

How seed mix design and first year management influence multifunctionality and cost effectiveness in prairie reconstruction



Tallgrass Prairie
CENTER

UNIVERSITY OF NORTHERN IOWA

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Conservation programs for specific ecosystem services

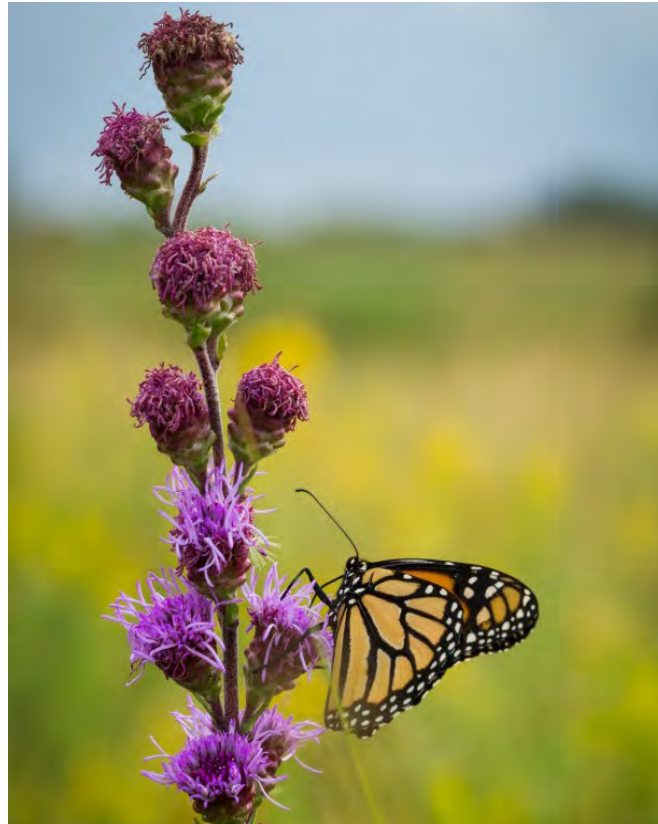
Emerging role of large ag conservation programs

Large conservation programs operating in ag landscapes strive to deliver services efficiently

- Conservation Reserve Program (CRP)
 - Targeted practices for specialized services
 - Erosion control, game bird habitat, historically
 - Utilize vast USDA infrastructure to operate at scale
 - Use revegetation as main tool

New role to address larger, more complex conservation issues

- More ecosystem rehabilitation activity
 - Rare/ declining habitat restoration
 - Pollinator and monarch recovery





More native vegetation on the ag landscape

Pressure to do more with less

Popular CPs require native vegetation

Pollinator Habitat (CP42)

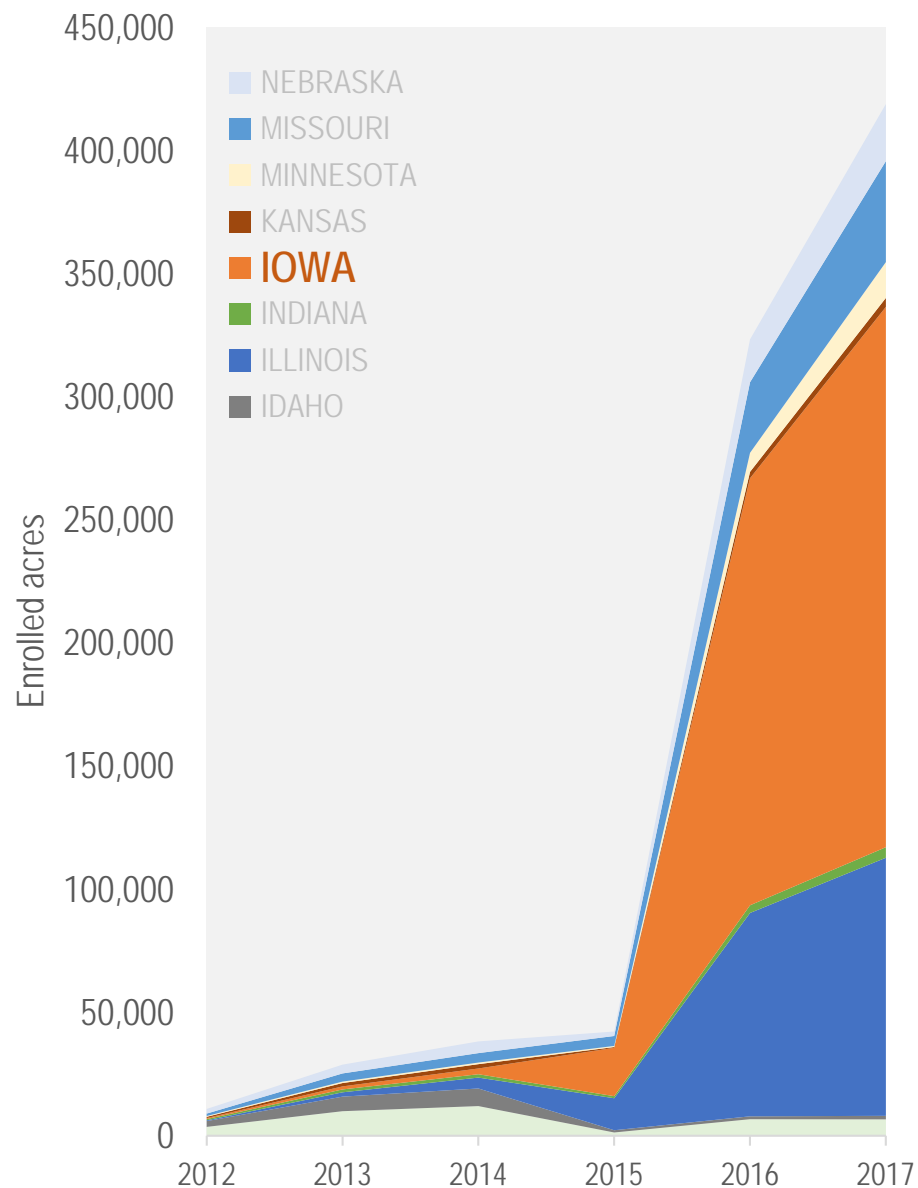
- “...create longer-lasting meadows of high-quality native wildflowers that support pollinators and other wildlife...”
- > 200,000 acres planted in IA alone

Rare and Declining Habitat (CP25)

- Nesting and escape cover
- Erosion control
- Pollinator habitat

Increasing scale of implementation but reduced funding for conservation

How can conservation programs achieve greater impact with limited resources (i.e., be more cost-effective)?





Balancing multiple ecological benefits rather than single services

An approach to cost-effectiveness

Diverse ecosystems provide many benefits simultaneously

Strategic tallgrass prairie reconstructions on agricultural fields:

- Reduce 82% N and P losses and 95% sediment runoff
- Increase pollinator abundance and bird species richness

ISU STRIPS team

Few studies have examined cost-effectiveness in prairie reconstruction

What ecological benefits are provided per unit project cost?





Influences on cost effectiveness in prairie reconstruction

Increasing establishment success, moderating cost of inputs

Seed mix

- **Grass-to-forb ratio**
For a fixed density overall seeding rate:
 - Grass too low: high cost, weed invasion, erosion
 - Grass too high: low cost, poor pollinator outcomes
- **Species selection**
 - Species selected to match site conditions
 - “Off-the-shelf” mixes to meet program specs



Establishment management

- **First year mowing**
 - More light for emerging seedlings increases establishment
 - Better establishment = higher cost effectiveness



Research objectives

Assess whether:

- 1) Prairie reconstructions installed at post-agricultural sites can effectively provide three ecosystem services (erosion control, weed resistance, and pollinator resources)
- 2) Seed mix design and first year mowing influence the degree of service enhancement

Research Approach

- Field experiment in post-agricultural land
- Research implemented at relevant scales using relevant equipment (tractor mounted seed drills, mowers)

Meissen, J. C., A. J. Glidden, M. E. Sherrard, K. J. Elgersma, and L. L. Jackson. 2019. Seed mix design and first year management influence multifunctionality and cost-effectiveness in prairie reconstruction. *Restoration Ecology*. In press.



Seed Mix Design Field Experiment

Split-plot design, two blocks

- $n = 36$, 3 seed mixes \times 2 mowing treatments \times 3 replicates \times 2 blocks
- Drill seeded in spring 2015, Nashua, IA

3 Seed mix treatments

- Pollinator Mix: 1:3 grass:forb seeding ratio (CP-42), off-the-shelf
- Diversity Mix: 1:1 grass:forb, customized for site conditions (soils, climate)
- Economy Mix: 3:1 grass:forb (CP-25), off-the-shelf

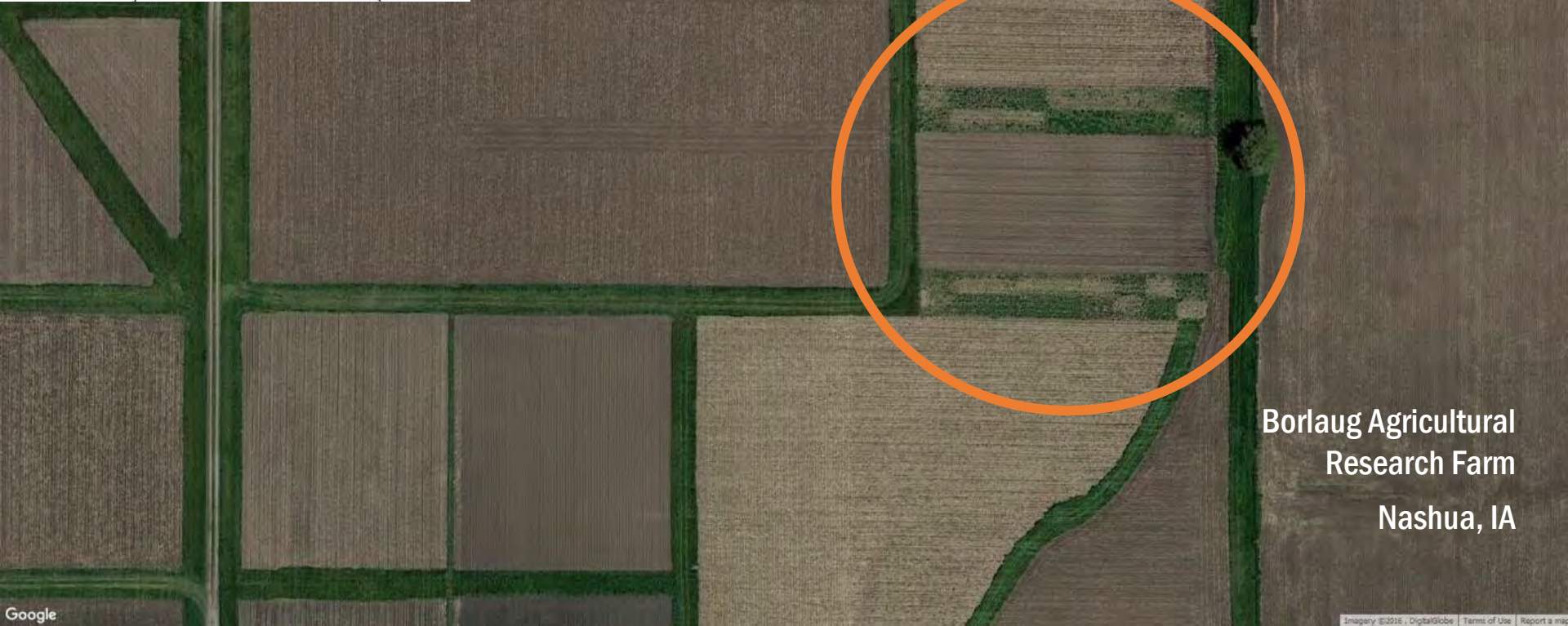
2 Mowing treatments

- Mowed: Mowed to 4.5in when vegetation >2 ft tall (4 times), only during first year
- Unmowed



Methods

Study site



Borlaug Agricultural
Research Farm
Nashua, IA



Study Site

Experiment layout

Seed mix treatments

- Economy 
- Diversity 
- Pollinator 

Mowing treatments

- Mow 
- No-Mow 



Borlaug Agricultural
Research Farm
Nashua, IA



Study Design

Seed Mix Treatments

Metric	Economy Mix	Diversity Mix	Pollinator Mix
Cost	\$130 per acre	\$291 per acre	\$368 per acre
Grass to forb seeding ratio	3:1	1:1	1:3
Grass seeding rate (seeds/ft ²)	30.1	20.1	10.9
Forb seeding rate (seeds/ft ²)	10.0	20.9	30.1
Species planted	21	71	38
Species selection method	Generalized (“Off-the-shelf”) CP-25	Customized for mesic/wet-mesic soils	Generalized (“Off-the-shelf”) CP-42



Methods

Data collection

Data collection 2015-2018

Randomly placed transects

- 5 quadrats (0.125m²) per transect
- No sampling within 1m of edges

In each quadrat, measure

- Canopy cover of vegetation types
- Planted native ramet density (stems)
- Inflorescence number

Use measures to estimate ecosystem function

- Erosion control: stem density, native cover
- Weed resistance: absence of weeds, absence of bare ground
- Pollinator resources: inflorescence production, floral richness





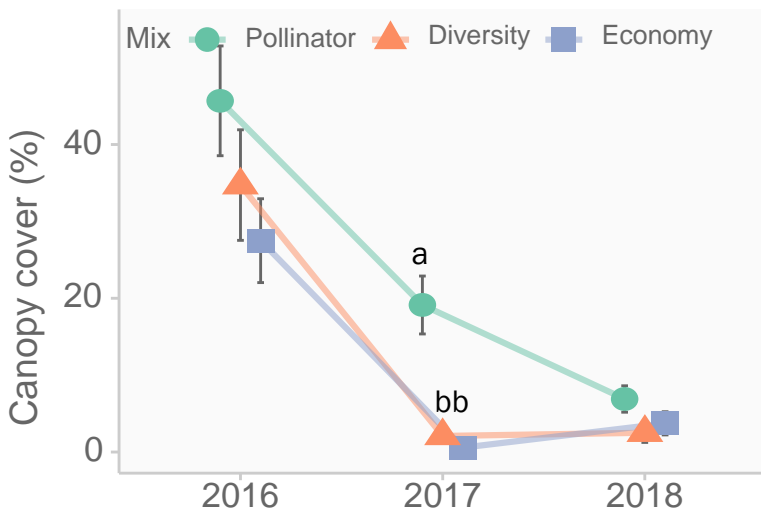
Experiment Results



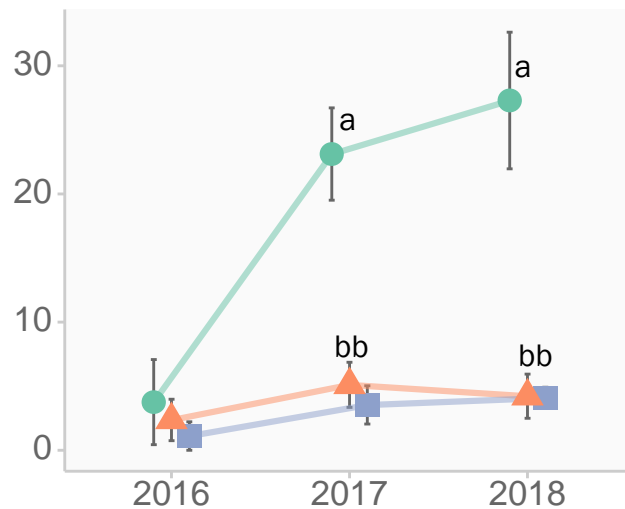
Effects of seed mix design (grass:forb ratio)

Overall stand structure (canopy cover)

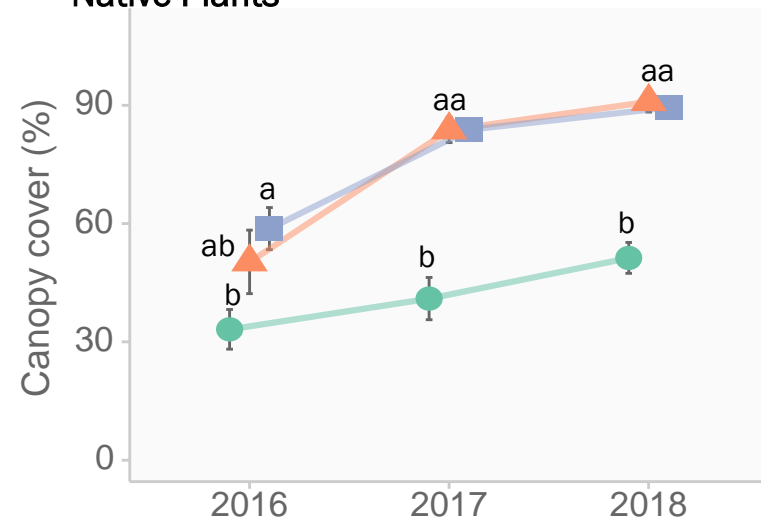
Annual Weeds



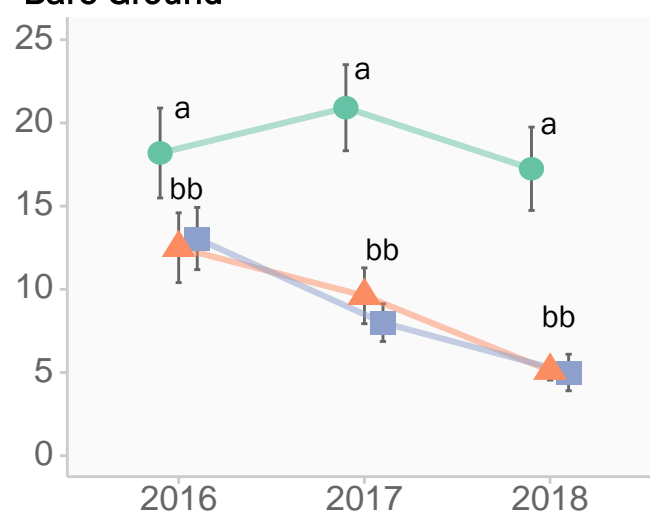
Perennial Weeds



Native Plants



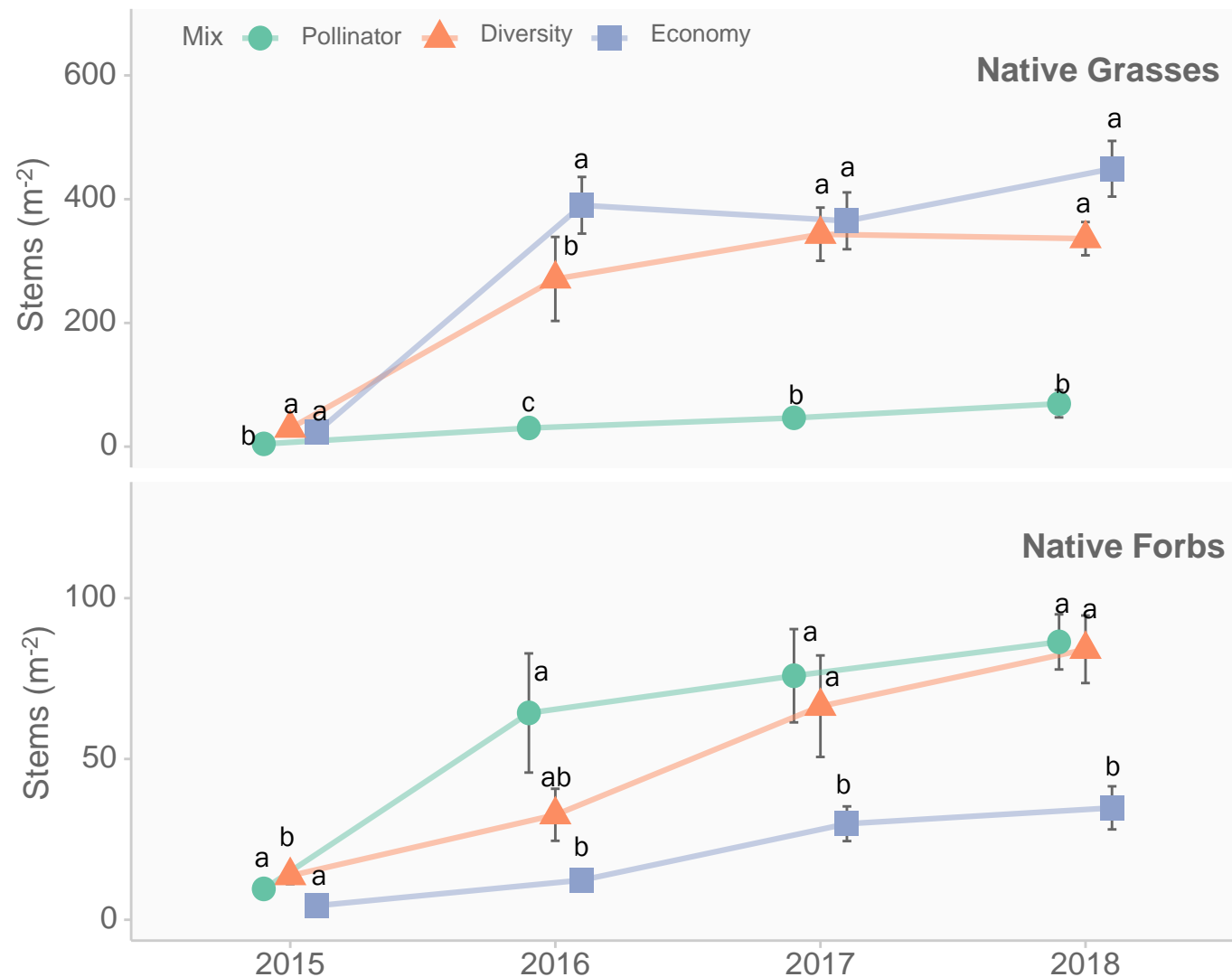
Bare Ground



- Annual weeds decreased in all mixes; fewer in economy/diversity mix
- Perennial weeds (eg. Canada thistle, quackgrass) increased only in pollinator mix
- High native cover only in diversity, economy mix
- Significant bare ground (after establishment) only in pollinator mix

Effects of seed mix design (grass:forb ratio)

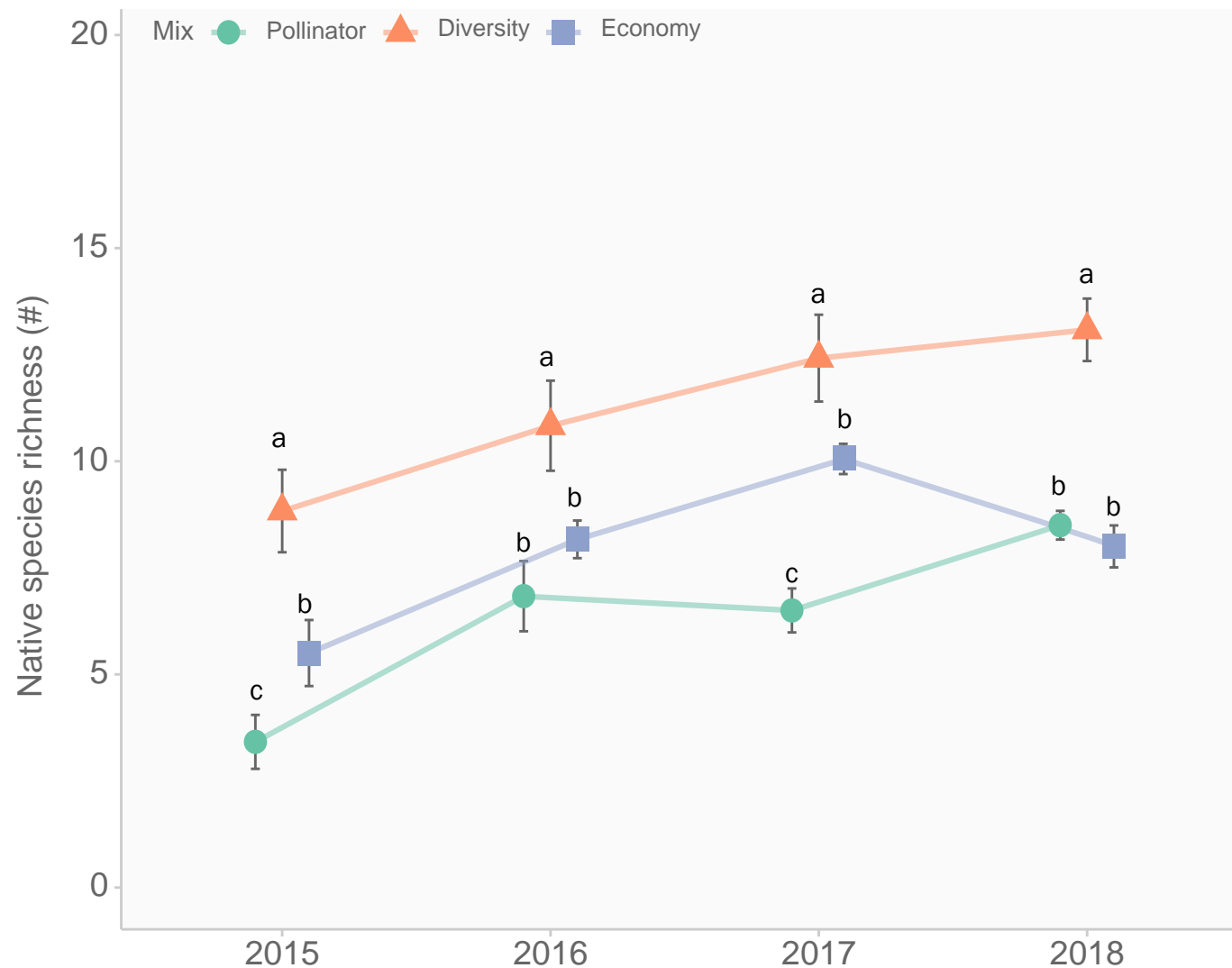
Native plant abundance (ramet density)



- Native grass stems high in both economy and diversity mix, extremely low in pollinator mix
- Forb stems high in both pollinator and diversity mix, low in economy mix
- Diversity mix provides many stems of all kinds, economy, pollinator only those planted at high levels

Effects of seed mix design (grass:forb ratio)

Plant diversity (species richness)



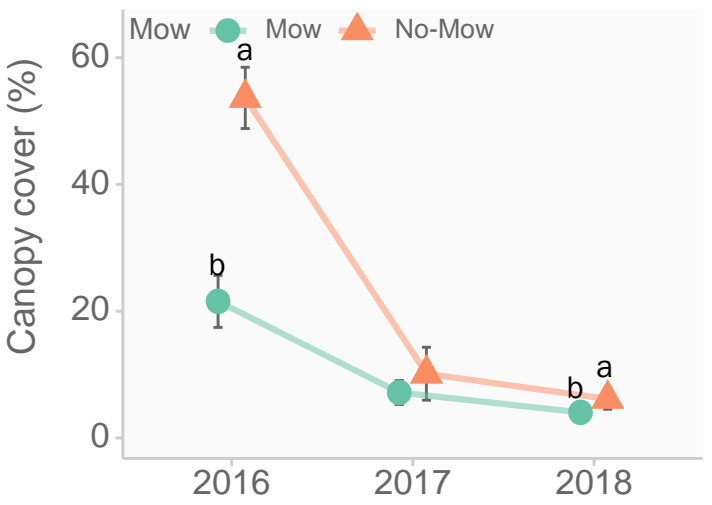
- Diversity mix produces most species consistently
- Species richness steady in diversity/pollinator mixes
- Signs of richness decreasing in economy mix



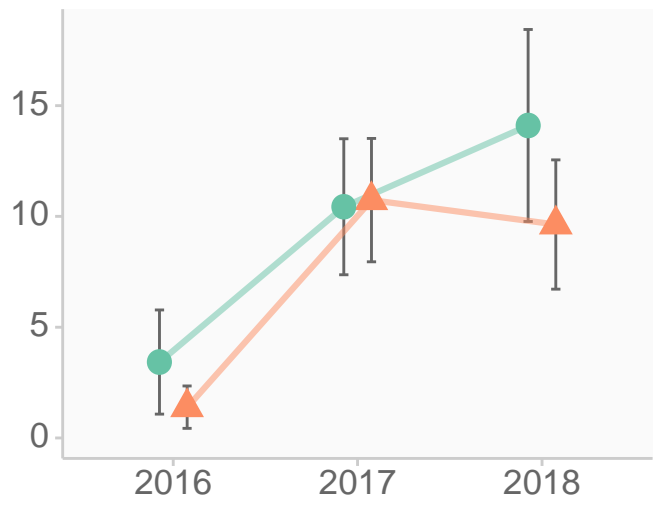
Effects of first-year mowing

Overall stand structure (canopy cover)

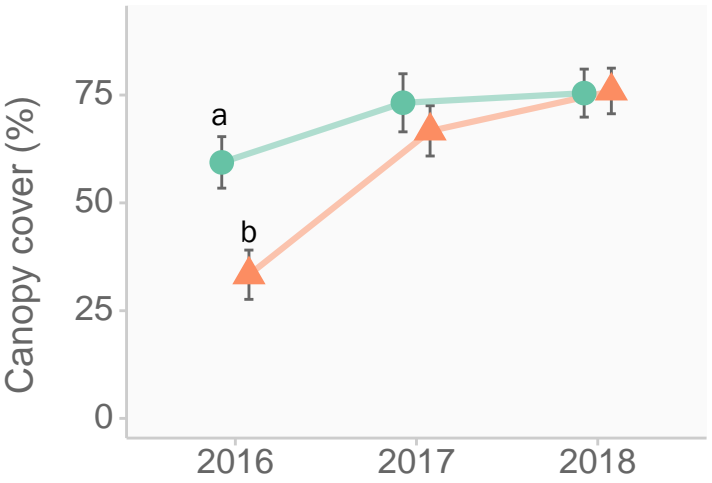
Annual Weeds



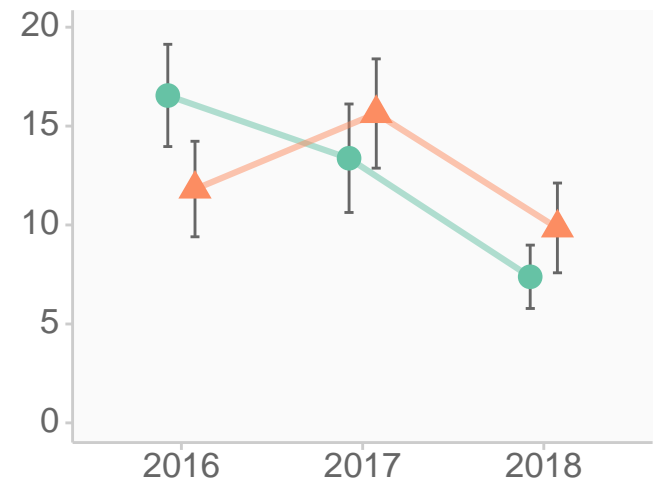
Perennial Weeds



Native Plants



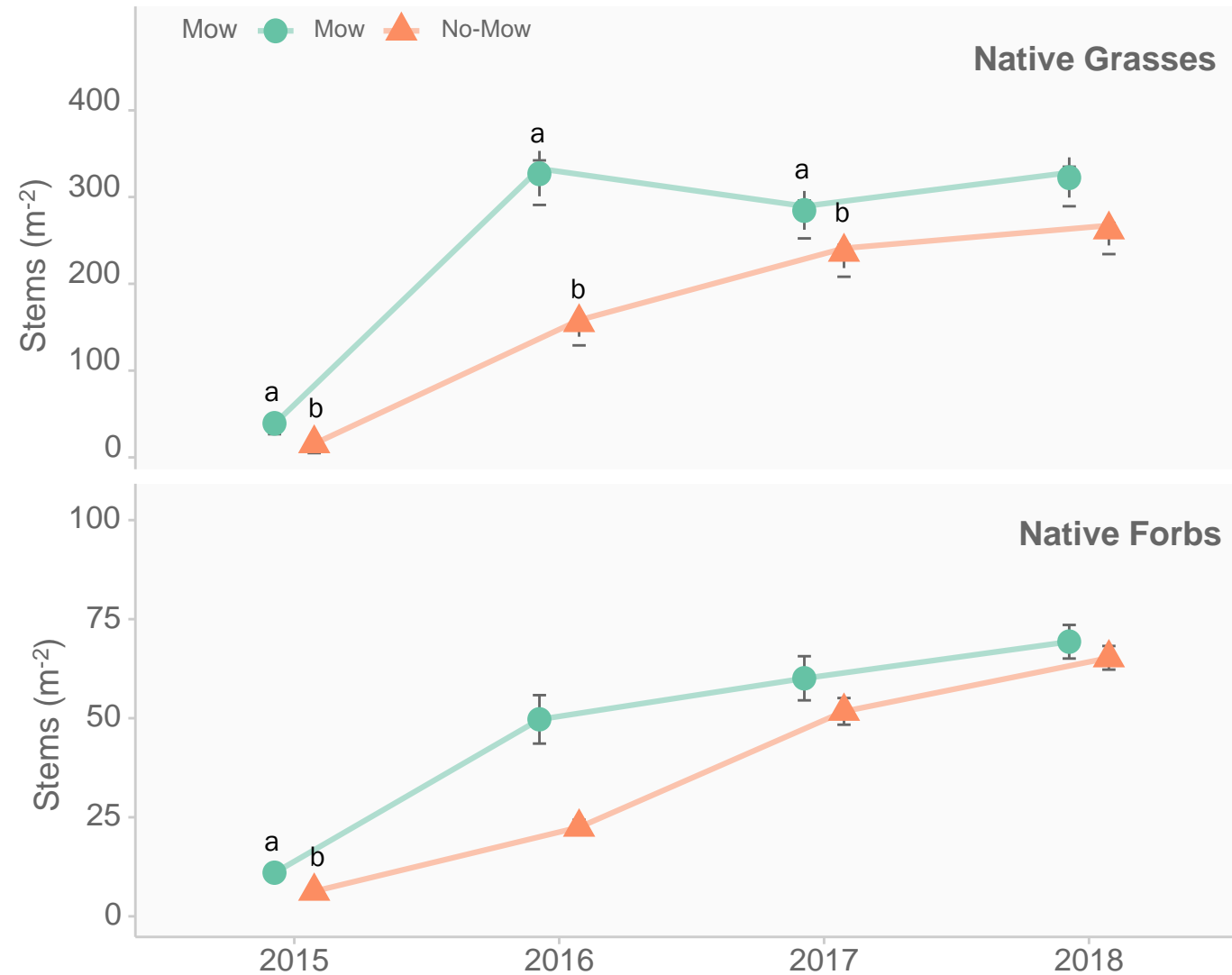
Bare Ground



- Mowing reduces annual weeds even after 3 yrs
- No significant mowing effects on perennial weeds
- Mowing increased native cover early on, but effect dissipated
- No mowing effect on bare ground

Effects of first-year mowing

Sown plant abundance (ramet density)

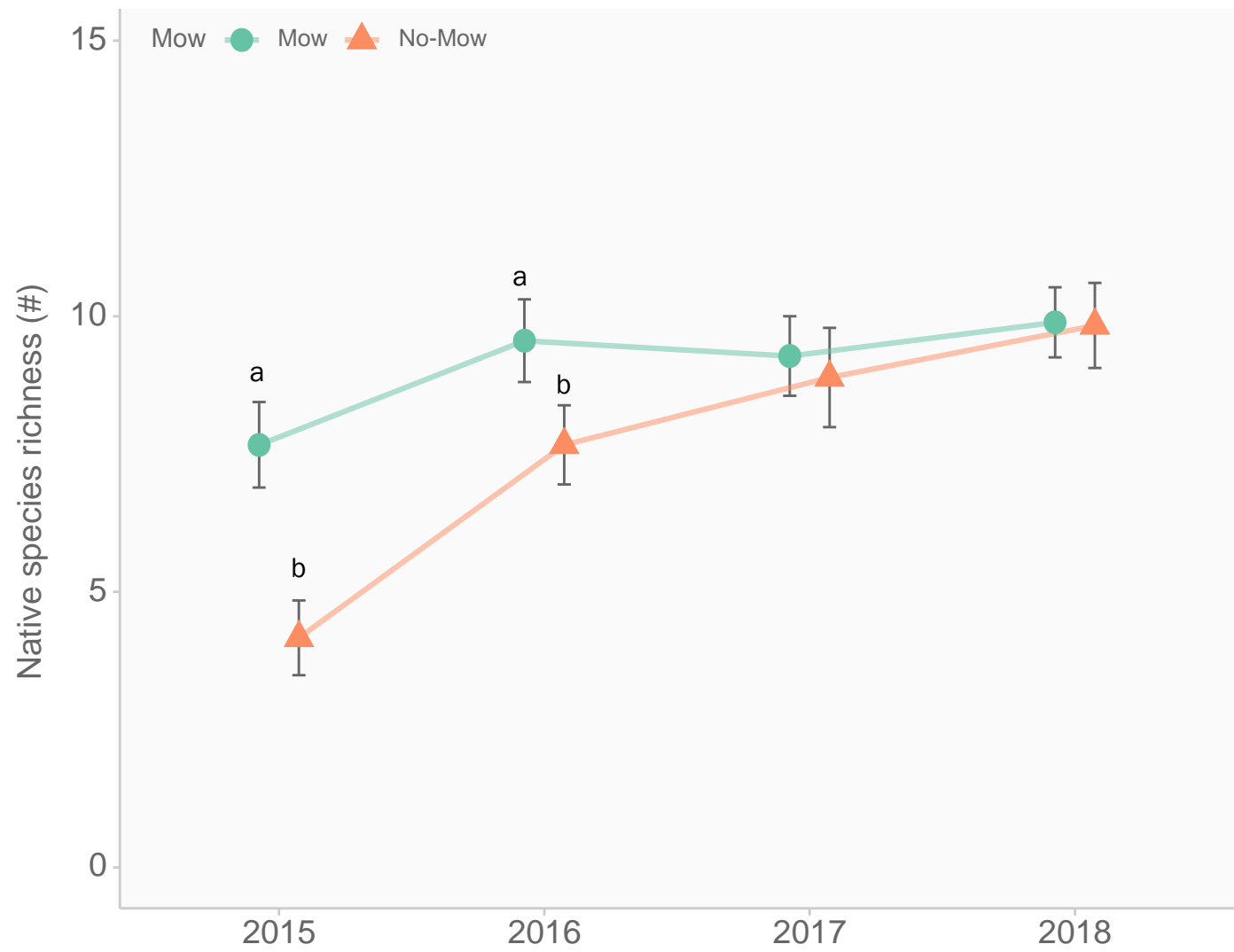


- Effects the first year with both grass and forbs
- Grasses benefited more from mowing, effects detectable up to year three
- Forb response less pronounced



Effects of first-year mowing

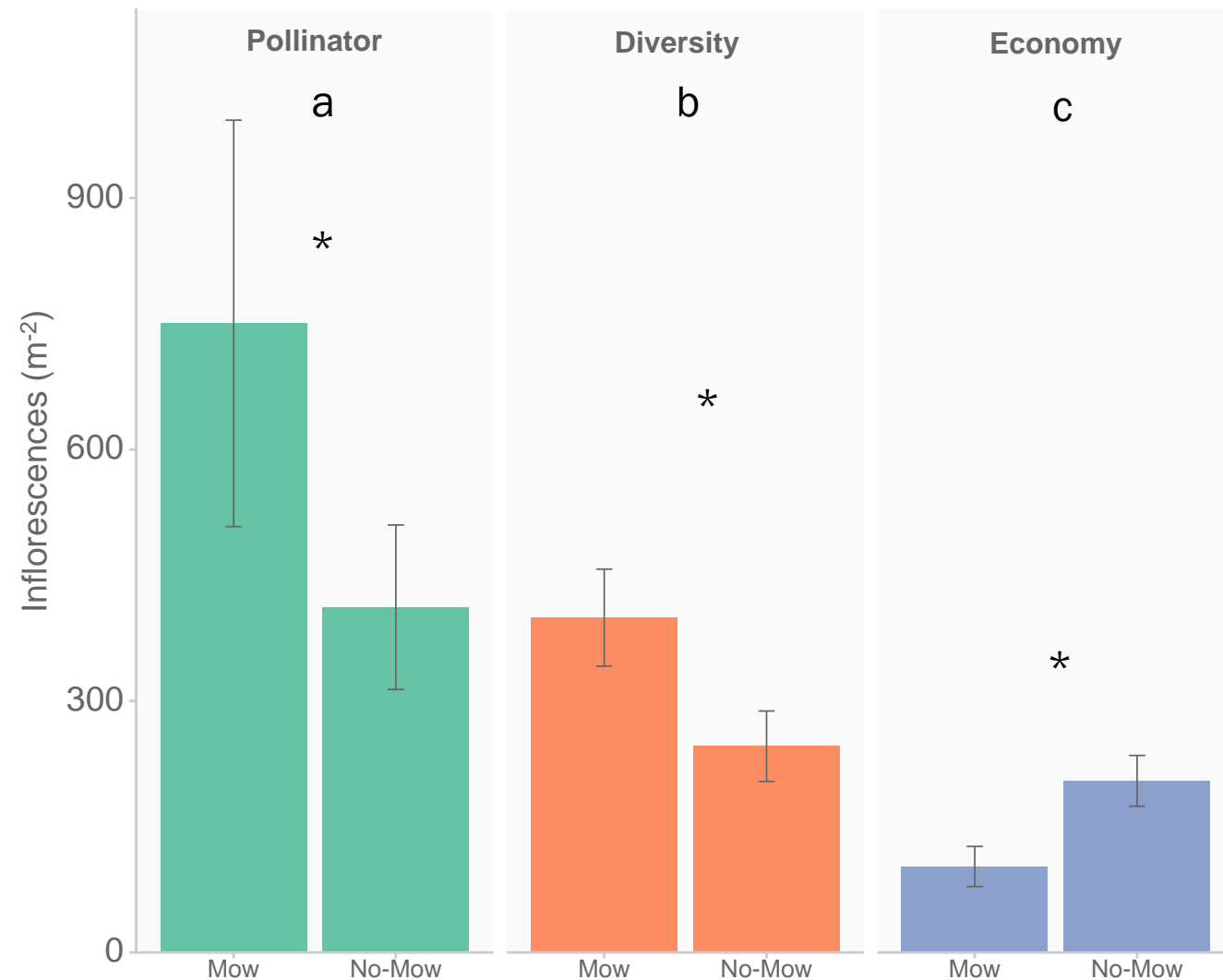
Plant diversity (species richness)



- Species richness improved with mowing in year 1 and 2
- Effect fades by year 3

Effects of seed mix design and first-year mowing

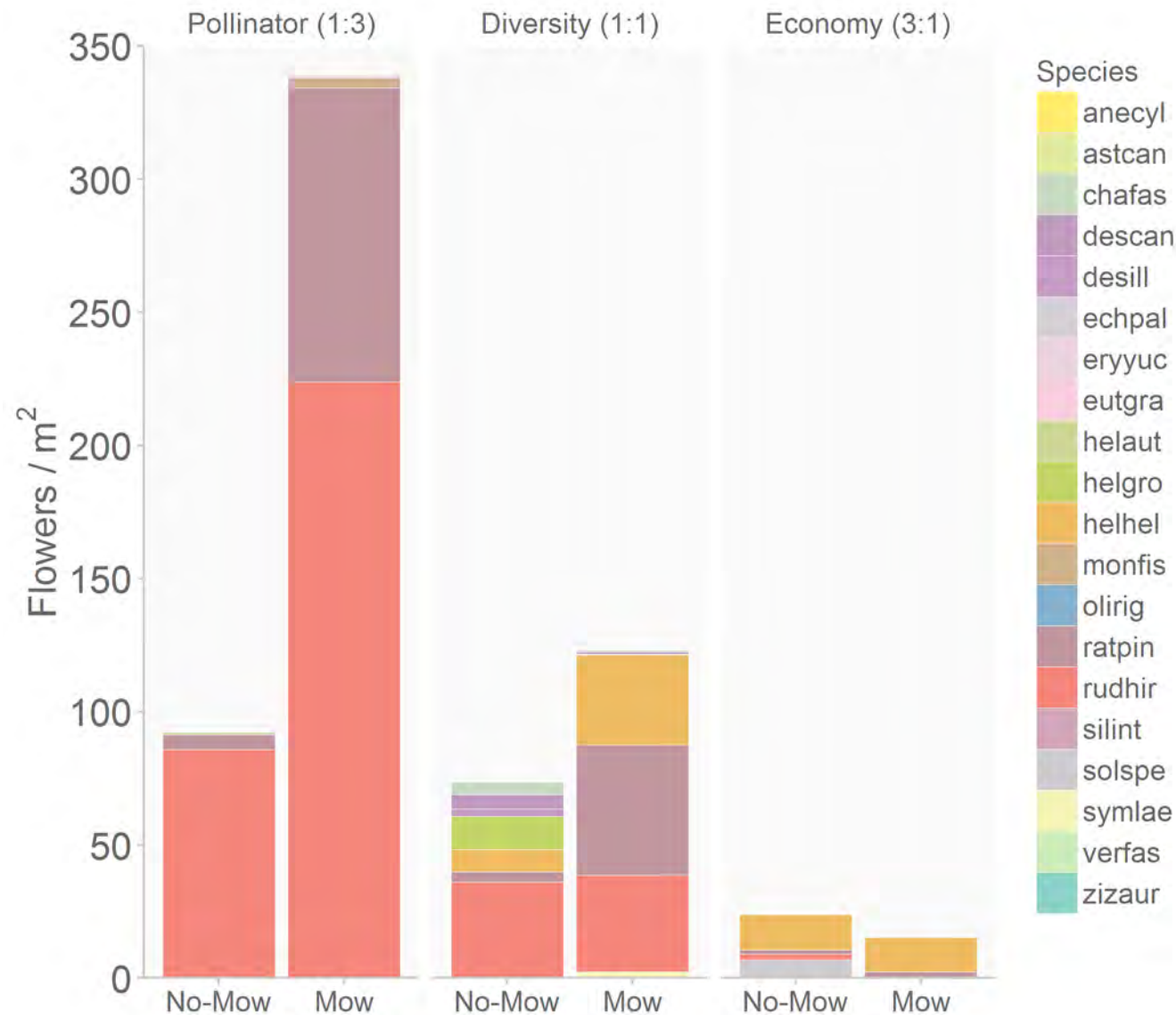
Floral resources (inflorescence number)



- Pollinator mix most floral resources, diversity mix intermediate
- Economy mix provides minimal pollinator habitat
- Mowing improved flowering in balanced and forb dominated mixes
- Mowing decreased flowering in grass dominated mix
- Floral diversity (Pielou's evenness) highest in diversity mix

Floral resources 2016 (Year 2)

Influence of Seed Mix and Mowing



- Black-eyed susan (rudhir) the dominant flower
- Oxeye (helhel) important in diversity and economy mixes
- Yellow coneflower (ratpin) important in mowed plots



Floral resources 2016

Pollinator Mix, July (Year 2)

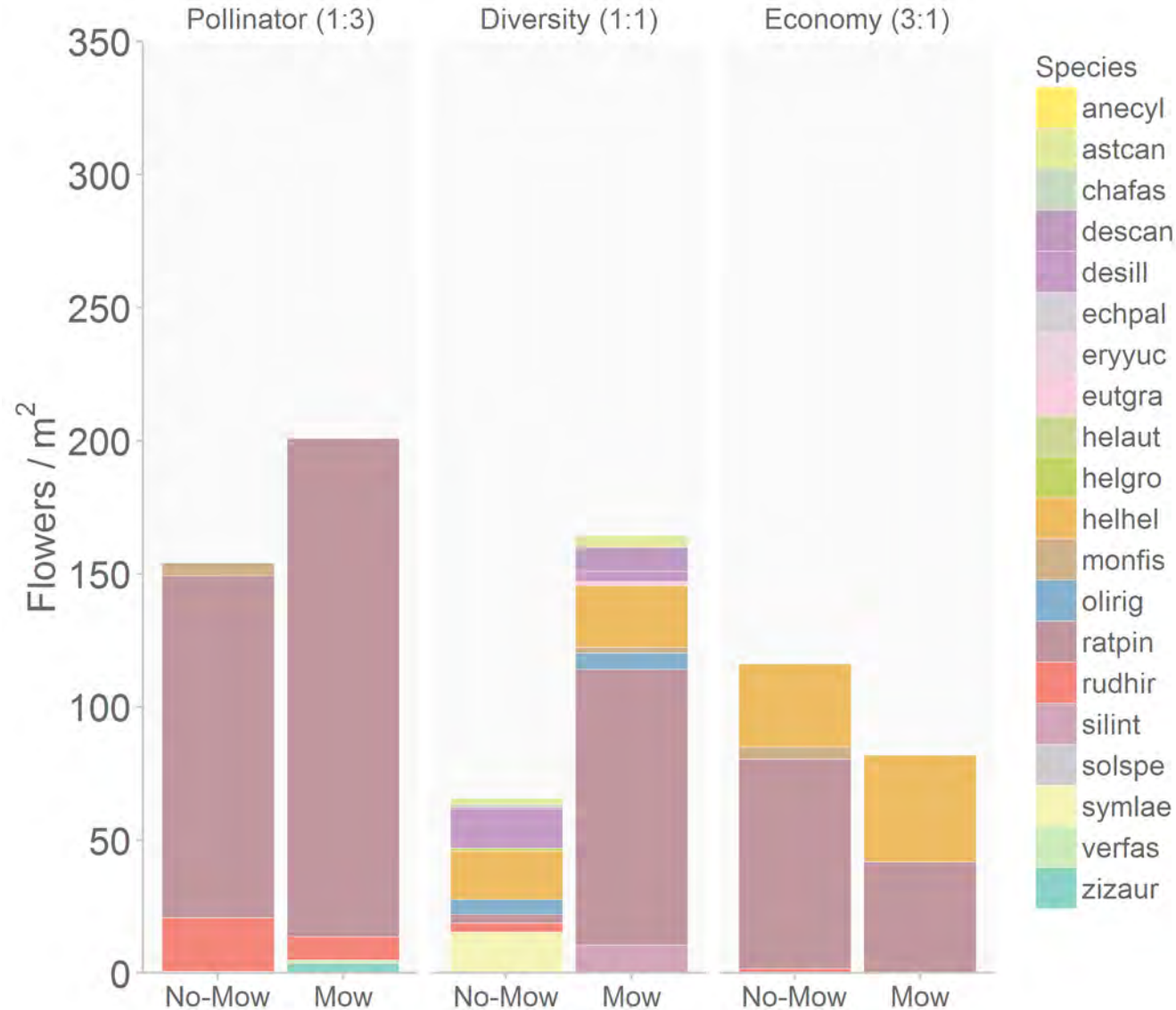


Mow

No-Mow

Floral resources 2017 (Year 3)

Importance of Seed Mix and Mowing



- Yellow coneflower (ratpin) the dominant flower
- Oxeye (helhel) important in diversity and economy mixes
- Large decrease in black-eyed susan (rudhir)



Floral resources 2017

Pollinator Mix, July (Year 3)

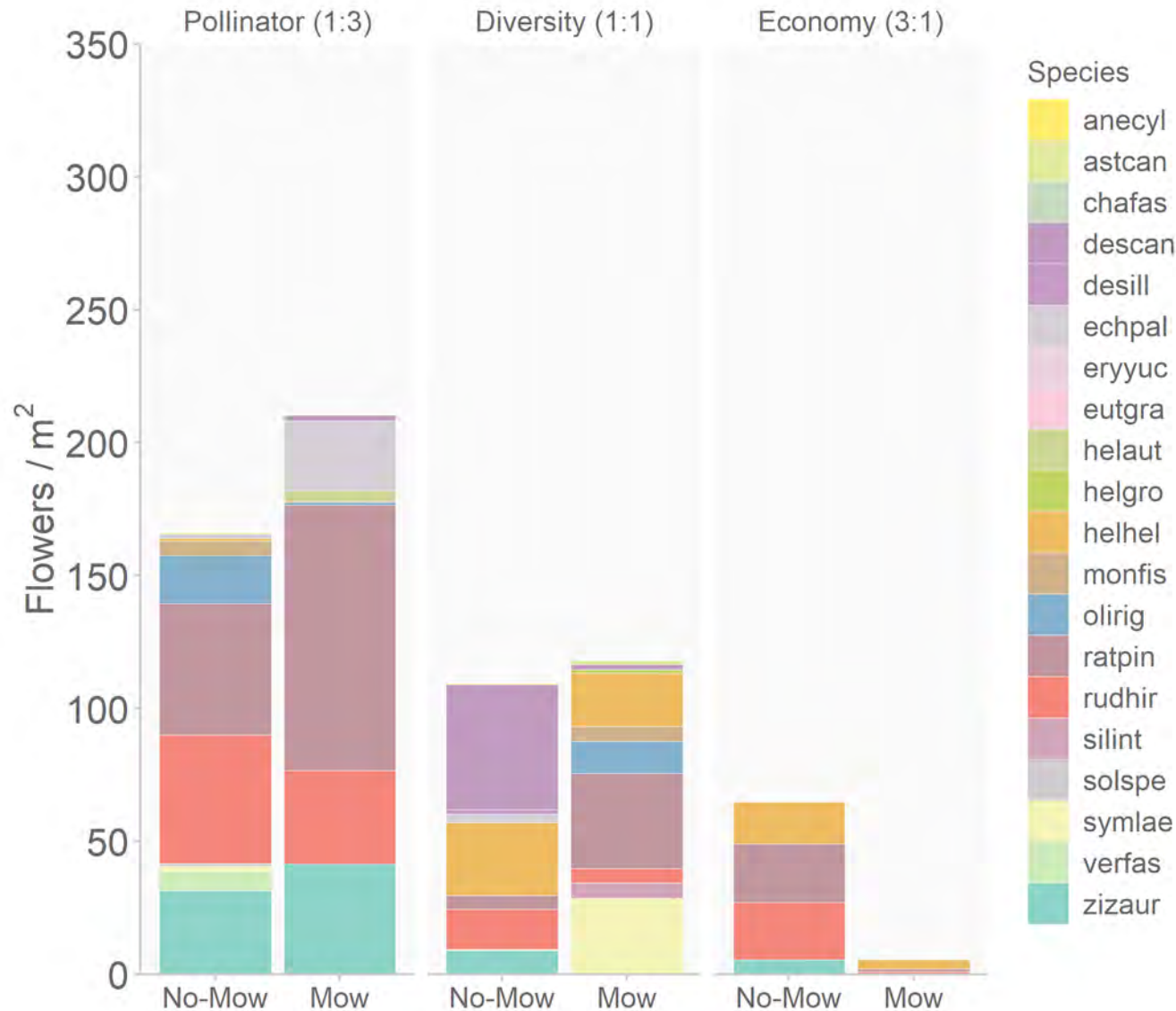


Mow

No-Mow

Floral resources 2018 (Year 4)

Importance of Seed Mix and Mowing



- No species especially dominant, flowering more even
- Large decrease in yellow coneflower (ratpin)
- Increase in golden alexander (zizaur)
- Practically no flowering in mowed economy mix



Floral resources 2018

Pollinator Mix, July (Year 4)



Mow

No-Mow



Floral resources 2019

Pollinator Mix, July (Year 5)

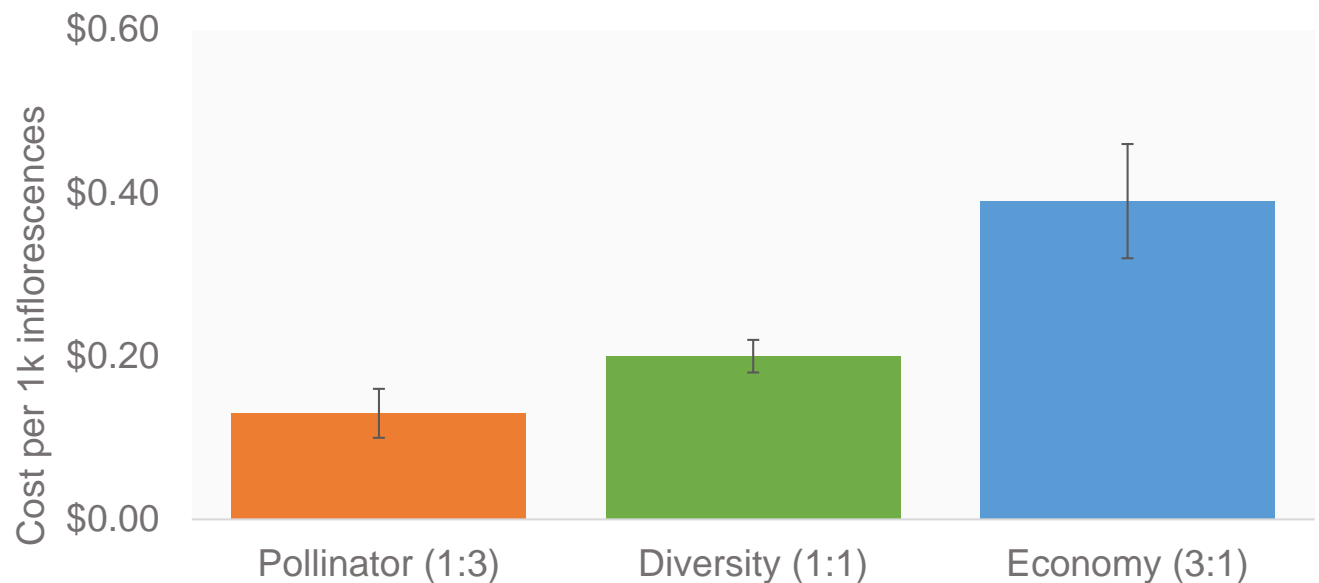
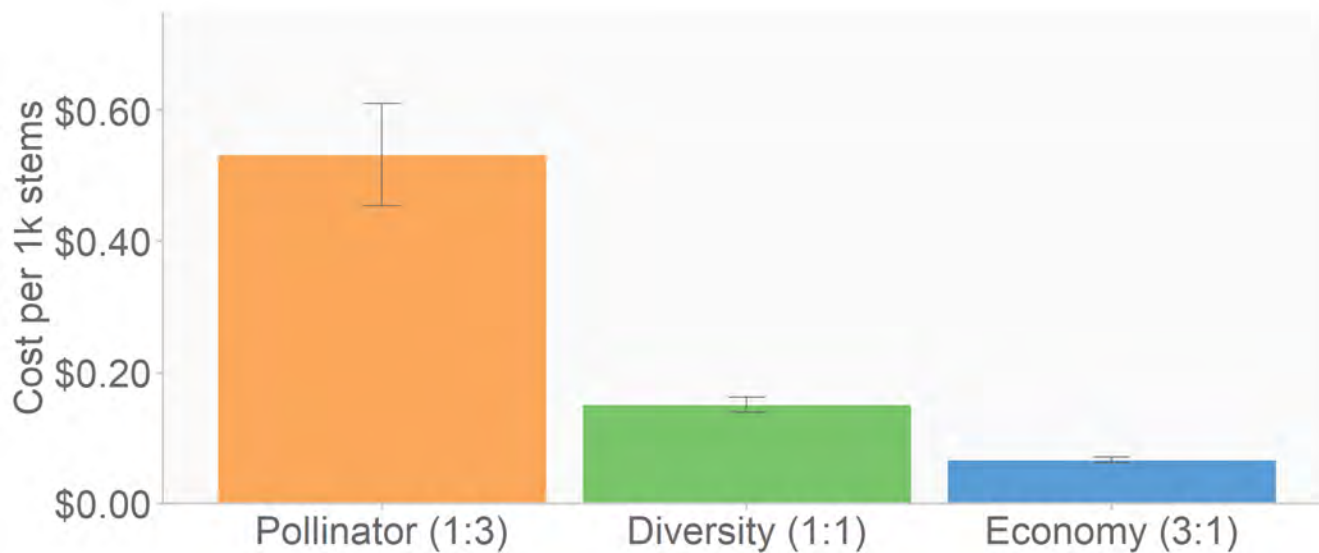


Mow

No-Mow

Effects of seed mix design (grass:forb ratio)

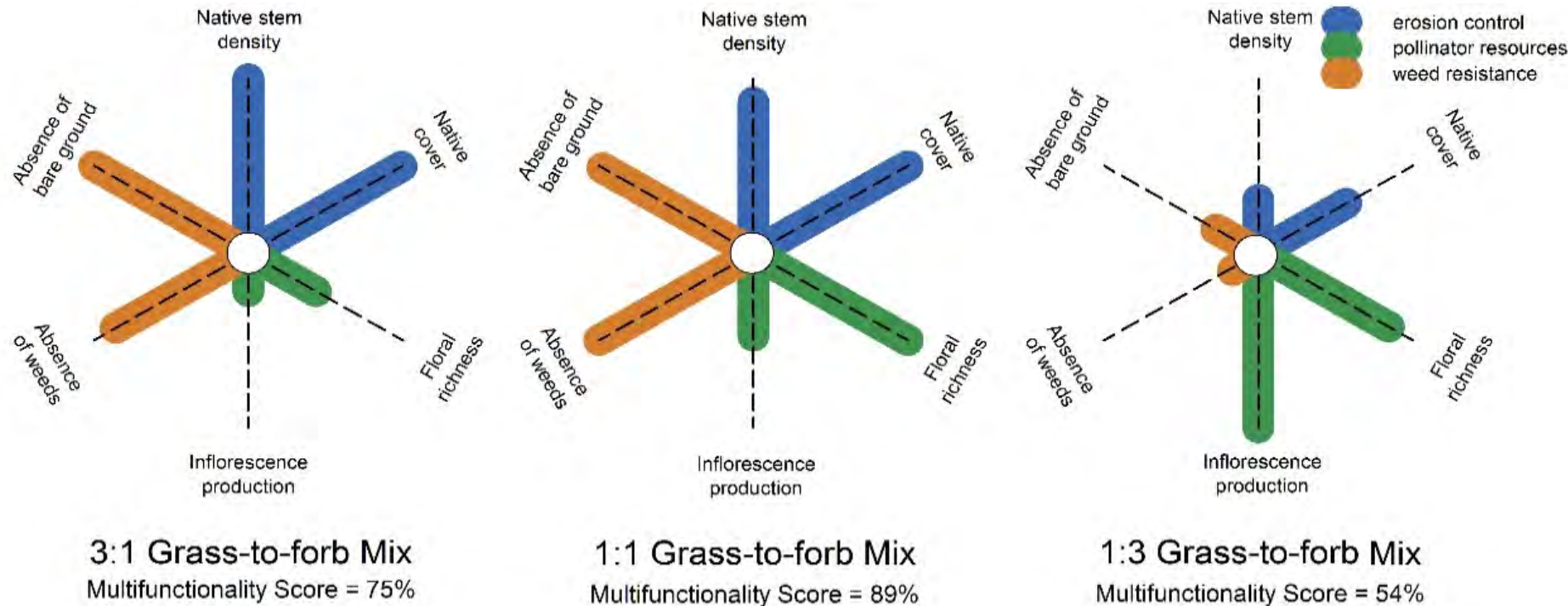
Cost-effectiveness



- Mixes designed for particular functions are cost effective for those functions but not others
- Functionally balanced approach not optimized, but moderately cost effective for multiple functions

Effects of seed mix design (grass:forb ratio)

Multifunctionality and ecosystem service provision



The Diversity Mix (1:1 grass:forb seeding ratio) most multifunctional

- In relative comparison with other mixes among ecosystem services, Diversity Mix provided most services at once (compared to optimization of one or few)

Research Summary

Seed mix design & mowing influences on multifunctionality and cost effectiveness

Seed mix design plays an influential role in ecosystem service provision

- 1) Strongly grass dominated mixes provide erosion control and weed resistance but minimal pollinator resources
- 2) Strongly forb dominated mixes provide pollinator resources but low erosion control and weed resistance
- 3) Balanced grass:forb seed mixes provide all three services at moderate to high levels

First year mowing positively influences the degree of service enhancement

- 1) Mowing generally increased pollinator resources
- 2) Mowing accelerated native establishment, but effects faded over time



Implications for practice

Improve CRP seed mix specs for cost-effectiveness and multifunctionality

- Balanced grass to forb ratio (1:1) with many species and functional groups would perform well for pollinators (CP42) and native cover (CP25)
- More cost efficient- moderate cost, high establishment

Use first year mowing when fast establishment required

- CRP contracts only 10-15 yrs so a lost year=contract performance 10% worse

Foregoing first year mowing not a death sentence for permanent plantings

- Cost/labor savings could be redirected under tight budgets



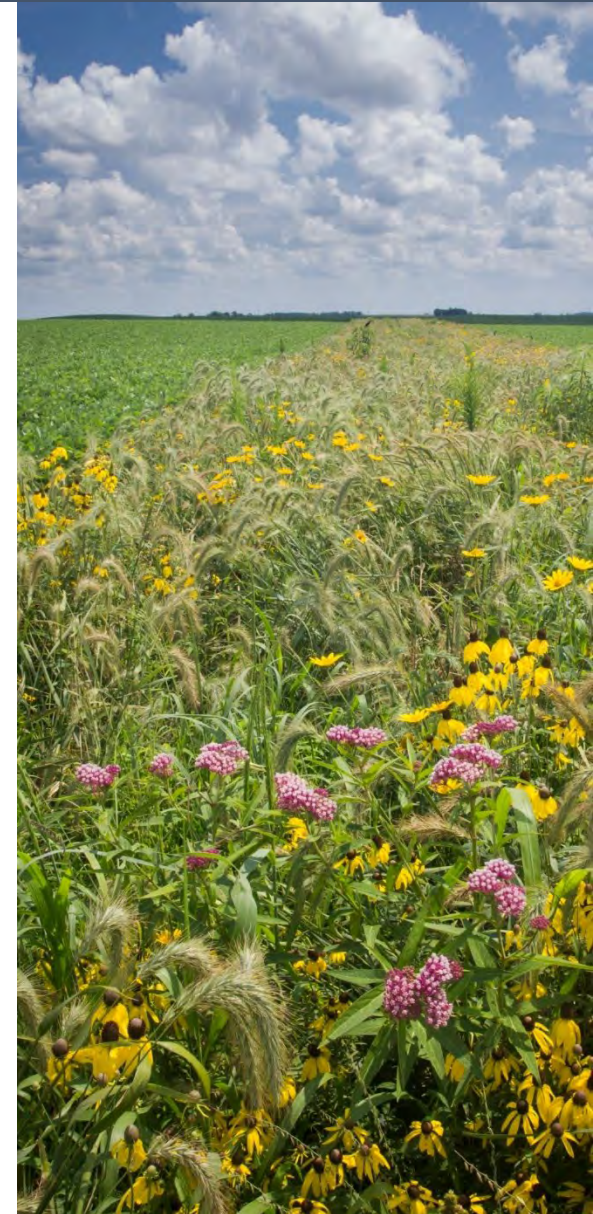
Acknowledgements

Collaborators

- ISU STRIPS
- Miller Creek Watershed Project
- People's Company, Randy Luze Farm
- ISU Northeast Research and Demonstration Farm

Funding

- Farm Service Agency
- Iowa Nutrient Research Center



Questions?



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ECONOMY MIX									
			Seeding Rate	Quantity sowed	Seeding Rate	Cost	2015 Cost		2016 Cost
Grass/Sedge	Scientific Name	Seeds sowed/sqm	Seeds /sq ft	grams PLS	lb/ac	per gram	per lb	2015 Cost	per ac
Big Bluestem	Andropogon gerardii	46.3	4.3	6.69	1.17	\$ 0.01	\$ 6	\$ 0.09	\$ 7
Side-oats Grama	Bouteloua curtipendula	46.3	4.3	7.74	1.35	\$ 0.02	\$ 10	\$ 0.17	\$ 14
Canada Wildrye	Elymus canadensis	46.3	4.3	10.79	1.89	\$ 0.02	\$ 10	\$ 0.24	\$ 19
Switchgrass	Panicum virgatum	32.3	3.0	2.92	0.51	\$ 0.02	\$ 10	\$ 0.06	\$ 5
Little Bluestem	Schizachyrium scoparius	46.3	4.3	4.37	0.77	\$ 0.04	\$ 18	\$ 0.17	\$ 14
Indian Grass	Sorghastrum nutans	46.3	4.3	5.82	1.02	\$ 0.04	\$ 16	\$ 0.21	\$ 16
Tall Dropseed	Sporobolus compositus	59.2	5.5	2.85	0.50	\$ 0.03	\$ 12	\$ 0.08	\$ 6
	TOTAL	322.8	30.0	41.19	7.21			\$ 1.02	\$ 81
Forbs (Legumes)	Scientific Name								
Milk Vetch	Astragalus canadensis	10.8	1.0	0.92	0.16	\$ 0.07	\$ 30	\$ 0.06	\$ 5
Purple Prairie Clover	Dalea purpurea	10.8	1.0	1.04	0.18	\$ 0.06	\$ 25	\$ 0.06	\$ 5
	TOTAL	21.5	2.0	1.95	0.34			\$ 0.12	\$ 9
Forbs (Non-Legumes)	Scientific Name								
Prairie Sage	Artemisia ludoviciana	10.8	1.0	0.06	0.01	\$ 0.56	\$ 253	\$ 0.03	\$ 3
Tall Boneset	Eupatorium altissimum	5.4	0.5	0.16	0.03	\$ 0.35	\$ 160	\$ 0.05	\$ 4
Ox-eye Sunflower	Heliopsis helianthoides	5.4	0.5	1.24	0.22	\$ 0.06	\$ 25	\$ 0.07	\$ 5
Wild Bergamot	Monarda fistulosa	10.8	1.0	0.22	0.04	\$ 0.22	\$ 100	\$ 0.05	\$ 4
Stiff Goldenrod	Oligoneuron rigidum	5.4	0.5	0.19	0.03	\$ 0.22	\$ 100	\$ 0.04	\$ 3
Prairie Cinquefoil	Potentilla arguta	10.8	1.0	0.07	0.01	\$ 0.26	\$ 120	\$ 0.02	\$ 1
Yellow Coneflower	Ratibida pinnata	10.8	1.0	0.52	0.09	\$ 0.08	\$ 35	\$ 0.04	\$ 3
Black-eyed Susan	Rudbeckia hirta	5.4	0.5	0.08	0.01	\$ 0.06	\$ 25	\$ 0.00	\$ 0
Sweet Coneflower	Rudbeckia subtomentosa	8.1	0.8	0.27	0.05	\$ 0.17	\$ 75	\$ 0.04	\$ 4
Showy Goldenrod	Solidago speciosa	5.4	0.5	0.08	0.01	\$ 0.53	\$ 240	\$ 0.04	\$ 3
New England Aster	Symphyotrichum novae-angliae	5.4	0.5	0.12	0.02	\$ 0.50	\$ 226	\$ 0.06	\$ 5
Golden Alexanders	Zizia aurea	2.7	0.3	0.35	0.06	\$ 0.13	\$ 60	\$ 0.05	\$ 4
	TOTAL	86.1	8.0	3.36	0.59			\$ 0.50	\$ 40
	FORBS	107.6	10.0	5.31	0.93		25%	\$ 0.62	\$ 49
	GRASS/SEDGE	322.8	30.0	41.19	7.21		75%	\$ 1.02	\$ 81
	GRAND TOTAL	430.4	40.0	46.50	8.14		100%		\$ 130

POLLINATOR MIX			Seeding Rate	Quantity sowed	Seeding Rate	Cost	2015 Cost		2016 Cost
			Seeds /sq ft	grams PLS	lb/ac	per gram	per lb	2015 Cost	per ac
Grass/Sedge	Scientific Name	Seeds sowed/sq/m	Seeds /sq ft	grams PLS	lb/ac	per gram	per lb	2015 Cost	per ac
Junegrass	Koeleria macrantha	31.6	2.9	0.23	0.04	\$ 0.26	\$ 120	\$ 0.06	\$ 5
Little Bluestem	Schizachyrium scoparius	29.1	2.7	2.75	0.48	\$ 0.04	\$ 18	\$ 0.11	\$ 9
Brown fox sedge	Carex vulpinoidea	19.8	1.8	0.29	0.05	\$ 0.21	\$ 96	\$ 0.06	\$ 5
Tall dropseed	Sporobolus compositus	17.8	1.7	0.86	0.15	\$ 0.03	\$ 12	\$ 0.02	\$ 2
Big bluestem	Andropogon gerardii	3.6	0.3	0.51	0.09	\$ 0.01	\$ 6	\$ 0.01	\$ 1
Side-oats grama	Bouteloua curtipendula	3.4	0.3	0.58	0.10	\$ 0.02	\$ 10	\$ 0.01	\$ 1
Prairie dropseed	Sporobolus heterolepis	3.0	0.3	0.29	0.05	\$ 0.13	\$ 60	\$ 0.04	\$ 3
	TOTAL	108.2	10.1	5.50	0.96			\$ 0.27	\$ 22
Forbs (Legumes)	Scientific Name								
Purple prairie clover	Dalea purpurea	25.2	2.3	2.43	0.42	\$ 0.06	\$ 25	\$ 0.13	\$ 11
White prairie clover	Dalea candida	22.5	2.1	1.71	0.30	\$ 0.06	\$ 25	\$ 0.09	\$ 7
Canada milk vetch	Astragalus canadensis	3.3	0.3	0.28	0.05	\$ 0.07	\$ 30	\$ 0.02	\$ 1
White wild indigo	Baptisia alba	0.6	0.1	0.55	0.10	\$ 0.26	\$ 120	\$ 0.15	\$ 12
	TOTAL	51.6	4.8	4.97	0.87			\$ 0.25	\$ 20
Forbs (Non-Legumes)	Scientific Name								
Culver's root	Veronicastrum virginicum	31.6	2.9	0.06	0.01	\$ 1.30	\$ 590	\$ 0.07	\$ 6
Alumroot	Heuchera richardsonii	27.7	2.6	0.06	0.01	\$ 1.54	\$ 700	\$ 0.09	\$ 7
Black-eyed susan	Rudbeckia hirta	25.5	2.4	0.40	0.07	\$ 0.06	\$ 25	\$ 0.02	\$ 2
Sneezeweed	Helenium autumnale	20.6	1.9	0.23	0.04	\$ 0.19	\$ 85	\$ 0.04	\$ 3
Wild bergamot	Monarda fistulosa	19.7	1.8	0.41	0.07	\$ 0.22	\$ 100	\$ 0.09	\$ 7
New England aster	Symphotrichum novae-angliae	15.9	1.5	0.35	0.06	\$ 0.50	\$ 226	\$ 0.17	\$ 14
Ironweed	Vernonia fasciculata	14.2	1.3	0.86	0.15	\$ 0.26	\$ 120	\$ 0.23	\$ 18
Golden alexander	Zizia aurea	14.1	1.3	1.85	0.32	\$ 0.13	\$ 60	\$ 0.25	\$ 19
Yellow coneflower	Ratibida pinnata	11.8	1.1	0.57	0.10	\$ 0.08	\$ 35	\$ 0.04	\$ 3
Foxglove beardtongue	Penstemon digitalis	10.3	1.0	0.11	0.02	\$ 0.20	\$ 90	\$ 0.02	\$ 2
Prairie cinquefoil	Potentilla arguta	9.0	0.8	0.06	0.01	\$ 0.26	\$ 120	\$ 0.02	\$ 1
Rattlesnake master	Eryngium yuccifolium	8.9	0.8	1.72	0.30	\$ 0.17	\$ 75	\$ 0.28	\$ 23
Prairie blazingstar	Liatris pycnostachya	8.7	0.8	1.15	0.20	\$ 0.40	\$ 180	\$ 0.45	\$ 36
Common Mt. Mint	Pycnanthemum virginianum	8.7	0.8	0.06	0.01	\$ 0.74	\$ 338	\$ 0.04	\$ 3
Stiff Goldenrod	Oligoneuron rigidum	8.1	0.8	0.29	0.05	\$ 0.22	\$ 100	\$ 0.06	\$ 5
Heath Aster	Symphotrichum ericoides	7.9	0.7	0.06	0.01	\$ 0.56	\$ 253	\$ 0.03	\$ 3
Pale Purple Coneflower	Echinacea pallida	6.2	0.6	1.70	0.30	\$ 0.11	\$ 51	\$ 0.19	\$ 15
Ohio Spiderwort	Tradescantia ohioensis	4.7	0.4	0.86	0.15	\$ 0.28	\$ 126	\$ 0.24	\$ 19
Smooth Blue Aster	Symphotrichum laeve	4.3	0.4	0.11	0.02	\$ 0.28	\$ 126	\$ 0.03	\$ 3
Showy Goldenrod	Solidago speciosa	3.8	0.4	0.06	0.01	\$ 0.53	\$ 240	\$ 0.03	\$ 2
Butterfly Milkweed	Asclepias tuberosa	3.4	0.3	1.16	0.20	\$ 0.66	\$ 300	\$ 0.77	\$ 61
Sky-blue Aster	Symphotrichum oolentangiense	3.1	0.3	0.06	0.01	\$ 0.53	\$ 240	\$ 0.03	\$ 2
Common Milkweed	Asclepias syriaca	1.6	0.2	0.58	0.10	\$ 0.22	\$ 100	\$ 0.13	\$ 10
Prairie Violet	Viola pedatifida	1.1	0.1	0.06	0.01	\$ 1.11	\$ 506	\$ 0.06	\$ 5
Compass Plant	Silphium laciniatum	0.8	0.1	1.65	0.29	\$ 0.19	\$ 85	\$ 0.31	\$ 24
Rosinweed	Silphium integrifolium	0.4	0.0	0.52	0.09	\$ 0.22	\$ 100	\$ 0.11	\$ 9
Prairie Phlox	Phlox pilosa	0.3	0.0	0.02	0.00	\$ 4.41	\$2,000	\$ 0.11	\$ 9
	TOTAL		25.3	15.00	2.62			\$ 3.93	\$ 312
	FORBS	324.2	30.1	19.97	3.49	12%	75%	\$ 4.32	\$ 343
	GRASS/SEDGE	108.2	10.1	5.50	0.96	0.00	25%	\$ 0.27	\$ 22
	GRAND TOTAL	432.4	40.2	25.47	4.46	0.12	100%	\$ 4.60	\$ 365

DIVERSITY MIX		Seeding Rate		Quantity sowed	Seeding Rate	Cost	2015 Cost		2016 Cost
		Seeds sowed/sqm	Seeds /sq ft	grams PLS	lb/ac	per gram	per lb	2015 Cost	per ac
Grass/Sedge	Scientific Name								
Big bluestem	Andropogon gerardii	21.5	2.0	3.11	0.54	\$ 0.01	\$ 6	\$ 0.04	\$ 3
Side-oats grama	Buteloua curtipendula	32.3	3.0	5.40	0.94	\$ 0.02	\$ 10	\$ 0.12	\$ 10
Prairie brome	Bromus kalmii	2.7	0.3	0.49	0.09	\$ 0.09	\$ 40	\$ 0.04	\$ 3
Yellow fox sedge	Carex annectens	10.8	1.0	0.17	0.03	\$ 0.44	\$ 200	\$ 0.08	\$ 6
Bicknell's sedge	Carex bicknellii	1.1	0.1	0.09	0.02	\$ 0.33	\$ 150	\$ 0.03	\$ 2
Plains oval sedge	Carex brevior	2.7	0.3	0.13	0.02	\$ 0.33	\$ 150	\$ 0.04	\$ 4
Heavy sedge	Carex gravida	0.2	0.0	0.03	0.00	\$ 2.12	\$ 960	\$ 0.05	\$ 4
Field oval sedge	Carex molesta	2.7	0.3	0.16	0.03	\$ 0.33	\$ 150	\$ 0.05	\$ 4
Canada wildrye	Elymus canadensis	10.8	1.0	2.51	0.44	\$ 0.02	\$ 10	\$ 0.06	\$ 4
Fowl mannagrass	Glyceria striata	10.8	1.0	0.10	0.02	\$ 0.42	\$ 192	\$ 0.04	\$ 3
switchgrass	Panicum virgatum	21.5	2.0	1.95	0.34	\$ 0.02	\$ 10	\$ 0.04	\$ 3
Little bluestem	Schizachyrium scoparium	21.5	2.0	2.03	0.36	\$ 0.04	\$ 18	\$ 0.08	\$ 6
Indiangrass	Sorghastrum nutans	21.5	2.0	2.71	0.47	\$ 0.04	\$ 16	\$ 0.10	\$ 8
Tall dropseed	Sporobolus compositus	53.8	5.0	2.59	0.45	\$ 0.03	\$ 12	\$ 0.07	\$ 5
Prairie dropseed	Sporobolus heterolepis	2.7	0.3	0.26	0.05	\$ 0.13	\$ 60	\$ 0.03	\$ 3
	TOTAL	216.5	20.1	21.72	3.80			\$ 0.88	\$ 70
Forbs (Legumes)	Scientific Name								
Leadplant	Amorpha canescens	2.2	0.2	0.17	0.03	\$ 0.33	\$ 150	\$ 0.06	\$ 5
Canada milk vetch	Astragalus canadensis	10.8	1.0	0.92	0.16	\$ 0.07	\$ 30	\$ 0.06	\$ 5
White wild indigo	Baptisia alba	0.2	0.0	0.18	0.03	\$ 0.26	\$ 120	\$ 0.05	\$ 4
Partridge pea	Chamaecrista fasciculata	3.2	0.3	0.73	0.30	\$ 0.02	\$ 10	\$ 0.04	\$ 3
Purple prairie clover	Dalea purpurea	10.8	1.0	1.04	0.18	\$ 0.06	\$ 25	\$ 0.06	\$ 5
Showy tick trefoil	Desmodium canadense	1.6	0.2	0.42	0.07	\$ 0.11	\$ 51	\$ 0.05	\$ 4
Illinois tick trefoil	Desmodium illinoense	2.7	0.3	0.90	0.16	\$ 0.03	\$ 15	\$ 0.03	\$ 2
Round-head bushclover	Lespedeza capitata	0.5	0.1	0.10	0.02	\$ 0.53	\$ 240	\$ 0.05	\$ 4
	TOTAL	32.0	3.0	5.47	0.96			\$ 0.39	\$ 31
Forbs (Non-Legumes)	Scientific Name								
Wild garlic	Allium canadense	1.1	0.1	0.19	0.03	\$ 0.19	\$ 85	\$ 0.03	\$ 3
Canada anemone	Anemone canadensis	0.2	0.0	0.04	0.01	\$ 0.88	\$ 400	\$ 0.03	\$ 3
Thimbleweed	Anemone cylindrica	0.5	0.1	0.03	0.01	\$ 1.32	\$ 600	\$ 0.04	\$ 3
Prairie sage	Artemisia ludoviciana	10.8	1.0	0.06	0.01	\$ 0.56	\$ 253	\$ 0.03	\$ 3
Swamp milkweed	Asclepias incarnata	1.1	0.1	0.32	0.06	\$ 0.19	\$ 85	\$ 0.06	\$ 5
Common milkweed	Asclepias syriaca	2.2	0.2	0.78	0.14	\$ 0.22	\$ 100	\$ 0.17	\$ 14
Butterfly milkweed	Asclepias tuberosa	0.3	0.0	0.11	0.02	\$ 0.66	\$ 300	\$ 0.07	\$ 6
Whorled milkweed	Asclepias verticillata	0.5	0.1	0.07	0.01	\$ 0.88	\$ 400	\$ 0.06	\$ 5
New Jersey tea	Ceanothus americanus	0.5	0.1	0.10	0.02	\$ 0.56	\$ 253	\$ 0.06	\$ 5
Prairie coreopsis	Coreopsis palmata	0.4	0.0	0.06	0.01	\$ 0.71	\$ 320	\$ 0.04	\$ 3
Shootingstar	Dodecatheon media	1.1	0.1	0.03	0.00	\$ 2.82	\$1,280	\$ 0.07	\$ 6
Pale purple coneflower	Echinacea pallida	2.2	0.2	0.59	0.10	\$ 0.11	\$ 51	\$ 0.07	\$ 5
Rattlesnake master	Eryngium yuccifolium	2.2	0.2	0.41	0.07	\$ 0.17	\$ 75	\$ 0.07	\$ 5
Tall boneset	Eupatorium altissimum	2.7	0.3	0.08	0.01	\$ 0.35	\$ 160	\$ 0.03	\$ 2
Flowering spurge	Euphorbia corollata	1.1	0.1	0.19	0.03	\$ 0.37	\$ 168	\$ 0.07	\$ 6
Grass-leaf goldenrod	Euthamia graminifolia	10.8	1.0	0.04	0.01	\$ 1.41	\$ 640	\$ 0.06	\$ 5
Northern bedstraw	Galium boreale	1.1	0.1	0.02	0.00	\$ 1.76	\$ 800	\$ 0.04	\$ 3
Bottle gentian	Gentiana andrewsii	5.4	0.5	0.03	0.00	\$ 1.76	\$ 800	\$ 0.05	\$ 4
Bigtooth sunflower	Helianthus grosseserratus	1.6	0.2	0.16	0.03	\$ 0.44	\$ 200	\$ 0.07	\$ 5
Prairie sunflower	Helianthus laetiflorus	0.2	0.0	0.08	0.01	\$ 0.74	\$ 338	\$ 0.06	\$ 5
Ox-eye sunflower	Helianthus scaberrimus	5.4	0.5	1.24	0.22	\$ 0.06	\$ 25	\$ 0.07	\$ 5
Prairie blazingstar	Liatris pycnostachya	1.1	0.1	0.14	0.02	\$ 0.40	\$ 180	\$ 0.06	\$ 4
Michigan lily	Lilium michiganense	0.1	0.0	0.02	0.00	\$ 3.76	\$1,704	\$ 0.06	\$ 5
Great blue lobelia	Lobelia siphilitica	10.8	1.0	0.03	0.01	\$ 0.44	\$ 200	\$ 0.01	\$ 1
Wild bergamot	Monarda fistulosa	8.1	0.8	0.17	0.03	\$ 0.22	\$ 100	\$ 0.04	\$ 3
Stiff goldenrod	Oligoneuron rigidum	8.1	0.8	0.28	0.05	\$ 0.22	\$ 100	\$ 0.06	\$ 5
Wild quinine	Parthenium integrifolium	1.1	0.1	0.22	0.04	\$ 0.19	\$ 85	\$ 0.04	\$ 3
Foxglove beardtongue	Penstemon digitalis	10.8	1.0	0.12	0.02	\$ 0.20	\$ 90	\$ 0.02	\$ 2
Prairie phlox	Phlox pilosa	0.2	0.0	0.02	0.00	\$ 4.41	\$2,000	\$ 0.07	\$ 6
Prairie cinquefoil	Potentilla arguta	10.8	1.0	0.07	0.01	\$ 0.26	\$ 120	\$ 0.02	\$ 1
Hairy mt. mint	Pycnanthemum pilosum	8.1	0.8	0.06	0.01	\$ 0.71	\$ 320	\$ 0.04	\$ 4
Slender mt. mint	Pycnanthemum tenuifolium	10.8	1.0	0.04	0.01	\$ 0.74	\$ 338	\$ 0.03	\$ 2
Common mt. mint	Pycnanthemum virginianum	10.8	1.0	0.07	0.01	\$ 0.74	\$ 338	\$ 0.05	\$ 4
Yellow coneflower	Ratibida pinnata	10.8	1.0	0.52	0.09	\$ 0.08	\$ 35	\$ 0.04	\$ 3
Black-eyed susan	Rudbeckia hirta	8.1	0.8	0.13	0.02	\$ 0.06	\$ 25	\$ 0.01	\$ 1
Sweet susan	Rudbeckia subtomentosa	8.1	0.8	0.27	0.05	\$ 0.17	\$ 75	\$ 0.04	\$ 4
Rosinweed	Silphium integrifolium	0.2	0.0	0.26	0.05	\$ 0.22	\$ 100	\$ 0.06	\$ 5
Compass plant	Silphium laciniatum	0.1	0.0	0.24	0.04	\$ 0.19	\$ 85	\$ 0.04	\$ 3
Showy goldenrod	Solidago speciosa	8.1	0.8	0.12	0.02	\$ 0.53	\$ 240	\$ 0.07	\$ 5
Smooth blue aster	Symphotrichum laeve	5.4	0.5	0.14	0.02	\$ 0.28	\$ 126	\$ 0.04	\$ 3
New England aster	Symphotrichum novae-angliae	5.4	0.5	0.12	0.02	\$ 0.50	\$ 226	\$ 0.06	\$ 5
Sky-blue aster	Symphotrichum oolentangiense	2.7	0.3	0.05	0.01	\$ 0.53	\$ 240	\$ 0.03	\$ 2
Purple meadow rue	Thalictrum dasycarpum	0.5	0.1	0.07	0.01	\$ 0.44	\$ 200	\$ 0.03	\$ 2
Prairie spiderwort	Tradescantia bracteata	0.5	0.1	0.08	0.01	\$ 0.56	\$ 253	\$ 0.04	\$ 3
Ohio spiderwort	Tradescantia ohiensis	1.1	0.1	0.19	0.03	\$ 0.28	\$ 126	\$ 0.05	\$ 4
Ironweed	Vernonia fasciculata	2.7	0.3	0.16	0.03	\$ 0.26	\$ 120	\$ 0.04	\$ 3
Culver's root	Veronicastrum virginicum	5.4	0.5	0.01	0.00	\$ 1.30	\$ 590	\$ 0.01	\$ 1
Golden alexander	Zizia aurea	2.7	0.3	0.35	0.06	\$ 0.13	\$ 60	\$ 0.05	\$ 4
	TOTAL	193.4	18.0	8.58	1.50			\$ 2.39	\$ 190
	FORBS	225.3	20.9	14.04	2.46		51%	\$ 2.78	\$ 221
	GRASS/SEDGE	216.5	20.1	21.72	3.80		49%	\$ 0.88	\$ 70
	GRAND TOTAL	441.8	41.1	35.77	6.26		100%	\$ 3.66	\$ 291