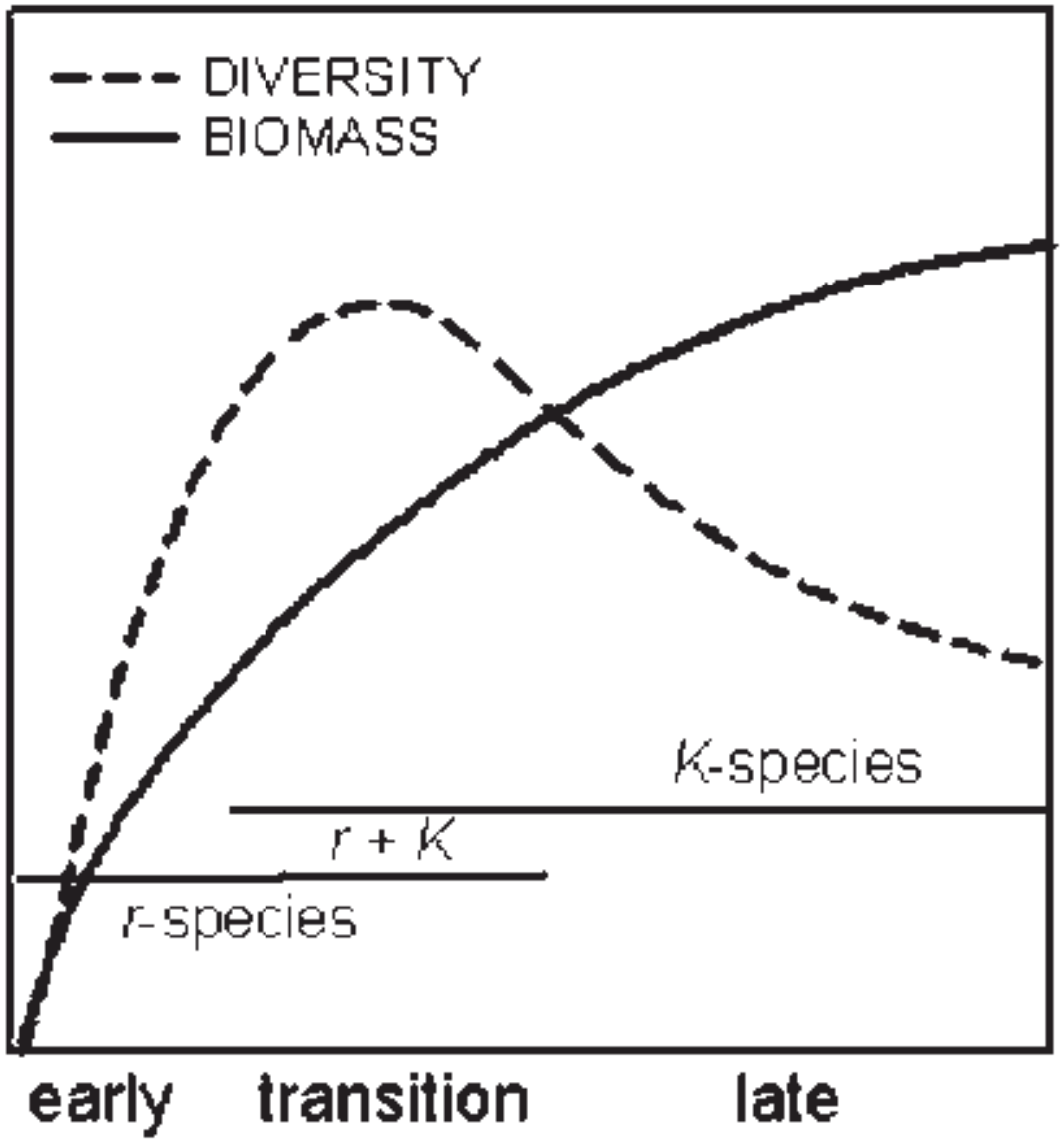


Restoration as Assisted Succession – Western US

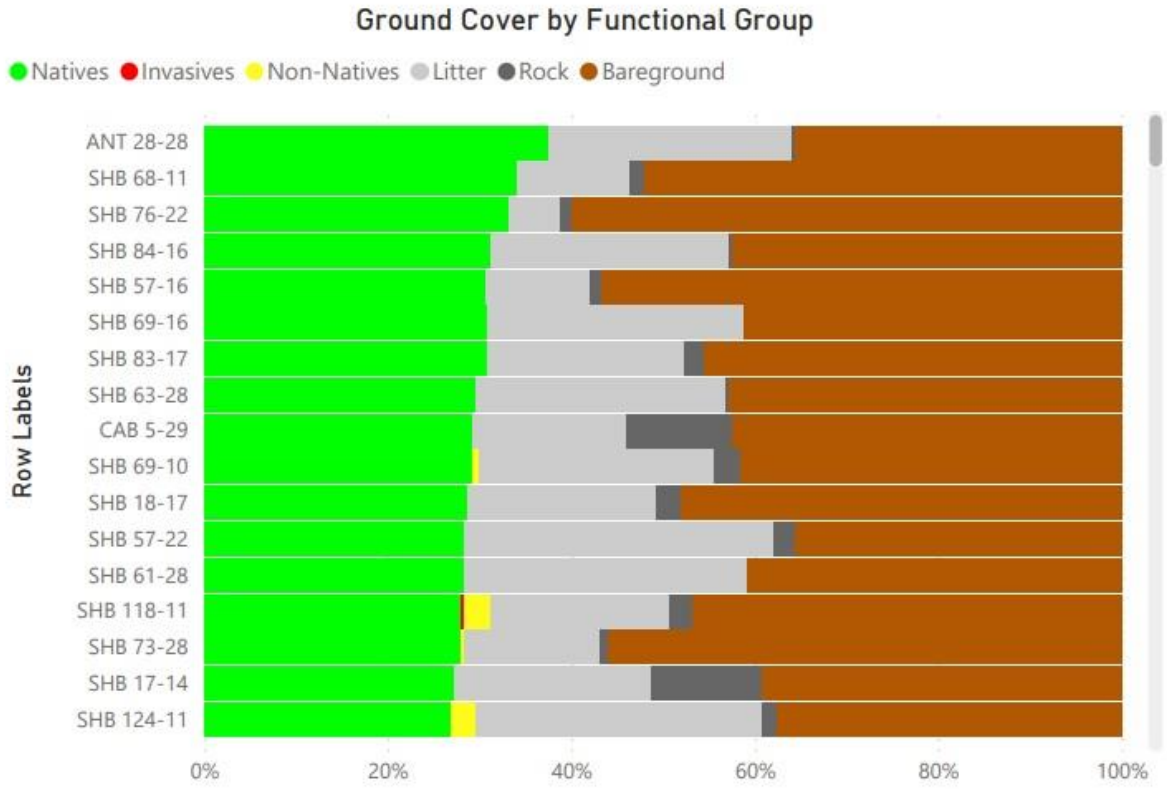


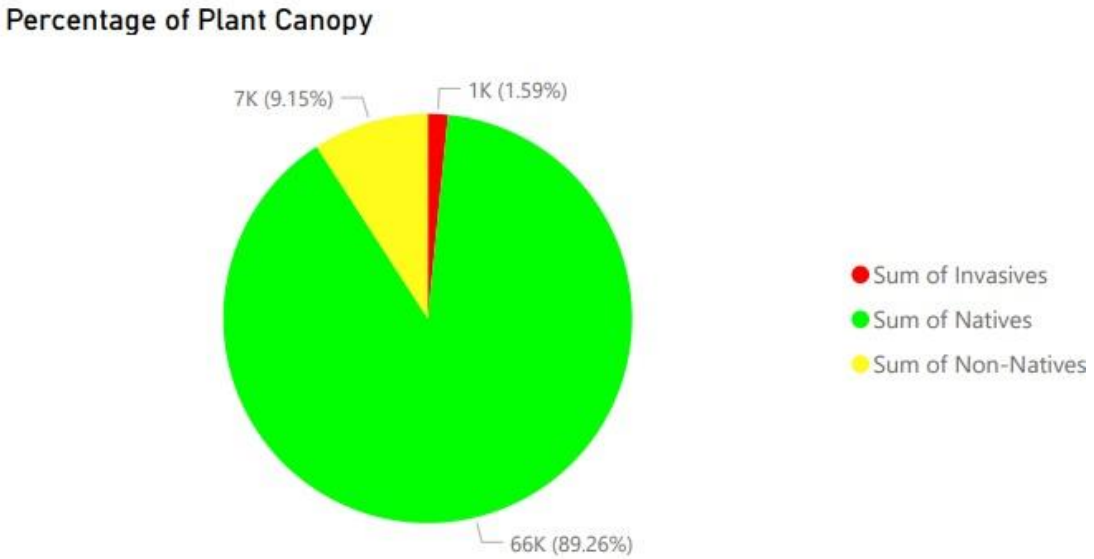





DIVERSITY
BIOMASS
K-species
r + K
r-species
early
transition
late

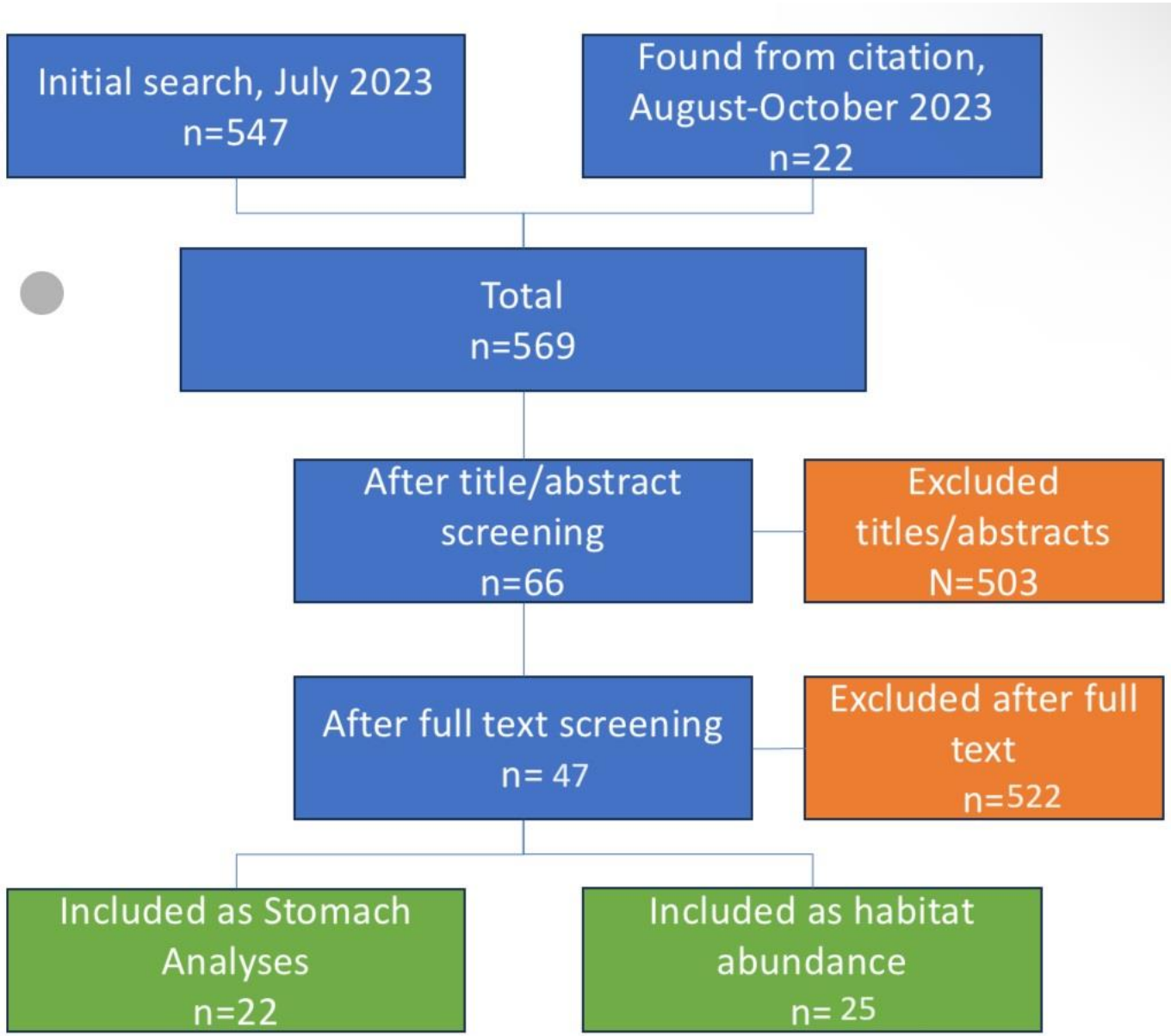
Example of a dashboard from Jonah (200 sites)

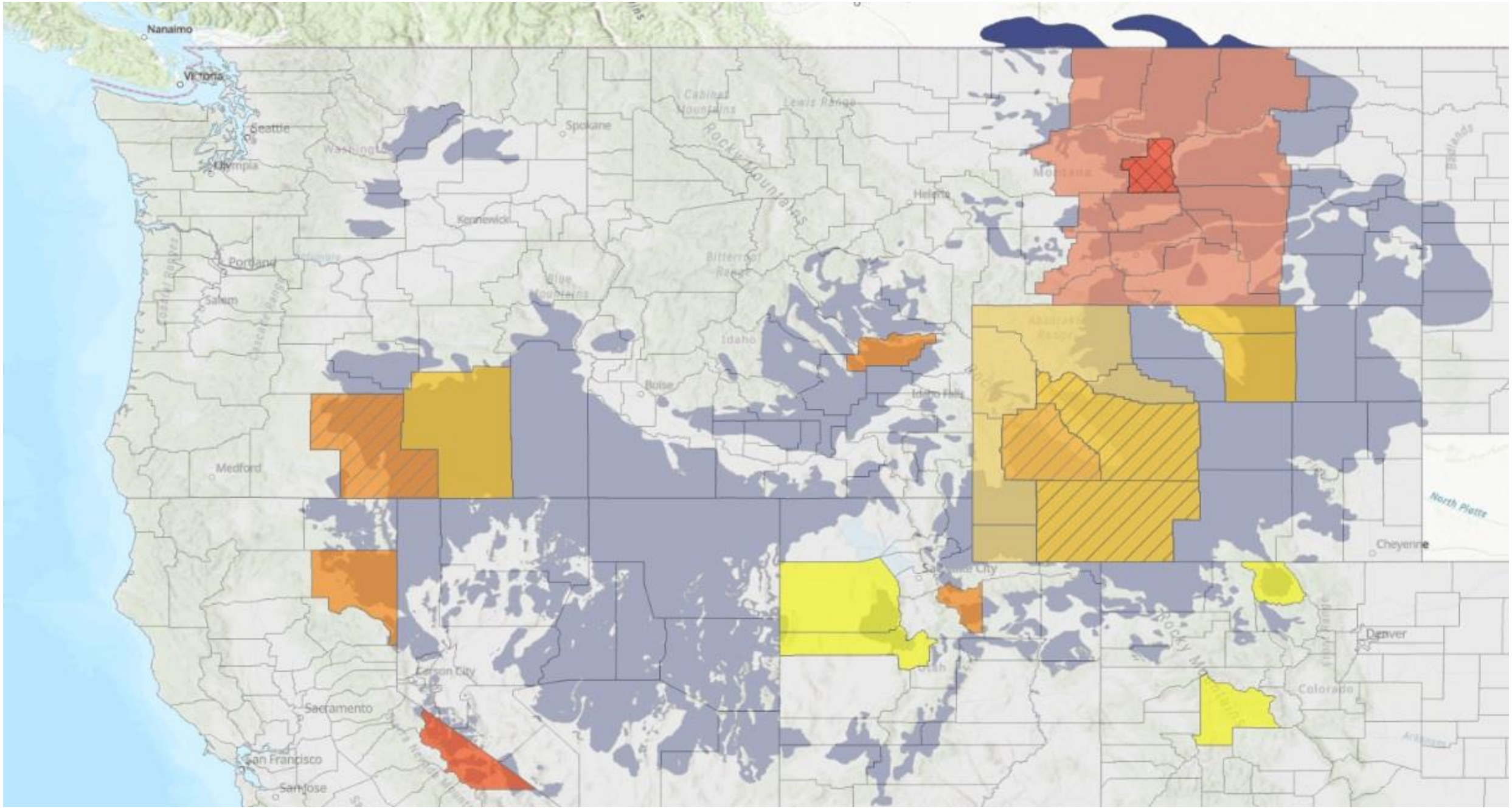


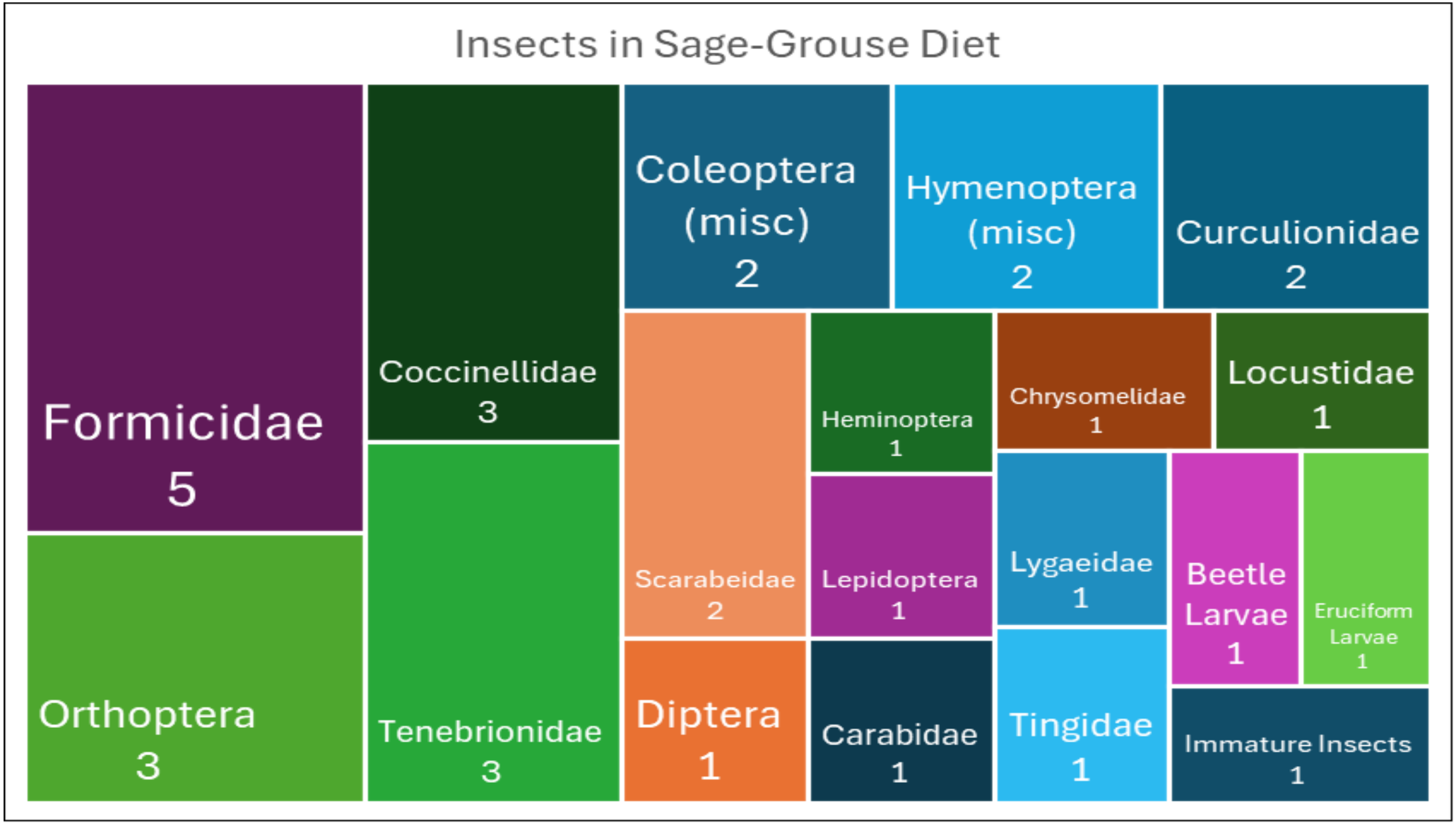


Reframing native, non-native, invasive

- Contributors – those plants which provide positive benefits to the terrestrial food web
- Non-contributors – those plants which provide little benefits to the terrestrial food web
- Detractors – those plants which do not provide benefits to the terrestrial food web and also disrupt native ecosystems


Initial search, July 2023
n=547
Found from citation, August-October 2023
n=22
Total
n=569
After title/abstract screening
n=66
Excluded titles/abstracts
N=503
After full text screening
n= 47
Excluded after full text
n=522
Included as Stomach Analyses
n=22
Included as habitat abundance
n= 25


Nanaimo
Victoria
Seattle
Olympia
Spokane
Kennewick
Portland
Salem
Medford
Boise
Idaho Falls
Helena
Sacramento
San Francisco
Sanjose
Denver
Cheyenne
North Platte
Colorado


Insects in Sage-Grouse Diet
Formicidae 5
Orthoptera 3
Coccinellidae 3
Tenebrionidae 3
Coleoptera (misc) 2
Hymenoptera (misc) 2
Curculionidae 2
Scarabeidae 2
Heminoptera 1
Chrysomelidae 1
Locustidae 1
Lepidoptera 1
Lygaeidae 1
Beetle Larvae 1
Eruciform Larvae 1
Diptera 1
Carabidae 1
Tingidae 1
Immature Insects 1

land

MDPI

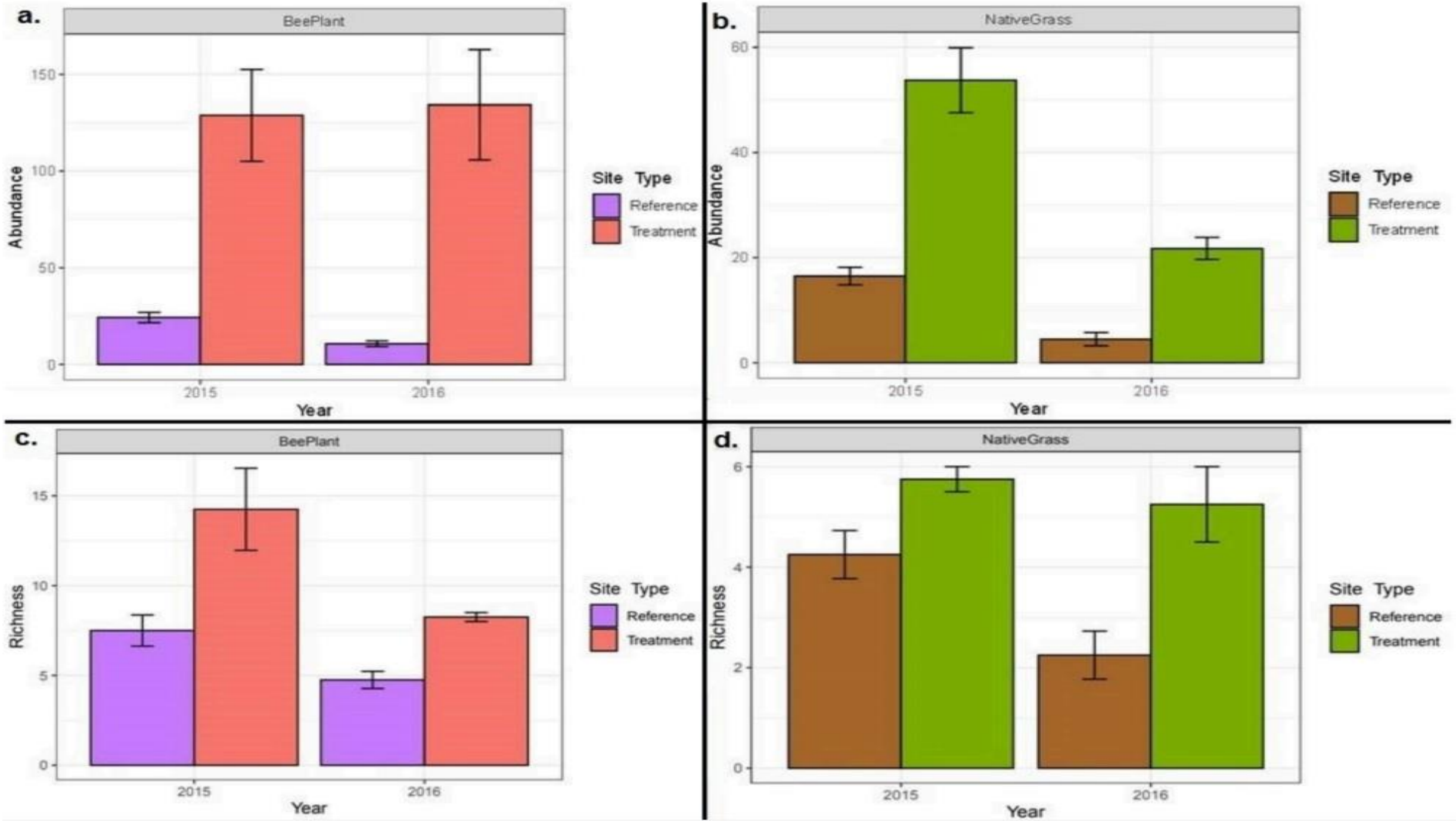
Article

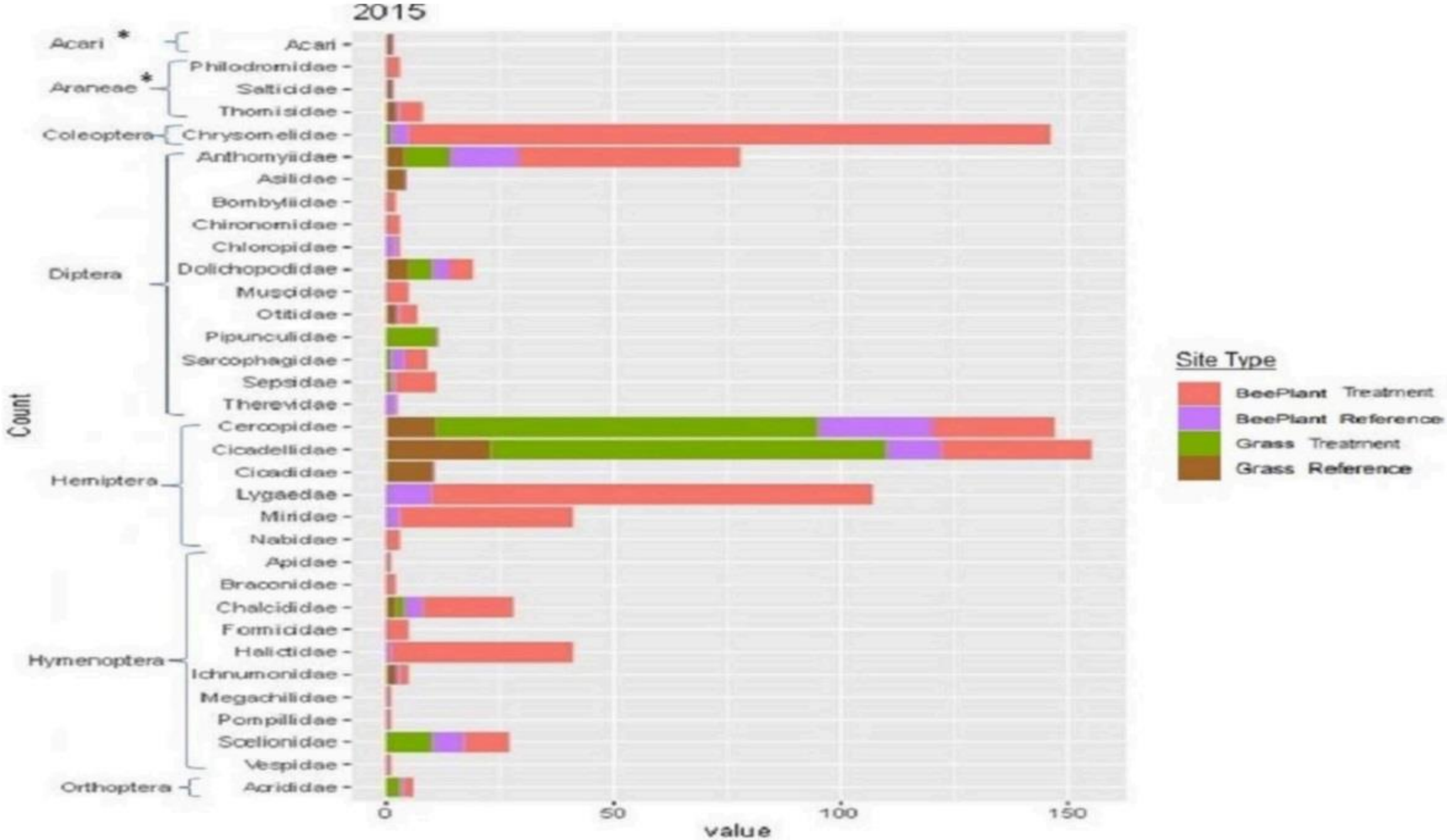
Insect Abundance and Diversity Respond Favorably to Vegetation Communities on Interim Reclamation Sites in a Semi-Arid Natural Gas Field

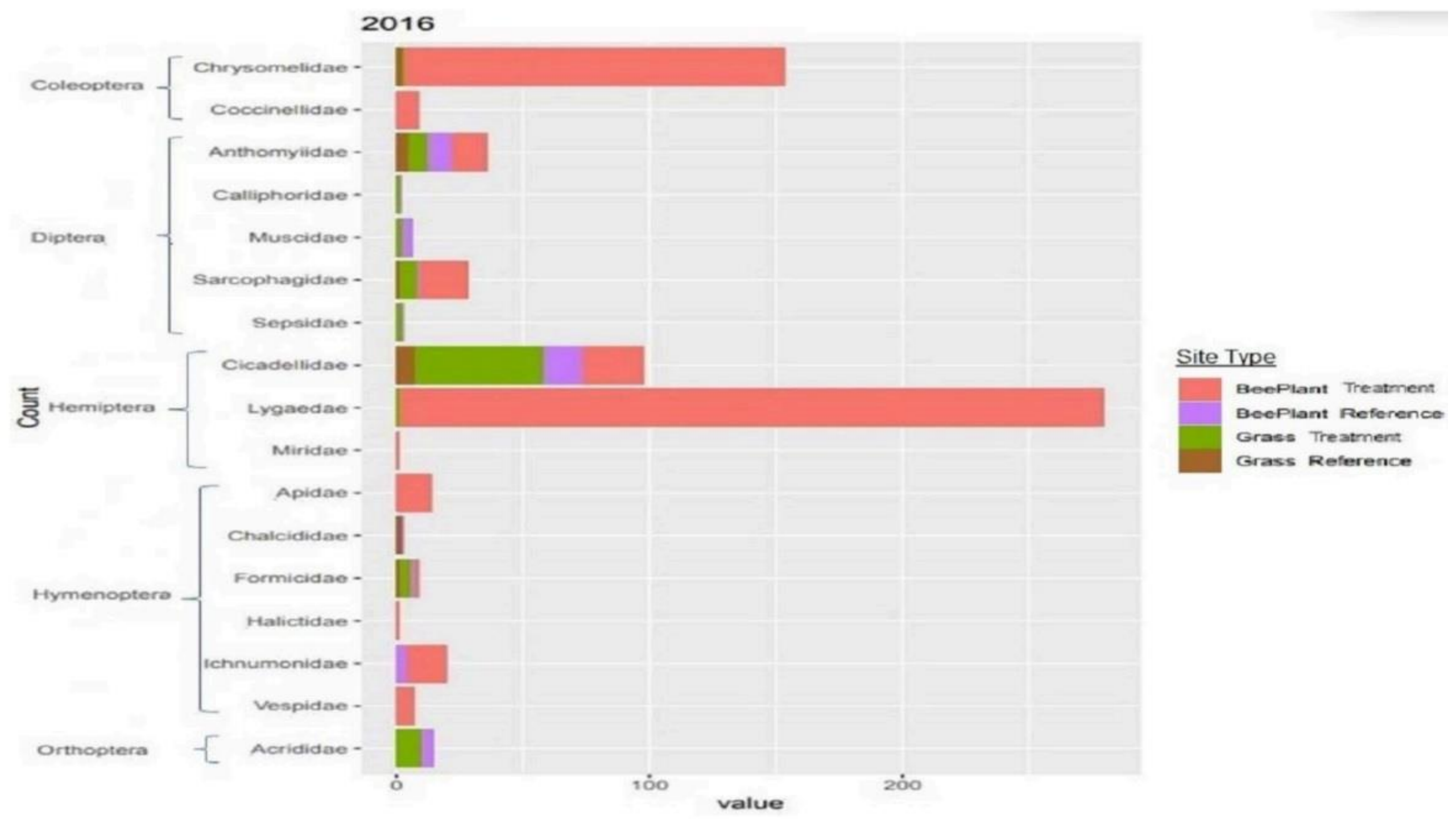
Michael F. Curran [1,2,3,*], Timothy J. Robinson [4], Pete Guernsey [5], Joshua Sorenson [6], Taylor M. Crow [7], Douglas I. Smith [1] and Peter D. Stahl [1,2,3]

- First year reclamation seeded with native, annual forb Rocky Mountain bee plant (and other native species)

- 2-3 year old reclamation seeded predominantly with native, perennial grass species


a.
BeePlant
Abundance
150
100
50
0
2015
2016
Year
Site Type
Reference
Treatment
b.
NativeGrass
Abundance
60
40
20
0
2015
2016
Year
Site Type
Reference
Treatment
c.
BeePlant
Richness
15
10
5
0
2015
2016
Year
Site Type
Reference
Treatment
d.
NativeGrass
Richness
6
4
2
0
2015
2016
Year
Site Type
Reference
Treatment

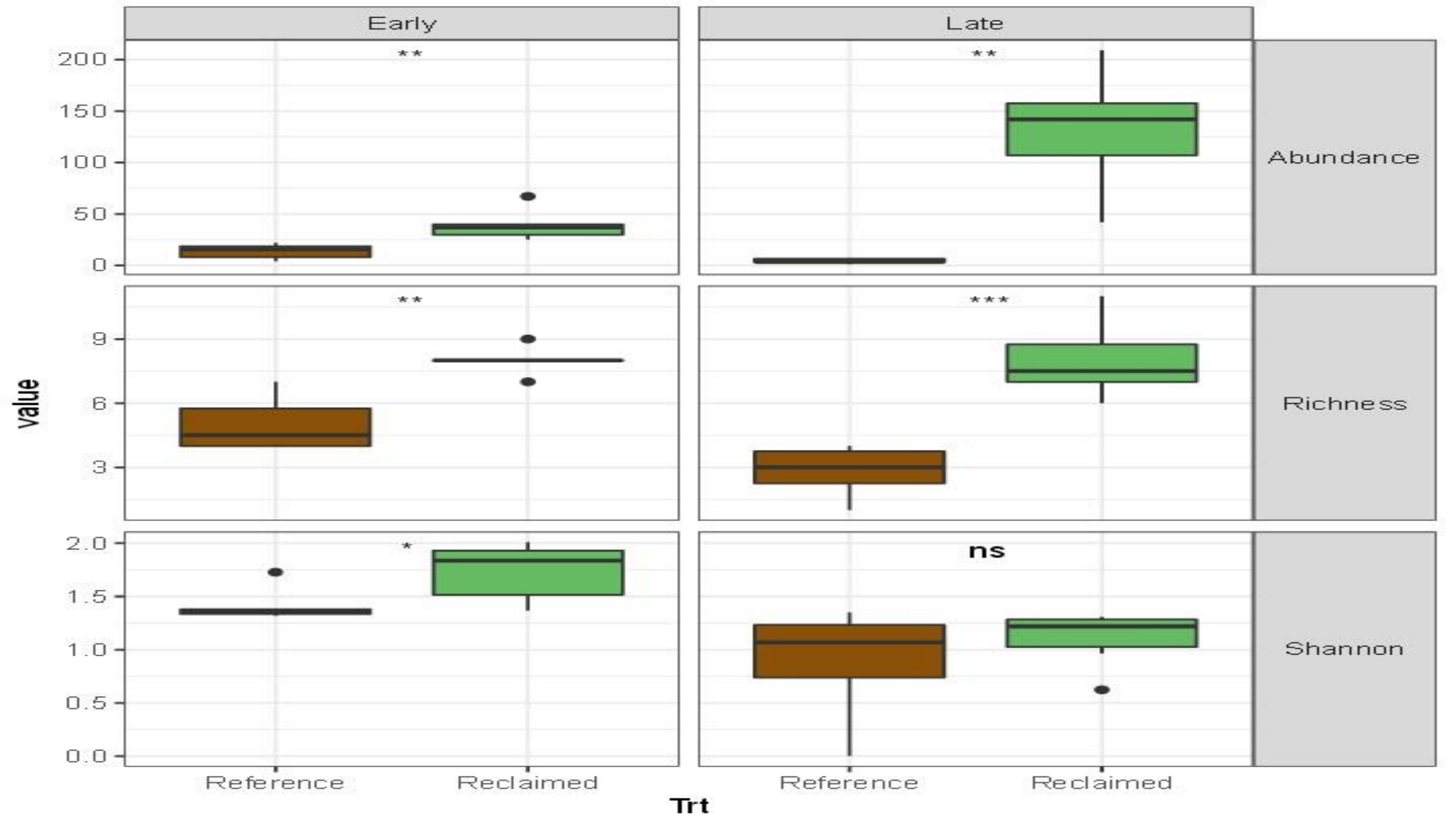

2015
Acari *
Araneae *
Coleoptera
Diptera
Hemiptera
Hymenoptera
Orthoptera
Acari
Philodromidae
Salticidae
Thomisidae
Chrysomelidae
Anthomyiidae
Asilidae
Bombyliidae
Chironomidae
Chloropidae
Dolichopodidae
Muscidae
Otitidae
Pipunculidae
Sarcophagidae
Sepsidae
Therevidae
Cercopidae
Cicadellidae
Cicadidae
Lygaeidae
Miridae
Nabidae
Apidae
Braconidae
Chalcididae
Formicidae
Halictidae
Ichnumonidae
Megachilidae
Pompilidae
Scelionidae
Vespidae
Acrididae
Count
0
50
100
150
value
Site Type
BeePlant Treatment
BeePlant Reference
Grass Treatment
Grass Reference

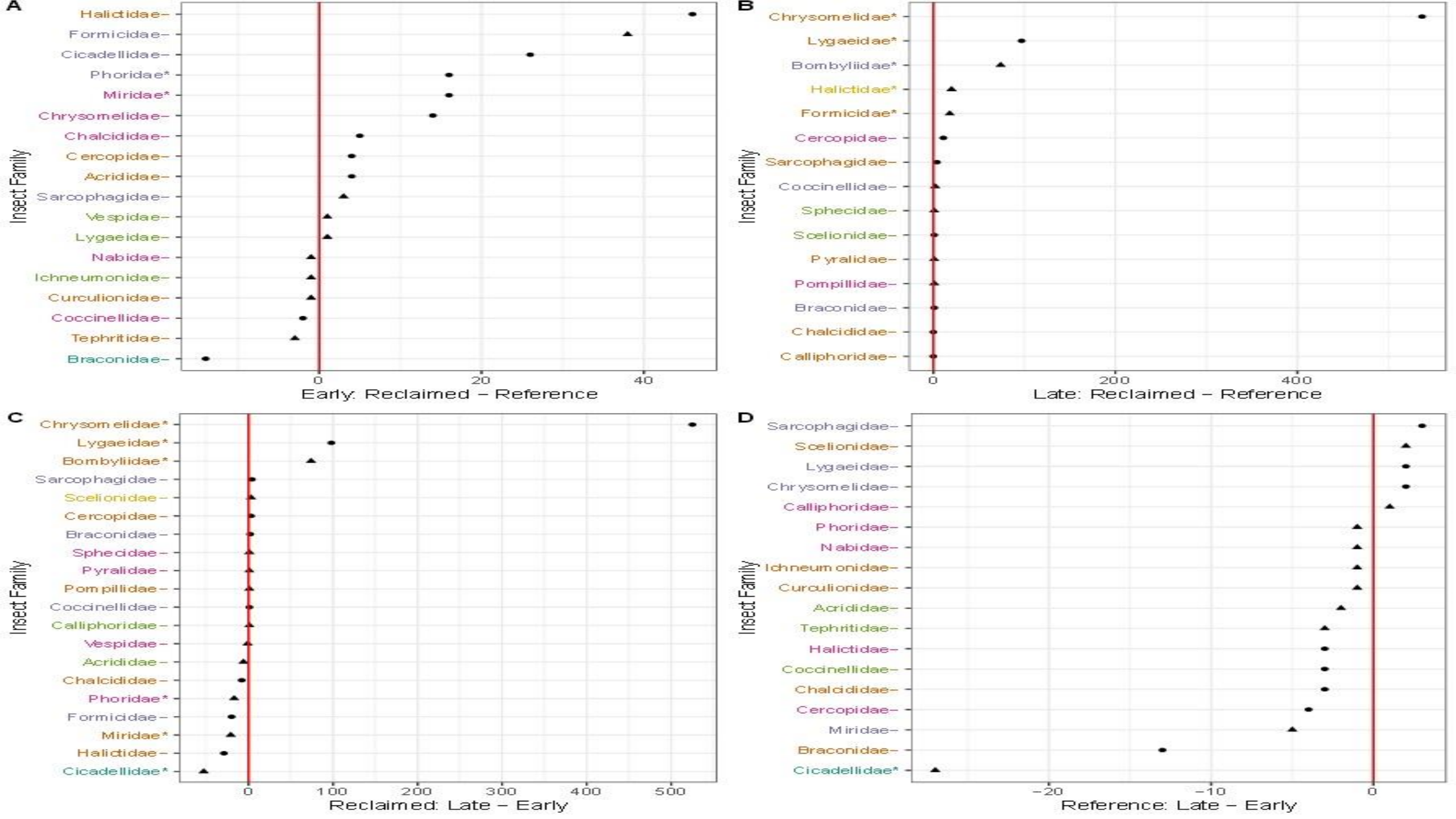

2016
Coleoptera
Chrysomelidae
Coccinellidae
Diptera
Anthomyiidae
Calliphoridae
Muscidae
Sarcophagidae
Sepsidae
Hemiptera
Cicadellidae
Lygaedae
Miridae
Hymenoptera
Apidae
Chalcididae
Formicidae
Halictidae
Ichnumonidae
Vespidae
Orthoptera
Acrididae
Count
0
100
200
value
Site Type
BeePlant Treatment
BeePlant Reference
Grass Treatment
Grass Reference

Conclusions of Study

- More insects on reclaimed sites
- Reclaimed sites with flowering plants contained more insects than reclaimed sites with only grass
  - 12x more pollinators
- More insects in reference areas adjacent to reclaimed sites with flowers than sites with grass
- Limited to late growing season

- Jonah Field
- Early season vs. late season blooming flowers
  - Early season – mainly yarrow, blue flax, penstemon species
  - Late season – mainly Rocky Mountain bee plant
- Do early season reclamation sites with flowering plants contain more insects than reference areas?
- Do late season reclamation sites with flowering plants contain more insects than reference areas?


Early
Late
Abundance
Richness
Shannon
**
**
**
***
*
ns
200
150
100
50
0
9
6
3
2.0
1.5
1.0
0.5
0.0
value
Reference
Reclaimed
Reference
Reclaimed
Trt


A
Halictidae–
Formicidae–
Cicadellidae–
Phoridae*
Miridae*
Chrysomelidae–
Chalcididae–
Cercopidae–
Acrididae–
Sarcophagidae–
Vespidae–
Lygaeidae–
Nabidae–
Ichneumonidae–
Curculionidae–
Coccinellidae–
Tephritidae–
Braconidae–
Insect Family
0
20
40
Early: Reclaimed − Reference
B
Chrysomelidae*
Lygaeidae*
Bombyliidae*
Halictidae*
Formicidae*
Cercopidae–
Sarcophagidae–
Coccinellidae–
Sphecidae–
Scelionidae–
Pyralidae–
Pompillidae–
Braconidae–
Chalcididae–
Calliphoridae–
Insect Family
0
200
400
Late: Reclaimed − Reference
C
Chrysomelidae*
Lygaeidae*
Bombyliidae*
Sarcophagidae–
Scelionidae–
Cercopidae–
Braconidae–
Sphecidae–
Pyralidae–
Pompillidae–
Coccinellidae–
Calliphoridae–
Vespidae–
Acrididae–
Chalcididae–
Phoridae*
Formicidae–
Miridae*
Halictidae–
Cicadellidae*
Insect Family
0
100
200
300
400
500
Reclaimed: Late − Early
D
Sarcophagidae–
Scelionidae–
Lygaeidae–
Chrysomelidae–
Calliphoridae–
Phoridae–
Nabidae–
Ichneumonidae–
Curculionidae–
Acrididae–
Tephritidae–
Halictidae–
Coccinellidae–
Chalcididae–
Cercopidae–
Miridae–
Braconidae–
Cicadellidae*
Insect Family
−20
−10
0
Reference: Late − Early

Conclusions

- Early season reclamation sites contained 2.82x more insects than reference areas
- Late season reclamation sites contained 21.45x more insects than reference areas
- More insect abundance in late season, though insect diversity was comparable across study times

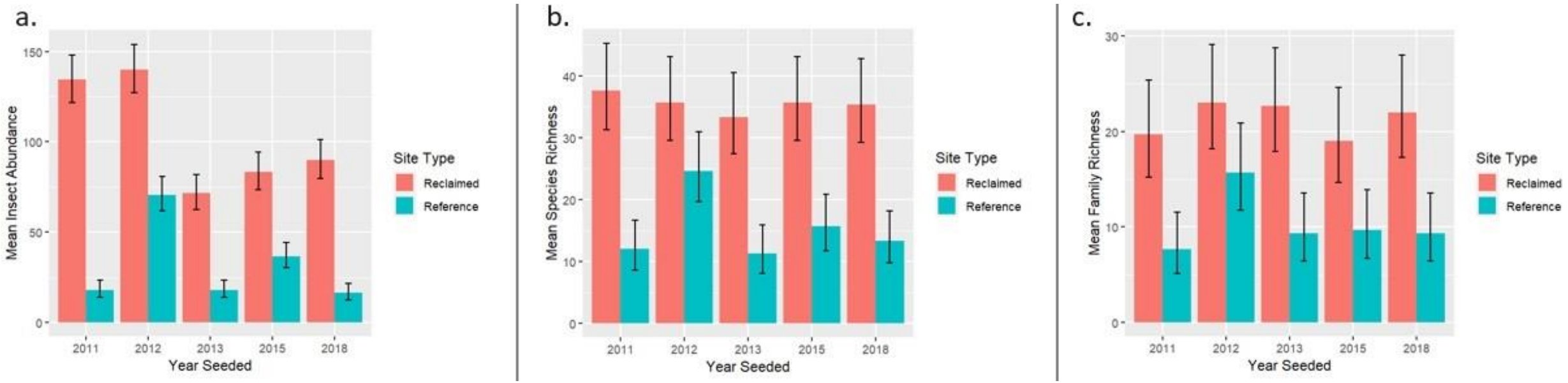
diversity

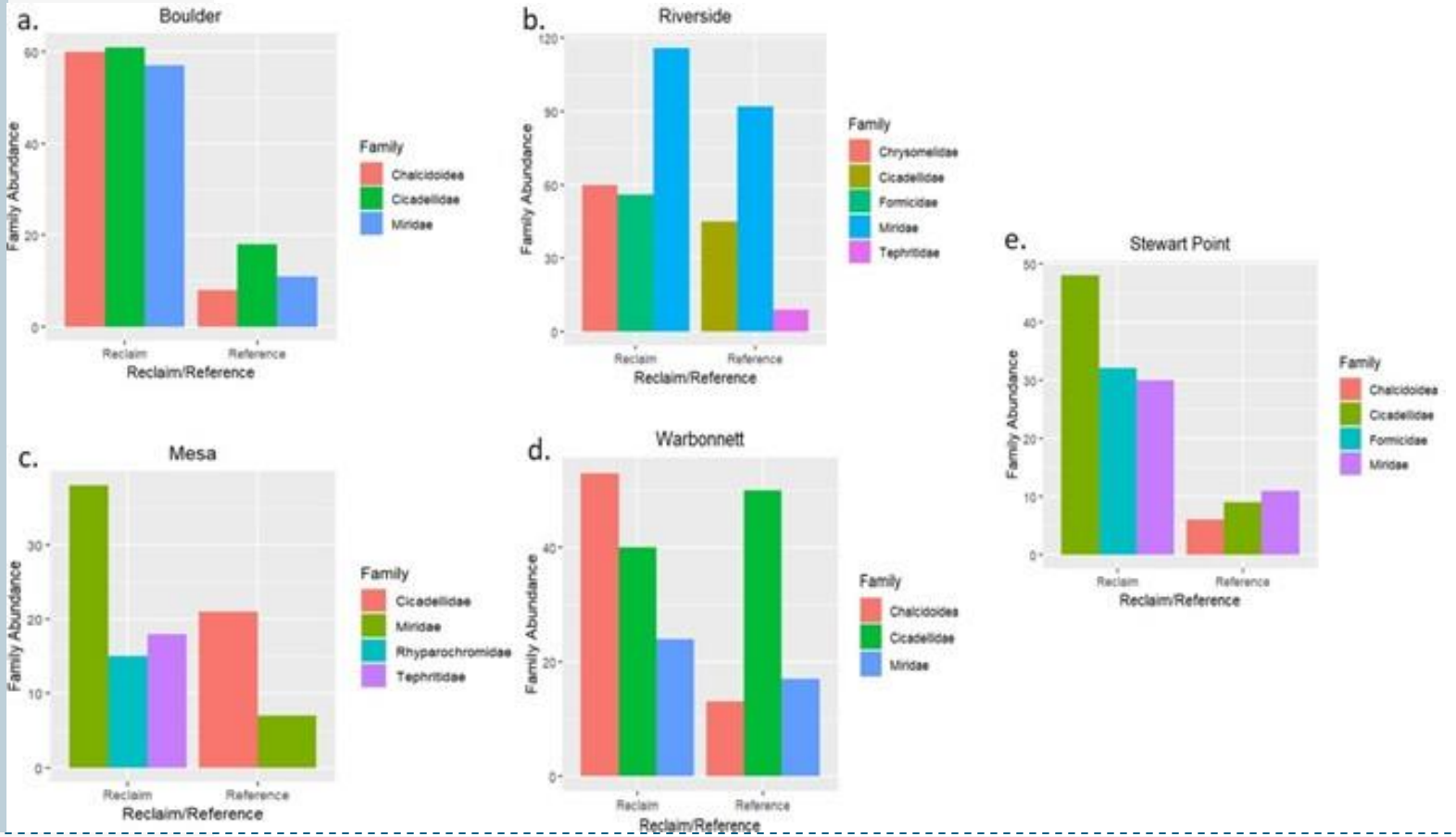
MDPI

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]

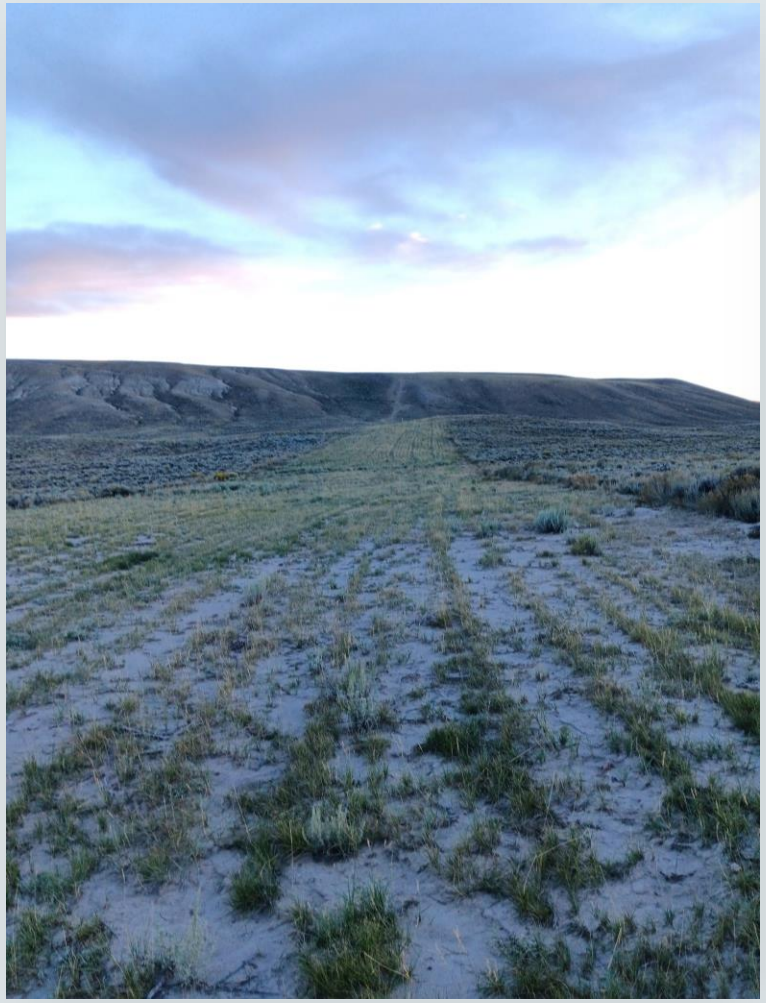


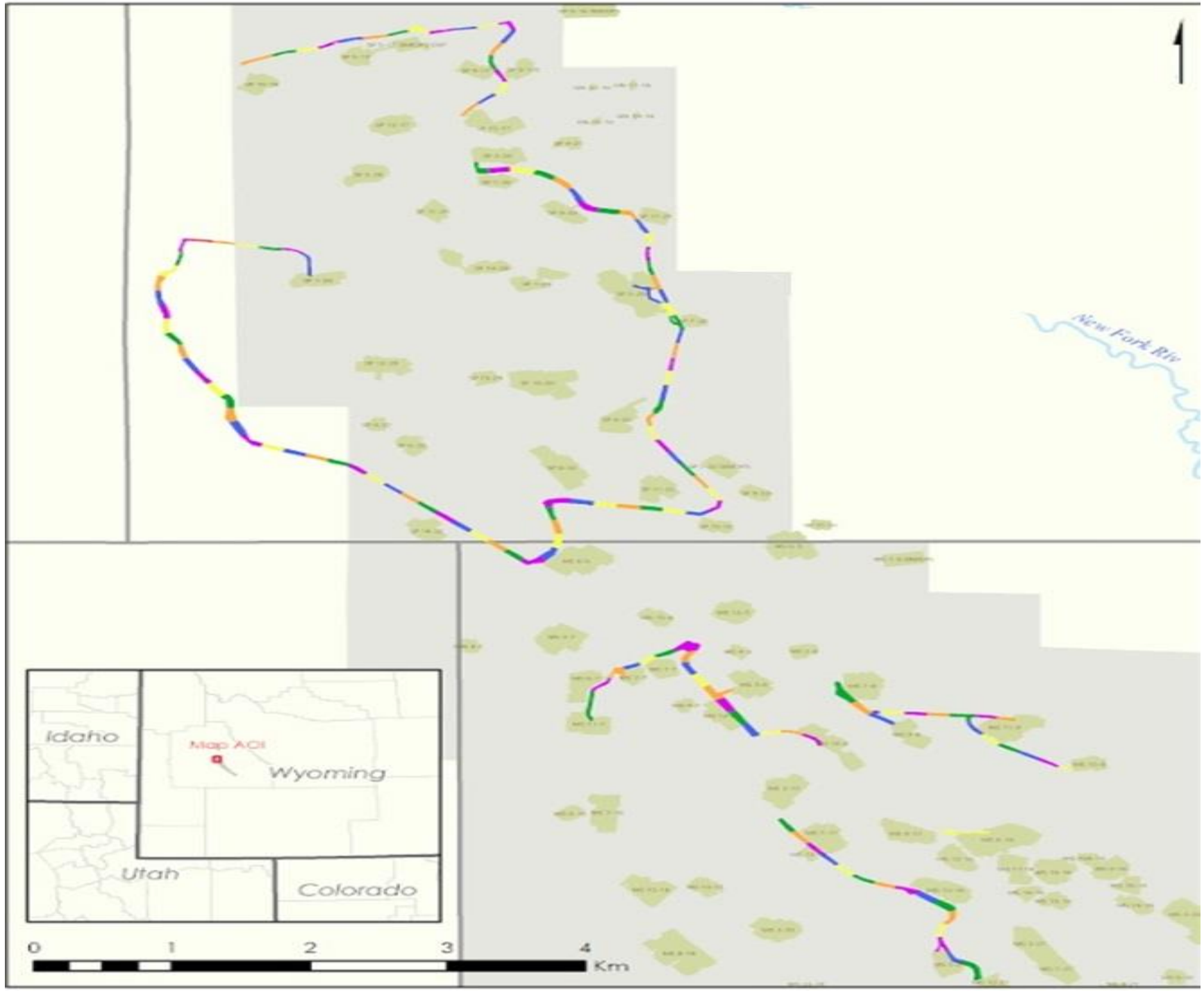


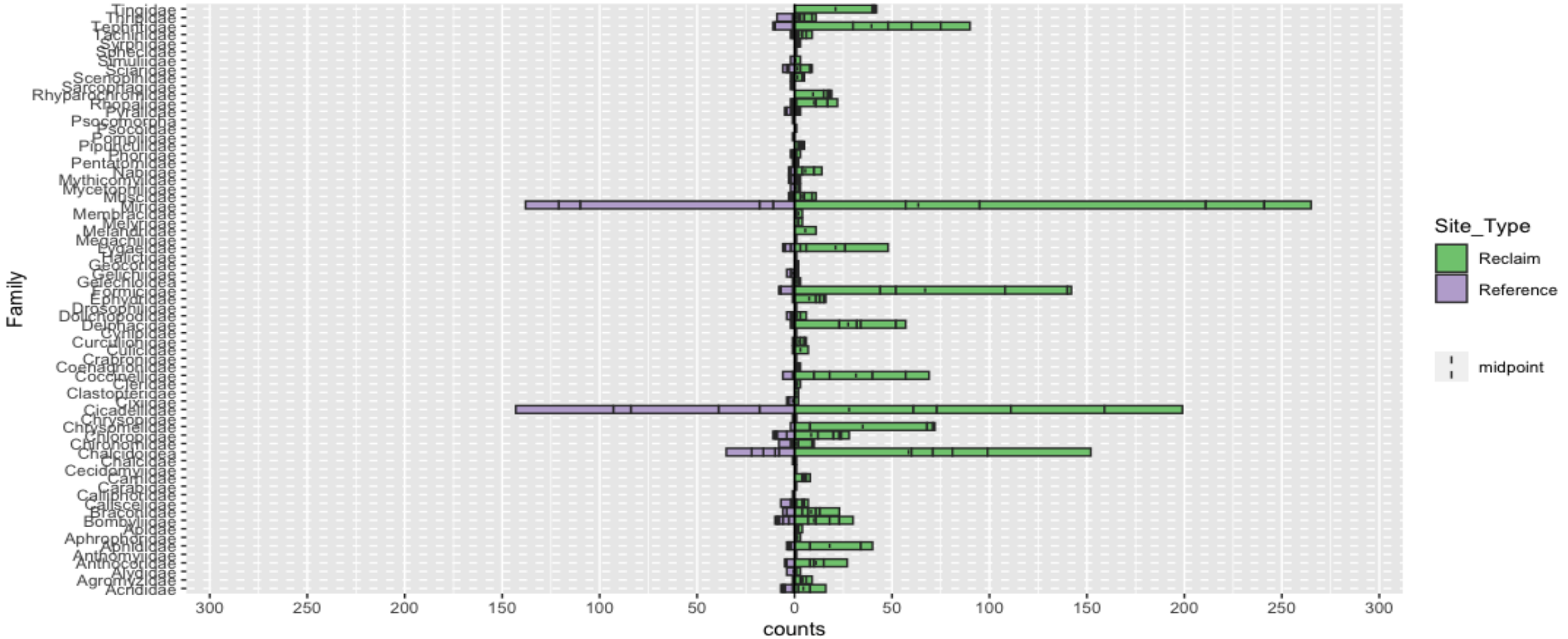
Summary Stats

- A total of 2036 individual insects representing 270 species from 71 families across 11 orders were identified across this study. A total of 1557 individuals (76.5%) were found on reclamation sites, whereas 479 (23.5%) were found in reference areas across the entire study. A total of 233 species (86.3% of total) were found on reclamation sites, whereas 121 species (44.8% of total) were found in reference areas across the entire study. A total of 67 families (94.4% of total) were found on reclamation sites, whereas 45 families (63.4% of total) were found in reference areas across the entire study.

What’s going on across the pipeline?




New Fork Riv
Idaho
Map AOI
Wyoming
Utah
Colorado
0
1
2
3
4
Km


Family
Tingidae
Thripidae
Tephritidae
Tachinidae
Syrphidae
Sphecidae
Simuliidae
Sciaridae
Scenopinidae
Sarcophagidae
Rhyparochromidae
Rhopalidae
Pyralidae
Psocomorpha
Psocidae
Formicidae
Ephydridae
Drosophilidae
Dolichopodidae
Delphacidae
Cynipidae
Curculionidae
Culicidae
Crabronidae
Coenagrionidae
Coccinellidae
Cicadellidae
Chrysopidae
Chrysomelidae
Chloropidae
Chironomidae
Chalcidoidea
Chalcidae
Cecidomyiidae
Camidae
Carabidae
Calliphoridae
Calliscelidae
Braconidae
Bombyliidae
Apidae
Aphrophoridae
Aphididae
Anthomyiidae
Anthocoridae
Alydidae
Agromyzidae
Acrididae
300
250
200
150
100
50
0
50
100
150
200
250
300
counts
Site_Type
Reclaim
Reference
midpoint

Conclusions

- Estabishing diverse, native vegetation communities on well pads and pipeline ROWs may have many benefits
  - Increased native plant propagules throughout the landscape
  - Increased terrestrial insect abundance
  - More functional and resilient ecosystems
- We are doing this at 7000-8000 feet, with little precipitation and devoid a growing season…. Just imagine if others took note!

Thank you!

- ASRS
- Contributors
  - Jasmine Allison
  - Bobby Saleh
  - Ellie Murphy
  - Josh Sorenson
  - Bee Bott
  - Steve Bower
  - Tim Robinson
  - Blair Robertson
  - Alex Knudson

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