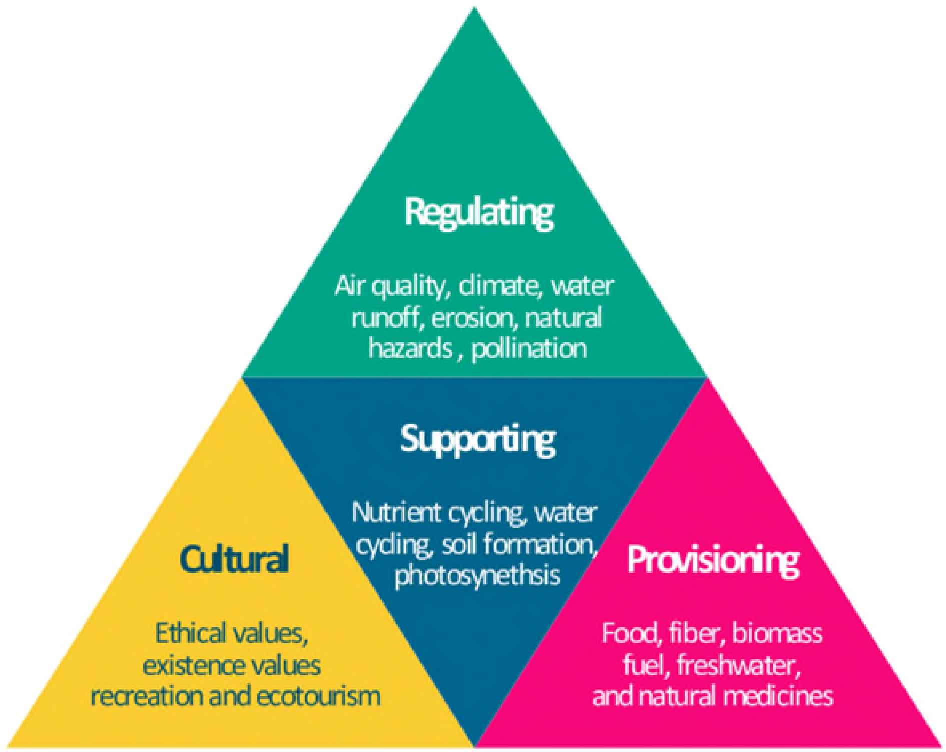
Ecological Restoration for Insect Conservation within Natural Gas Fields

Michael Curran, PhD, CERP

Josh Sorenson, Tim Robinson, Taylor Crow, Zoe Craft, Bee Bott

Ecosystem Services

- 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



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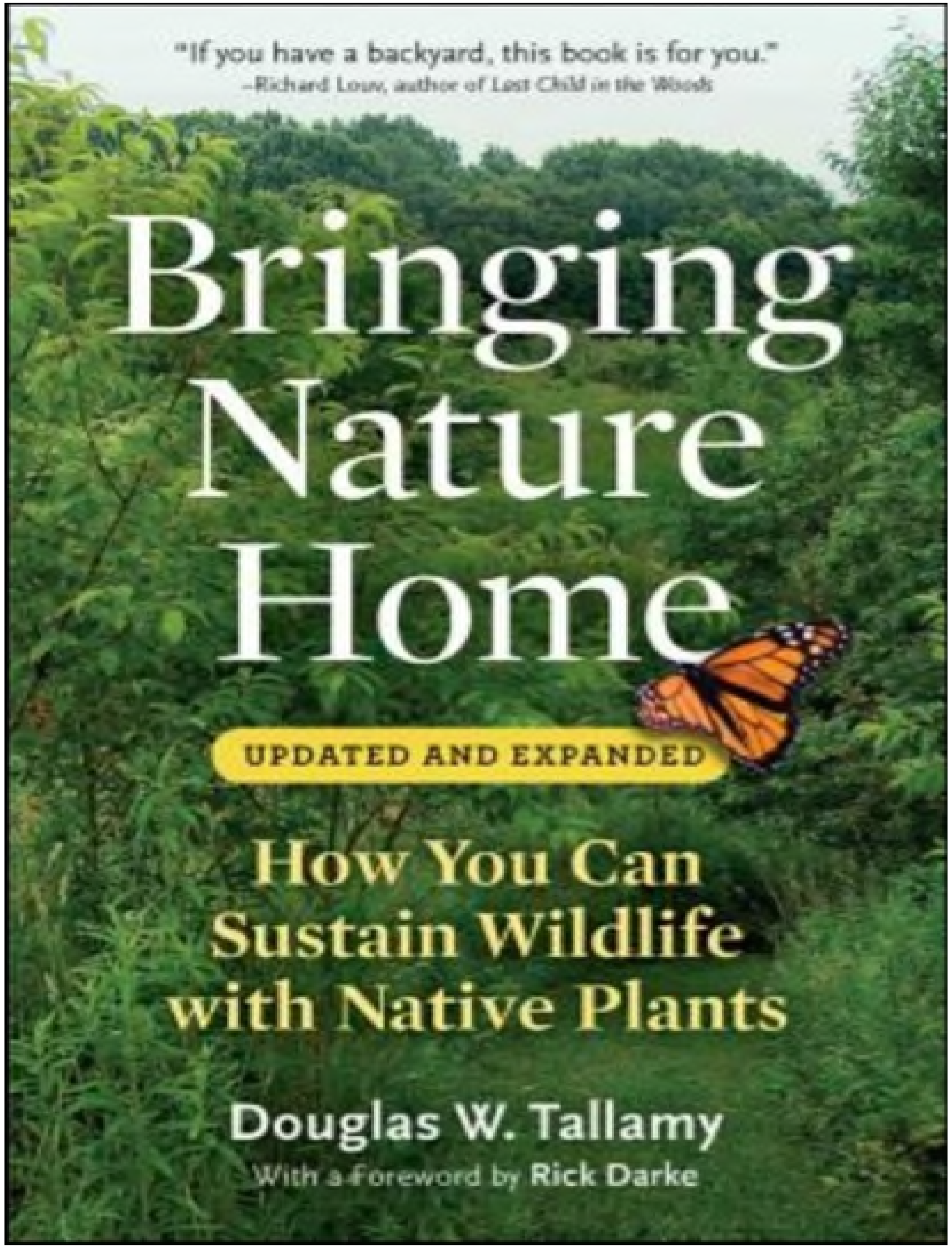

Douglas W. Tallamy
Professor of Entomology and Wildlife Ecology
Verified email at udel.edu - Homepage
insect ecology

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 Tallamy, 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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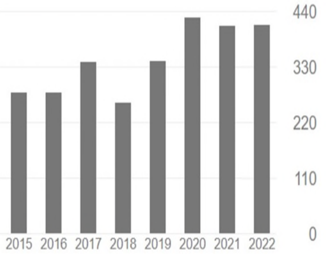

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JOURNAL ARTICLE

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

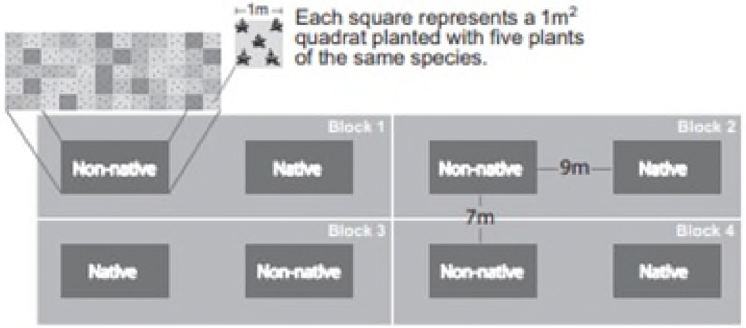
Arthropod Communities on Native and Nonnative Early Successional Plants

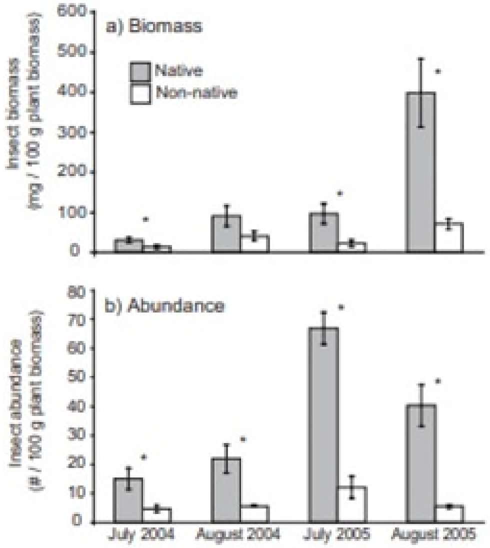
MEG BALLARD,[1] JUDITH HOUGH-GOLDSTEIN,[1,2] AND DOUGLAS TALLAMY[1]

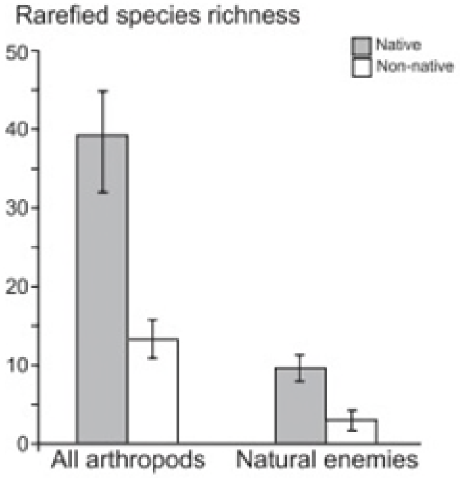
Non-native plants reduce abundance, richness, and host specialization in lepidopteran communities

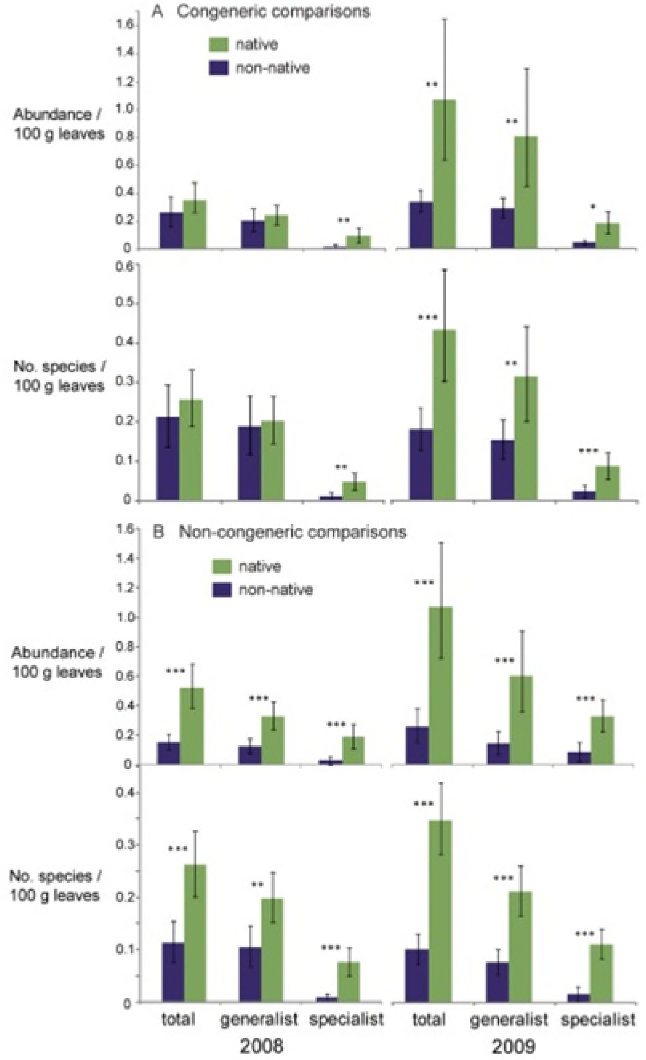
Karin T. Burghardt,[1,†] Douglas W. Tallamy, Christopher Philips,[2] and Kimberley J. Shropshire

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

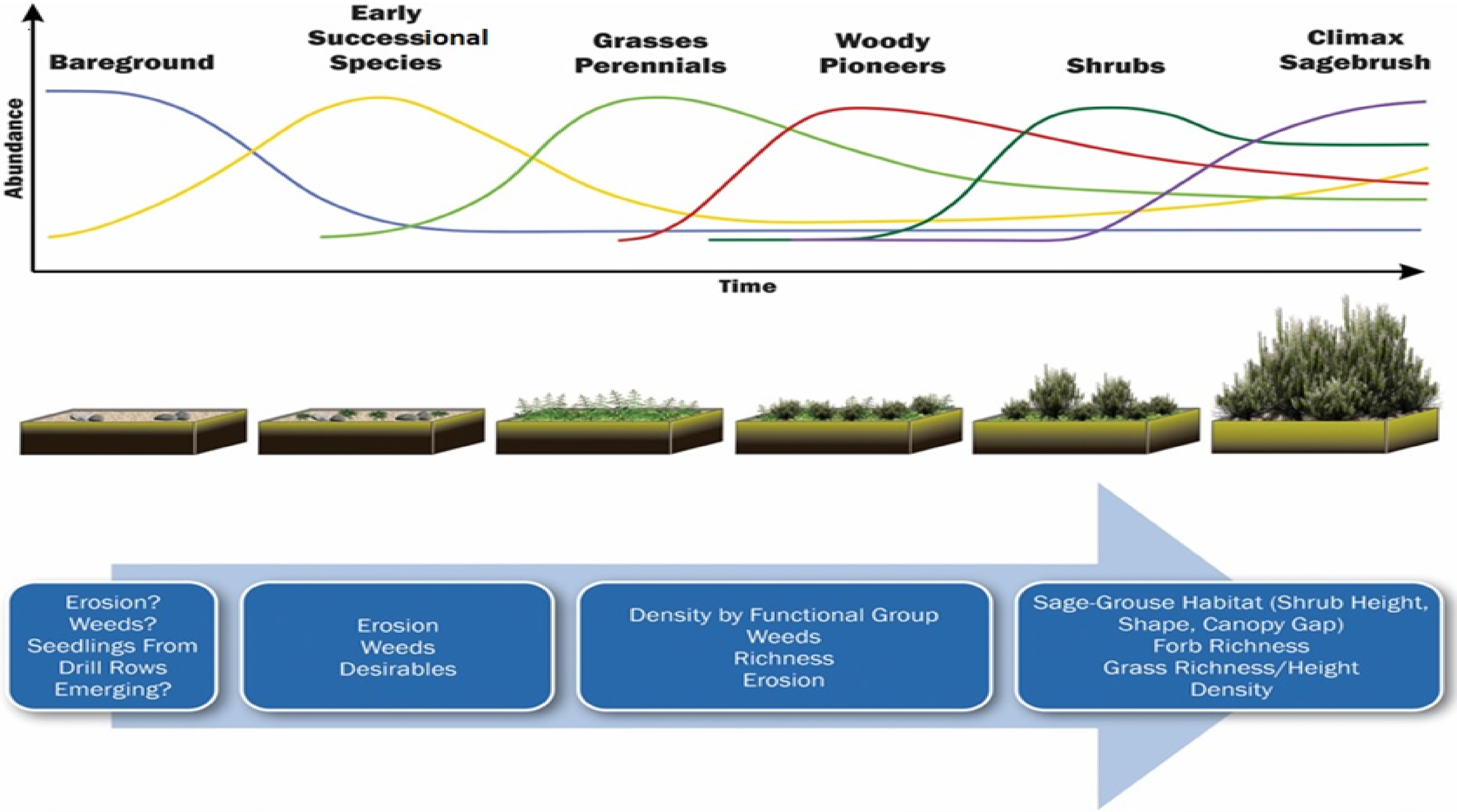








Restoration as Assisted Succession – Western US



Why Insects?

- Insects are the most diverse and abundant animals on Earth
- Insects are wildlife
- Insects provide more ecosystem services than other animals
  - Pollination services
  - Food sources for higher trophic levels
    - ~96% of terrestrial birds rear their young solely or primarily on insects
  - Nutrient Cycling
  - Biological Control
  - Genetic Diversity
- Insects can be used as indicators of a functional ecosystem

Information about Insects from previous literature

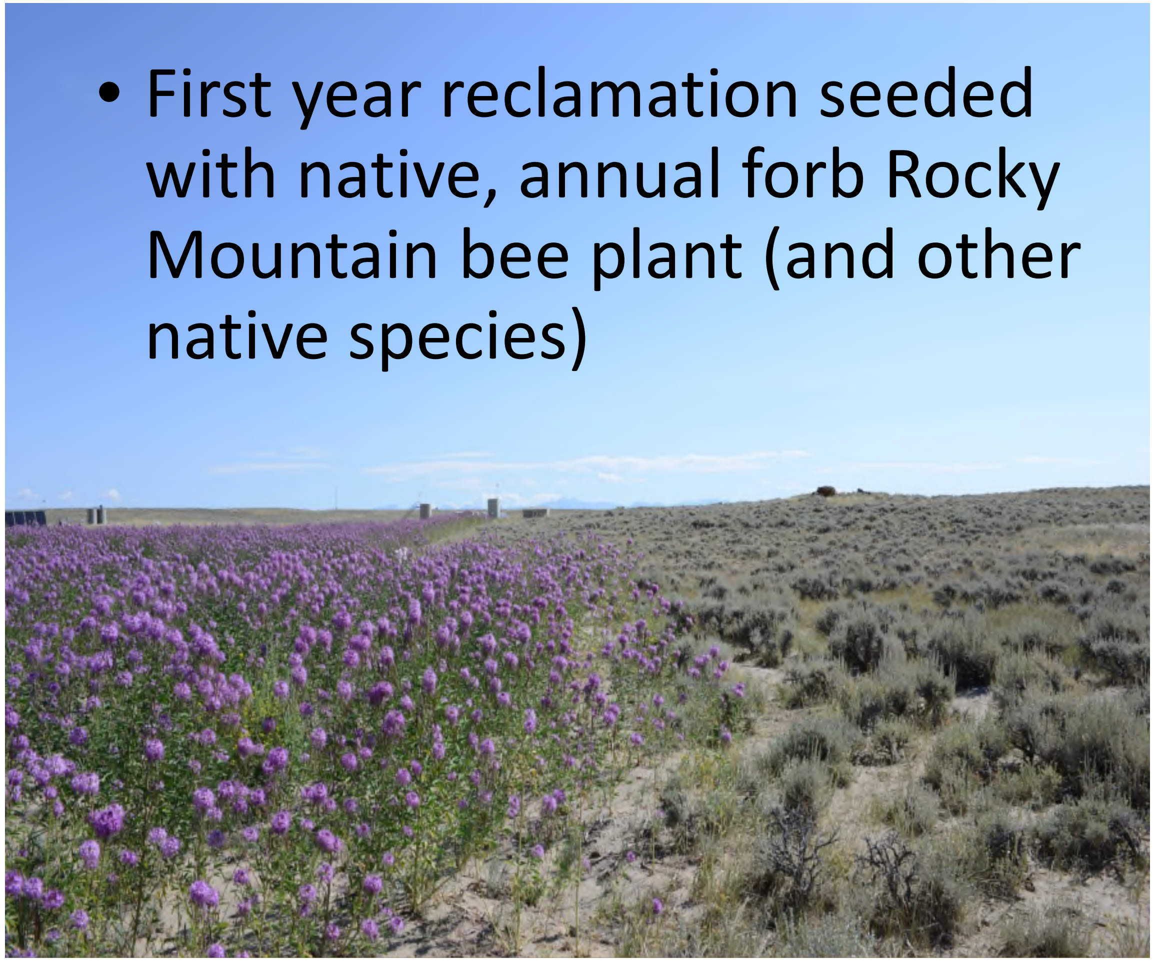
- Plant-vigor hypothesis (Price 1991)
- Mass-flowering hypothesis (Westphal et al. 2003)
- Many insects avoid terpenoids (produced by old sagebrush) and very few insect families eat wood
- Not much is known about wild pollinators in rangelands (Harmon 2011)
  - **Estimated >75% of plants require or benefit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

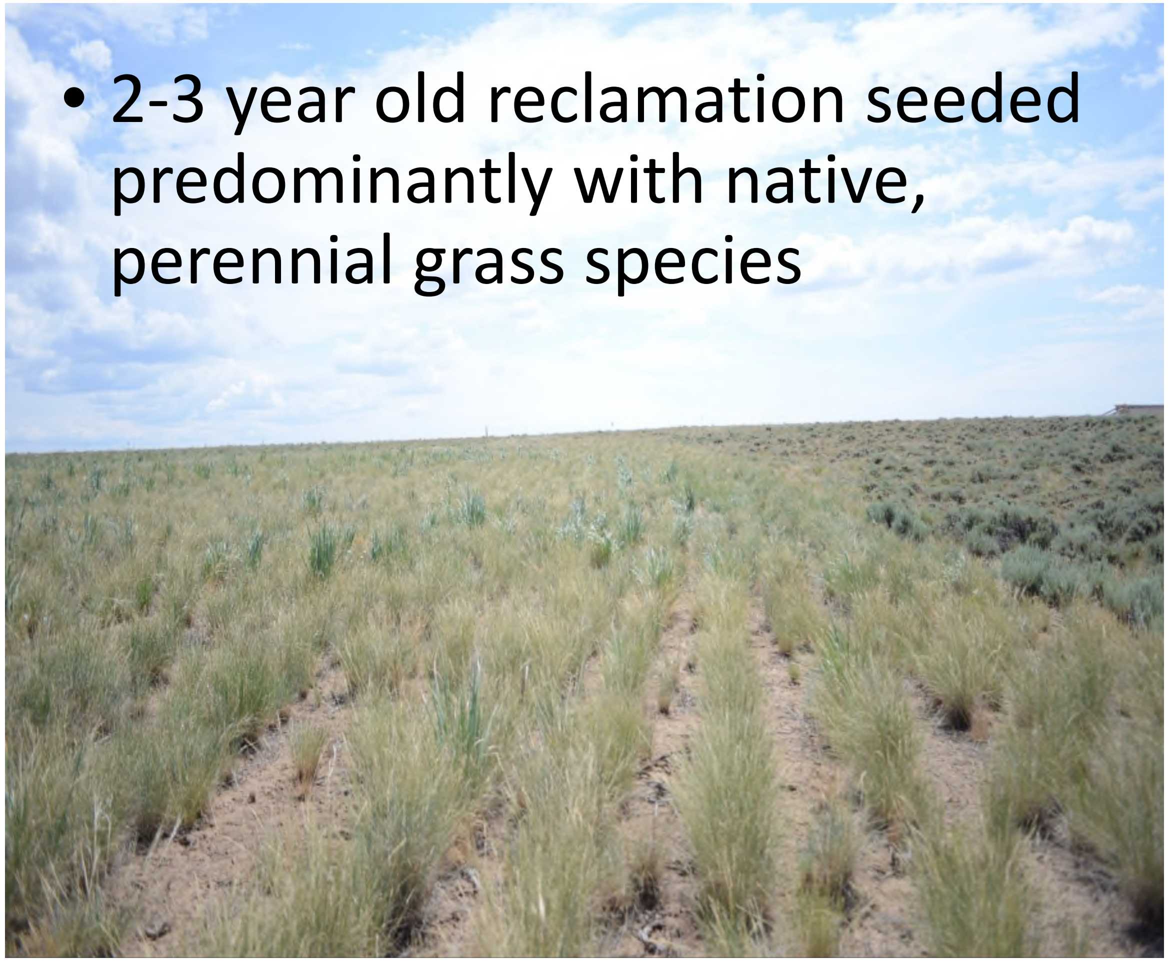
land MDPI

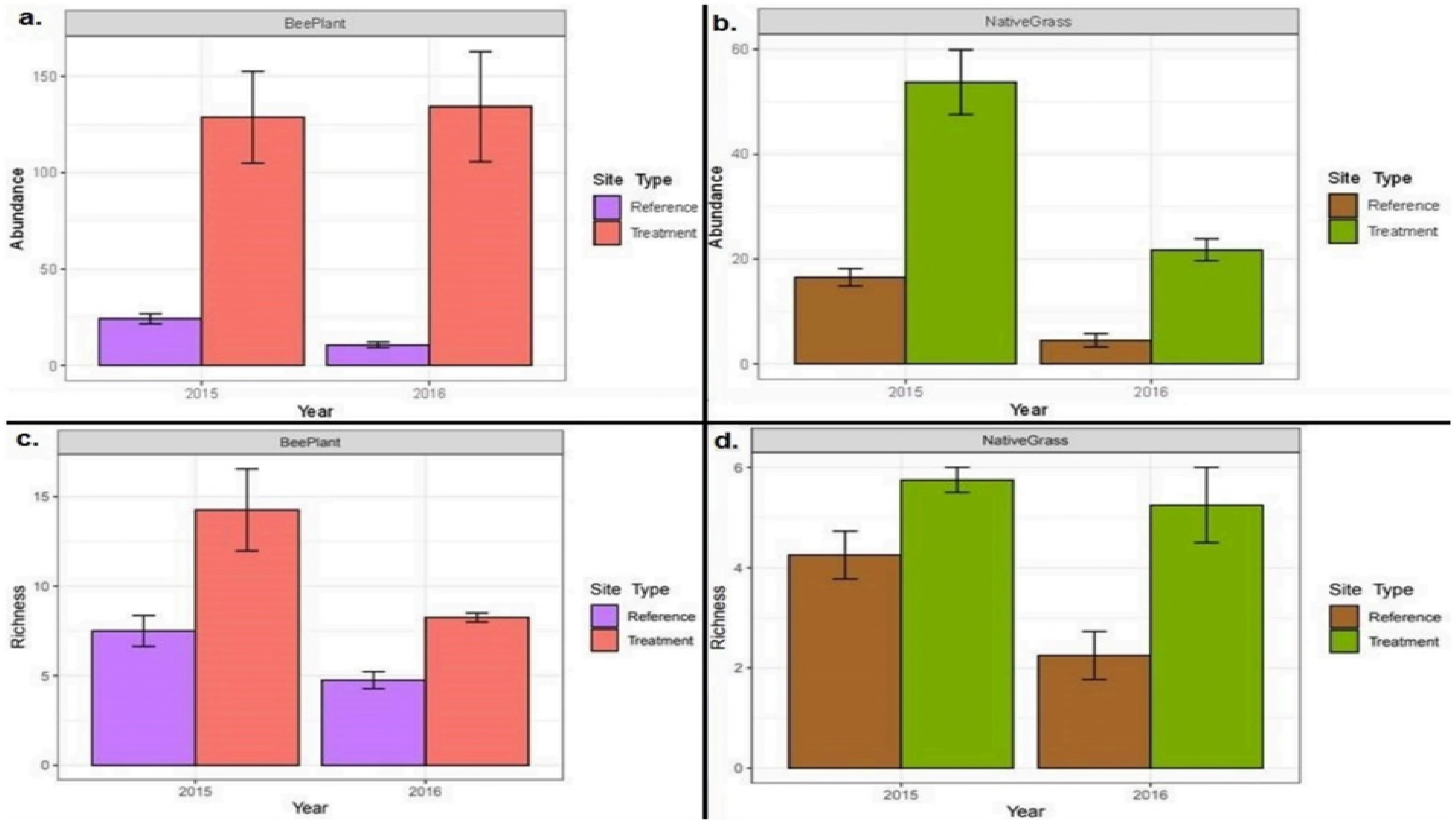
Article

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]







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BeePlant
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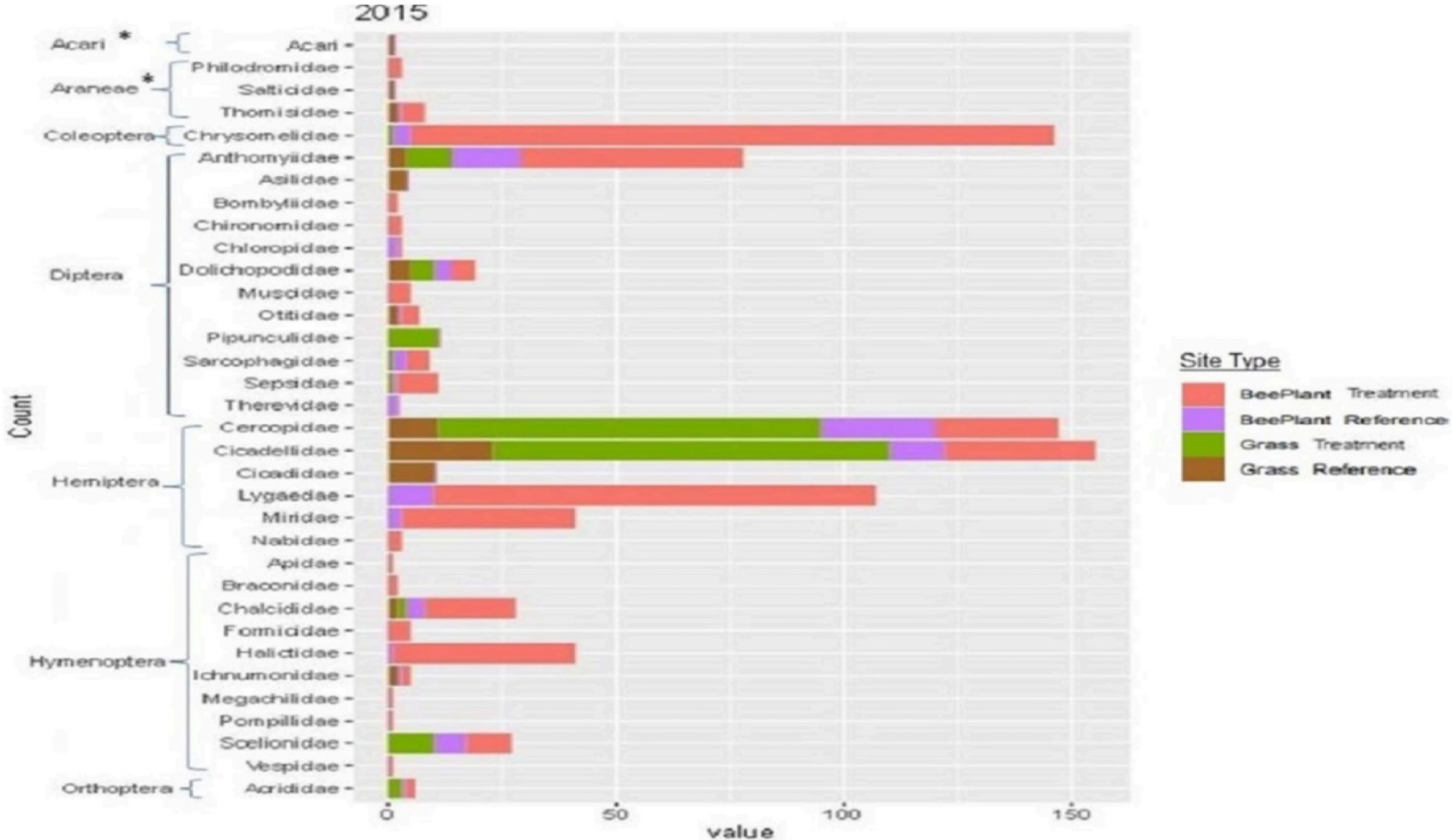

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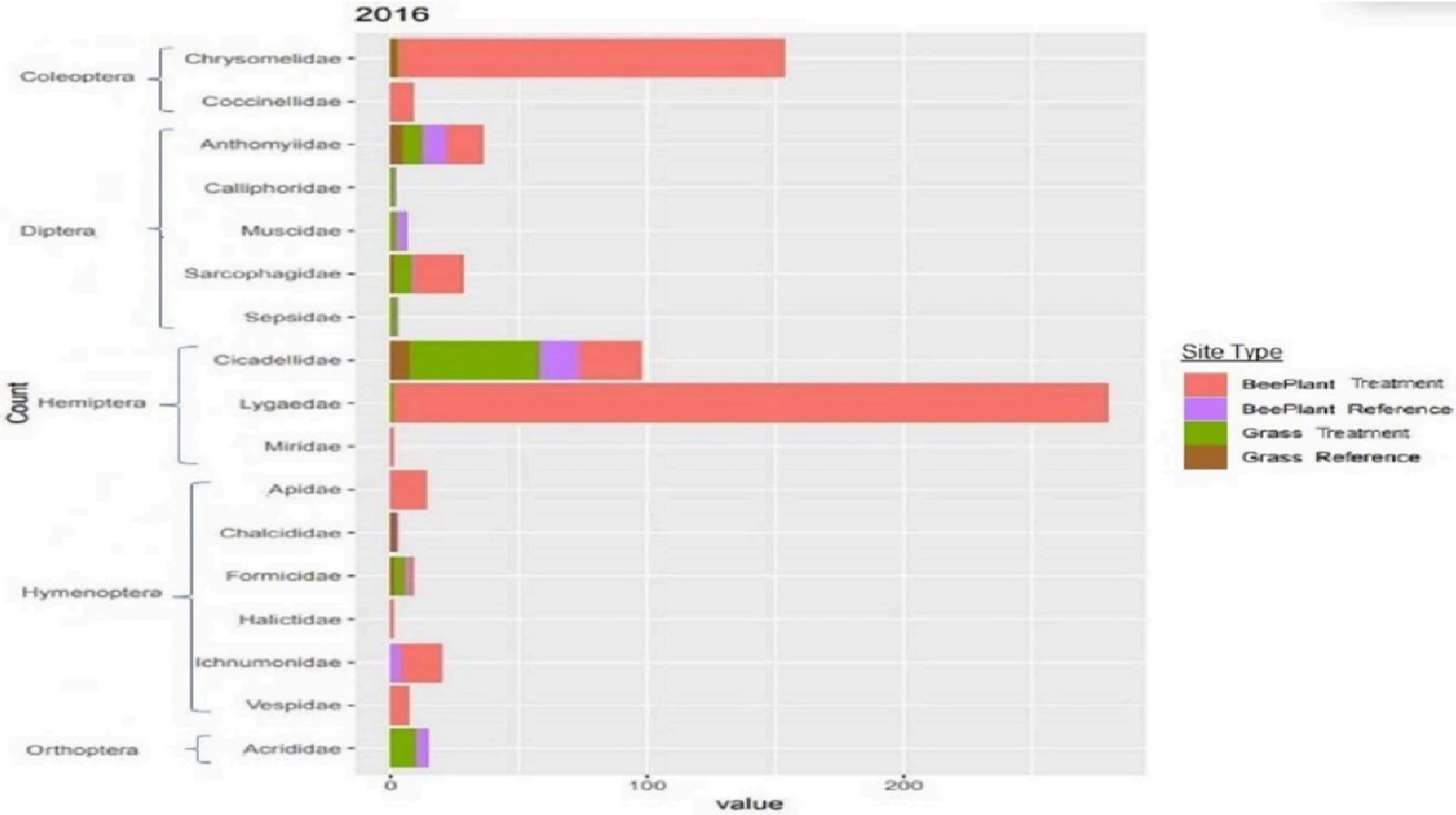

2016
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Lygaedae
Miridae
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Apidae
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Formicidae
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Ichnumonidae
Vespidae
Orthoptera
Acrididae
Count
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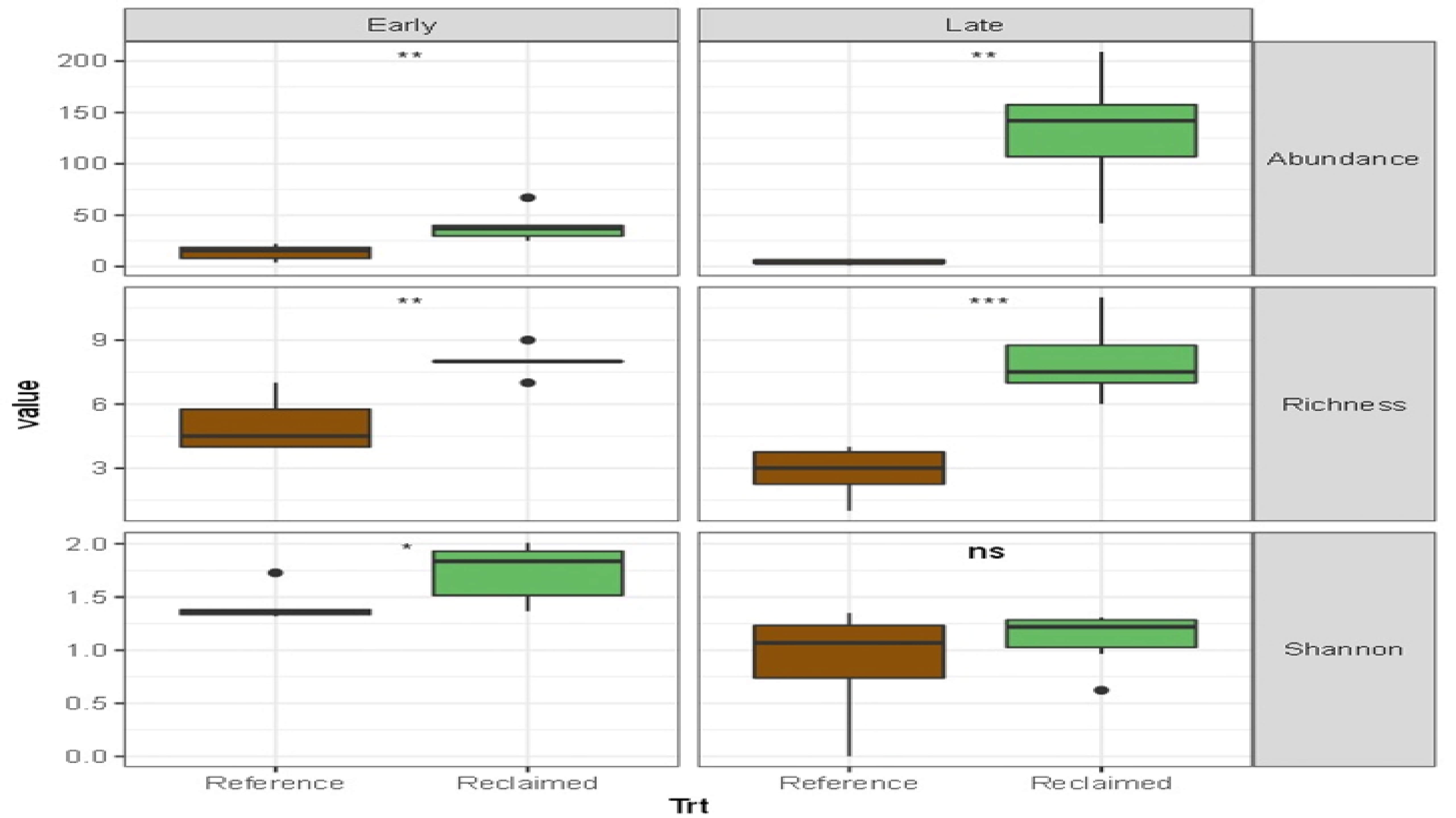
Site Type
BeePlant Treatment
BeePlant Reference
Grass Treatment
Grass Reference

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

Follow-up Study

- 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?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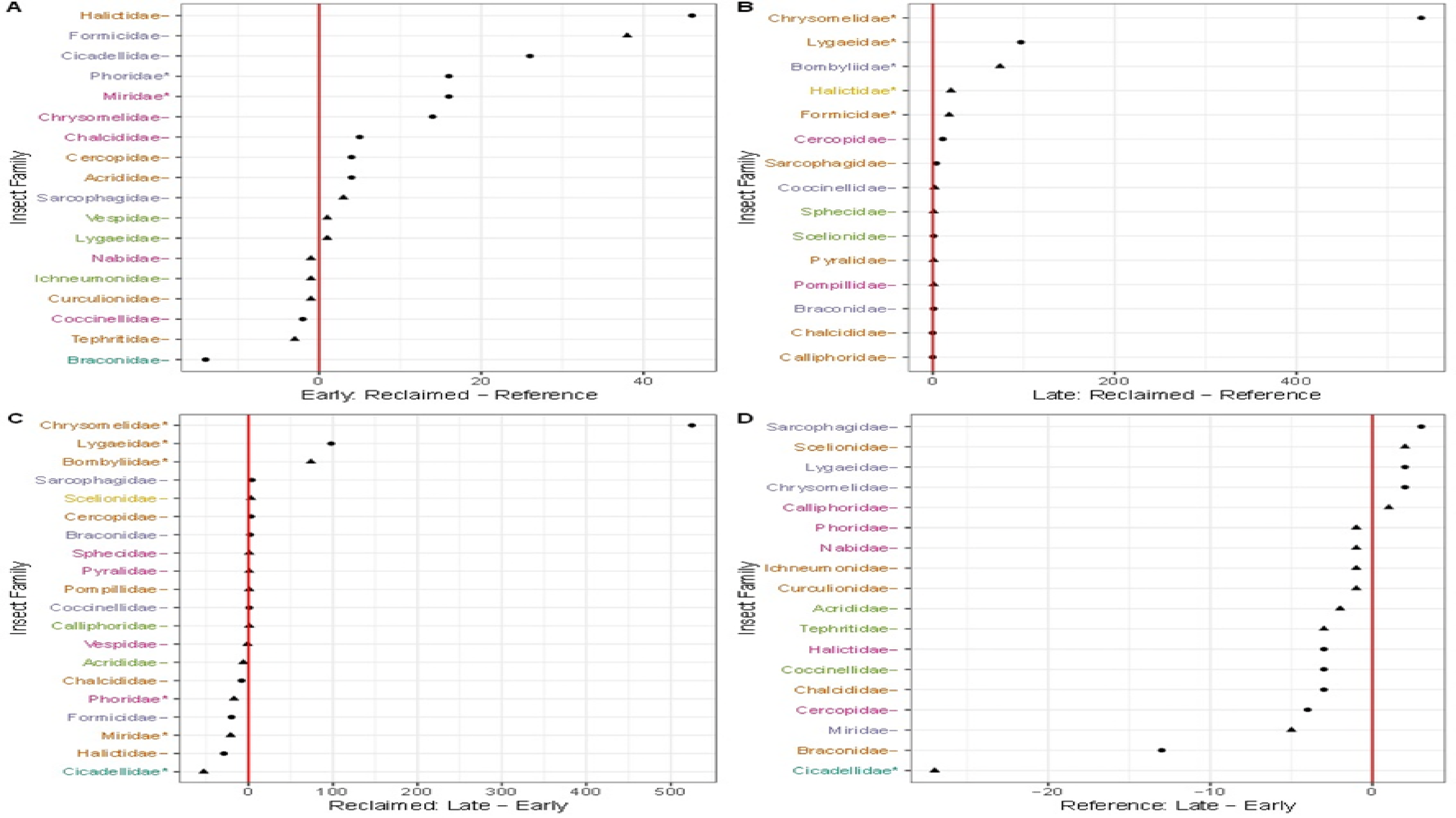
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Reference: Late – Early

Conclusions

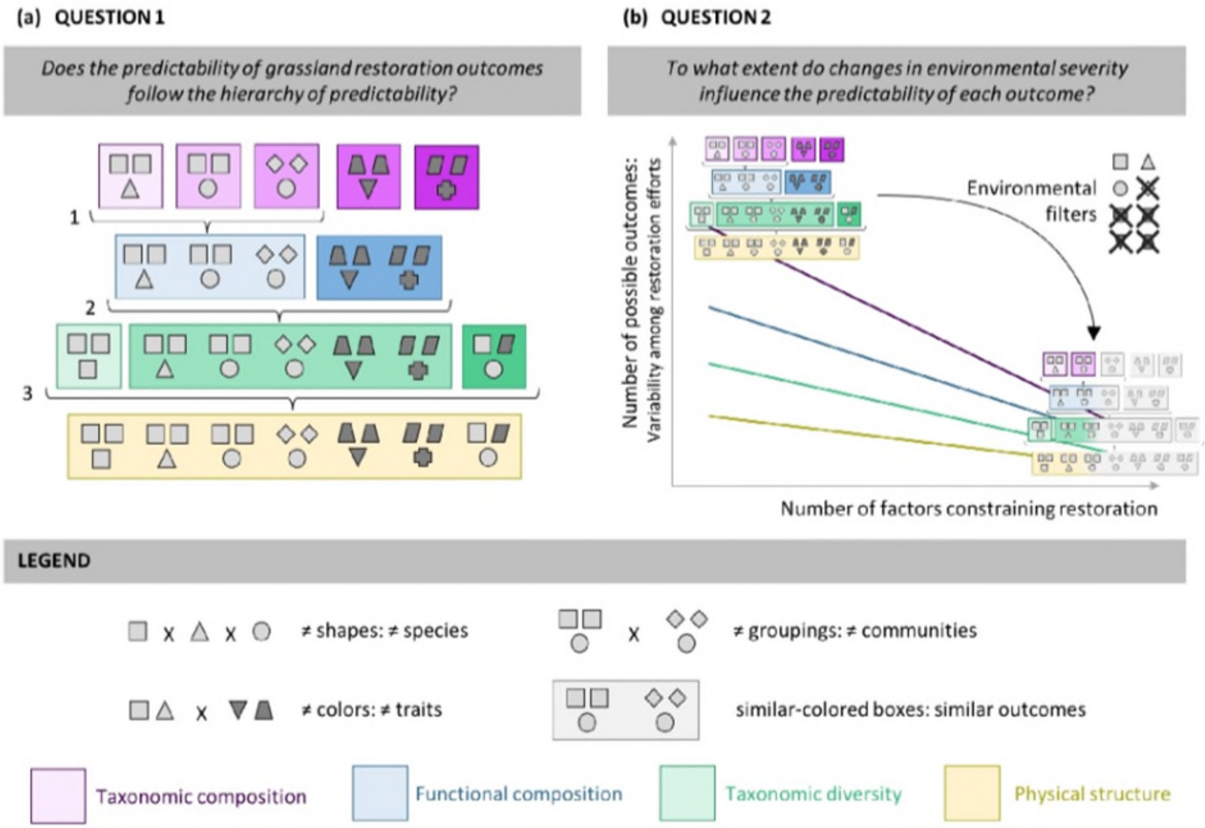
- Early season reclamation sites contained 2.82x more insects than reference areas
- Late season reclamation sites contained 21.45x more insects than reference areas
- More insect abundance in late season, though insect diversity was comparable across study times

Take Home Message & Implications

- Insects respond favorably to reclamation efforts when:
  - Native plants become established
  - Native flowering plants are abundant
- Utilizing diverse seed mixes, especially those which contain flowering plants blooming throughout the growing season, not only has potential to improve vegetation diversity, but also has positive benefits on insect/pollinator diversity and it is likely to benefit higher trophic levels
  - 96% of terrestrial birds rear their young solely or primarily on insect protein
  - Insects beneficial to other wildlife
  - Establishing plant-pollinator interactions is of utmost important to reclamation and likely can benefit surrounding areas
- ESG calls for diversity
  - Insects, the most abundant and diverse animals on Earth, are a low-hanging fruit

Next Steps

- Can we use this data to improve reclamation practices for endangered species and wildlife?



Bertuol-Garcia, Ladoucuer, Brudvig, Laughlin, Munson, Davies, Svejcar, Shackelford – Testing the hierarchy of predictability in grassland restoration across a gradient of environmental severity

Sage-grouse Diet

Survival of greater sage-**grouse** chicks and broods in the northern Great Basin
MA Gregg, JA Crawford - The Journal of Wildlife Management, 2009 - Wiley Online Library
… **insect** abundance could affect survival because they are the primary **foods** of sage-**grouse** … , growth, and development (**Klebenow** and **Gray** 1968, Peterson 1970, Johnson and Boyce …
Save Cite Cited by 109 Related articles All 8 versions

Long-term effects of fire on sage **grouse** habitat
PJ Nelle, KP Reese, JW Connelly - 2000 - repository.arizona.edu
… Brood-rearing habitat must provide forbs and **insects** for food. Total … the **diet** of sage **grouse** chicks (Patterson 1952, **Klebenow** and **Gray** 1968, Peterson 1970), and the amount of **insects** …
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Sagebrush, greater sage-**grouse**, and the occurrence and importance of forbs
VE Pennington, DR Schlaepfer, JL Beck… - Western North American …, 2016 - BioOne
… their importance to Greater Sage-**Grouse diets** and habitats, how … and summer, Greater Sage-**Grouse diets** consist of forbs (… **Feeding** trials with **insects** in the **diet** of sage **grouse** chicks. …
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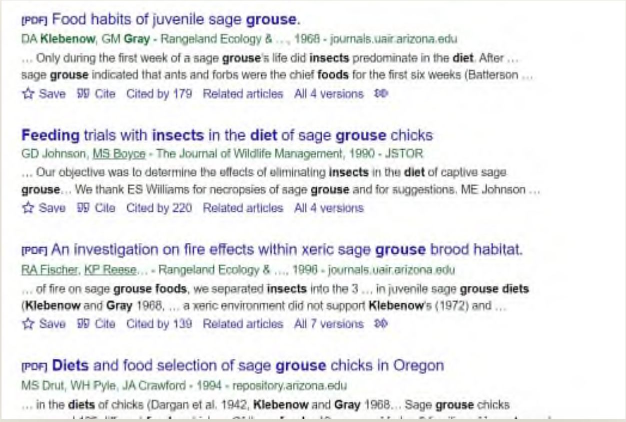

[PDF] Food habits of juvenile sage **grouse**.
DA **Klebenow**, GM **Gray** - Rangeland Ecology & …, 1968 - journals.uair.arizona.edu
… Only during the first week of a sage **grouse**'s life did **insects** predominate in the **diet**. After … sage **grouse** indicated that ants and forbs were the chief **foods** for the first six weeks (Batterson …
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Feeding trials with **insects** in the **diet** of sage **grouse** chicks
GD Johnson, MS Boyce - The Journal of Wildlife Management, 1990 - JSTOR
… Our objective was to determine the effects of eliminating **insects** in the **diet** of captive sage **grouse**… We thank ES Williams for necropsies of sage **grouse** and for suggestions. ME Johnson …
Save Cite Cited by 220 Related articles All 4 versions

[PDF] An investigation on fire effects within xeric sage **grouse** brood habitat.
RA Fischer, KP Reese… - Rangeland Ecology & …, 1996 - journals.uair.arizona.edu
… of fire on sage **grouse foods**, we separated **insects** into the 3 … in juvenile sage **grouse diets** (**Klebenow** and **Gray** 1968, … a xeric environment did not support **Klebenow**'s (1972) and …
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[PDF] **Diets** and food selection of sage **grouse** chicks in Oregon
MS Drut, WH Pyle, JA Crawford - 1994 - repository.arizona.edu
… in the **diets** of chicks (Dargan et al. 1942, **Klebenow** and **Gray** 1968… Sage **grouse** chicks

ELSEVIER
Rangelands
Volume 37, Issue 6, December 2015, Pages 211-216

Original Research

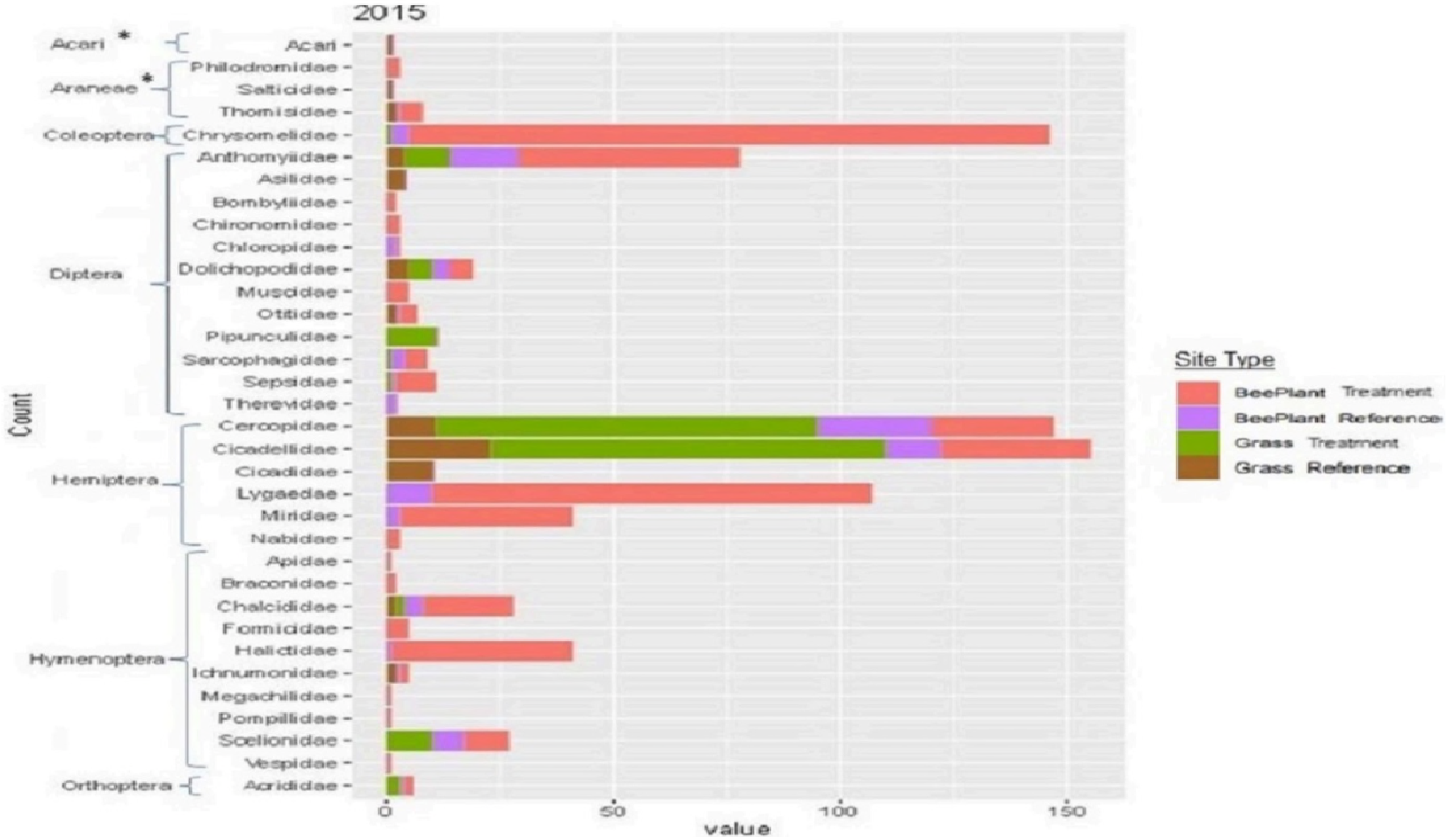
Forbs and Greater Sage-grouse Habitat Restoration Efforts: Suggestions for Improving Commercial Seed Availability and Restoration Practices

Michael F. Curran, Taylor M. Crow, Kristina M. Hufford, Peter D. Stahl

Show more

Food item	Age (weeks)																	
	1st		2nd		3rd		4th		5th		6th		7th		8th–10th		Total	
	(4)		(4)		(2)		(5)		(7)		(9)		(7)		(6)		(44)	
	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency	% volume	% frequency
Forbs																		
Common Yarrow (*Achillea millifolium*)							1	20	tr	14	8	22	2	29	tr	16	2	18
Mountain Dandelion (*Agoseris* sp.)											2	11					tr	2
Loco (*Astragalus convallarius*)			25	75			10	80	1	29	5	33	12	57	tr	33	6	41
Sego Lily (*Calochortus macrocarpus*)							3	40	3	29	9	44	23	43	6	16	10	27
Paintedcup (*Castilleja angustifolia*)	1	25											3	29			1	7
Tapertip Hawksbeard (*Crepis acuminata*)			25	25	tr	50			tr	14							1	7
Prickly Lettuce (*Lactuca serriola*)											6	33			tr	16	1	9
Harkness Gilia (*Linanthus harknessii*)	45	50	12	25			6	40	tr	14	1	22					1	18
Nuttall Monolepis (*Monolepis nuttaliana*)									tr	14	2	11			1	16	tr	5
Phlox (*Phlox longifolia*)			2	25													tr	2
Common Dandelion (*Taraxacum officinale*)			25	25			48	60	88	100	25	67	27	71	57	84	47	61
Goatsbeard (*Tragopogon dubius*)							8	40	2	14	27	56	11	71	7	16	11	32
Shrubs																		
Big Sagebrush (*Artemisia tridentata*)							1	40	1	14	6	22	11	14	14	50	8	20
Threetip Sagebrush (*A. tripartita*)									1	14			1	14			tr	5
Lanceleaf Rabbitbrush (*Chrysothamnus viscidiflorus* var. *lanceolatus*)													1	29			tr	5
Total plant volume	48	75	90	100	14	50	77	100	98	100	93	100	91	100	85	100	89	95
Insects																		
Ants (Formicidae)	5	75	3	75	tr	100	4	80	1	86	2	78	2	86	12	100	4	84
Leaf Beetles (Chrysomelidae)							tr	40			2	56	2	43	2	16	1	25
Ladybird Beetles (Coccinellidae)			1	25	tr	50	1	60	tr	14	tr	22	tr	14	tr	33	tr	25
Weevils (Curculionidae)			tr	50			1	60					tr	14			tr	14
Lamellicorn Beetles (Scarabeidae)	45	25	5	25			1	40	1	14	1	22					1	16
Darkling Beetles (Tenebrionidae)							1	20									tr	2
Beetle Larvae	2	25	tr	25	tr	50	11	40	tr	14	1	33	tr	29	tr	50	2	32
Grasshoppers (Locustidae)											tr	11	5	29	tr	16	1	9
Lace Bugs (Tingidae)							1	20									tr	2
Eruciform Larvae							3	20									tr	2
Total insect volume	52	75	10	100	88	100	23	80	2	86	7	78	9	100	15	100	11	89

Klebenow & Grey, 1968 – Food Habits of the Juvenile Sage-grouse



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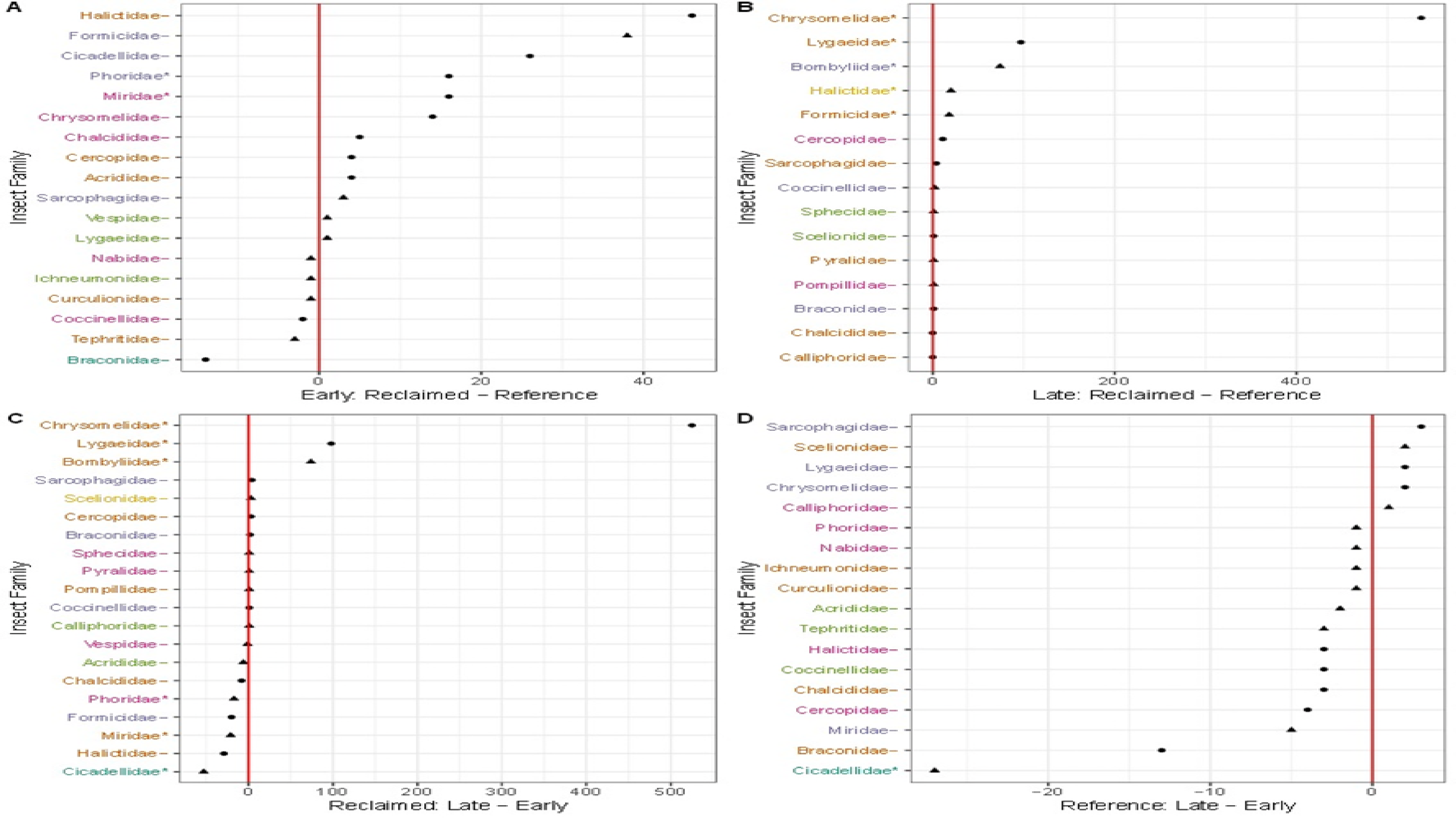

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Acknowledgements

- Co-authors
- Jonah Energy
- Wyoming Game & Fish Department