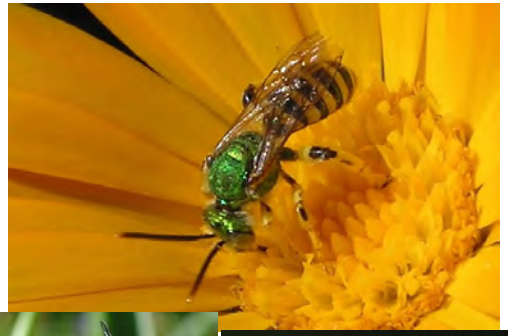
Safeguarding bees: Nutrition, Pesticides, and IPPM

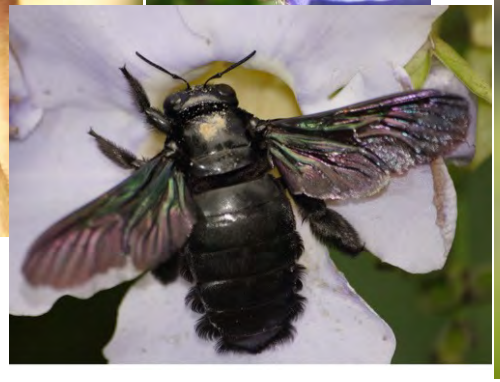
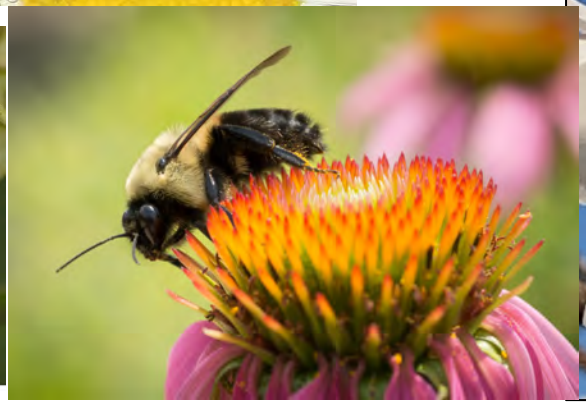
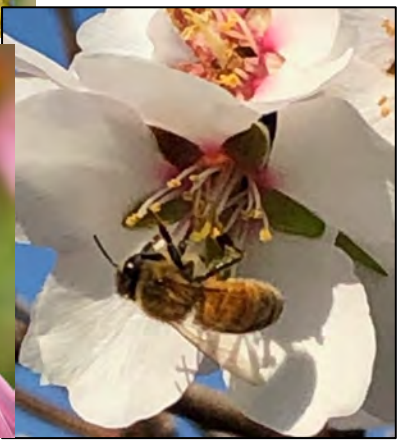
Diana L. Cox-Foster

USDA/ARS/PWA Pollinating Insect Research Unit

Logan, Utah

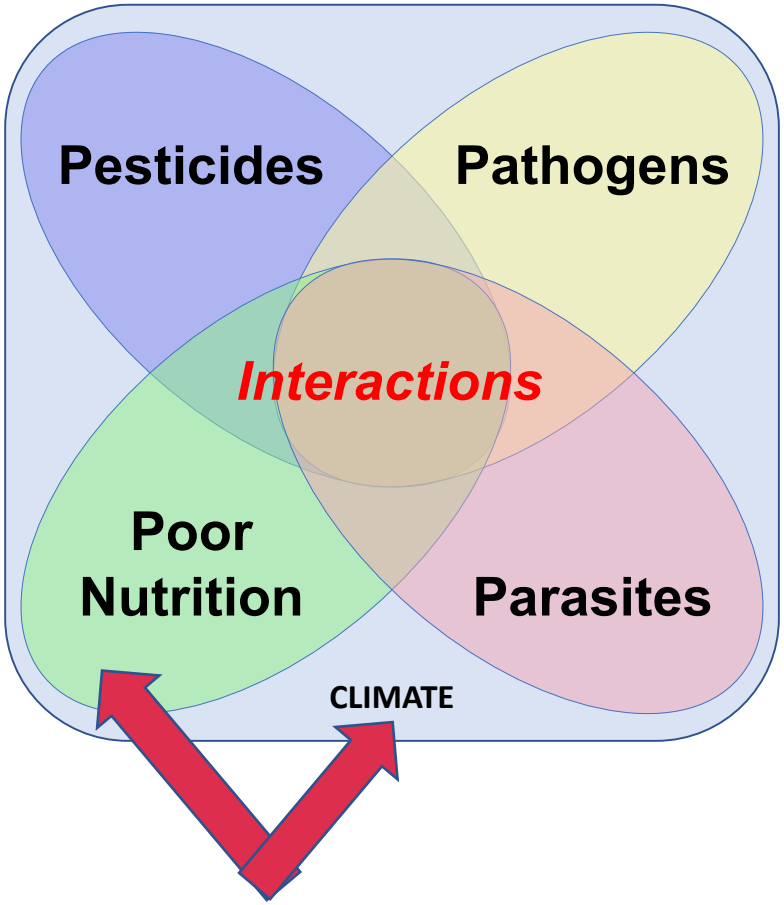





Bee Diversity

- 20,000 species globally
- 4,000+ in North America
- *Keystones* in food supply and environments

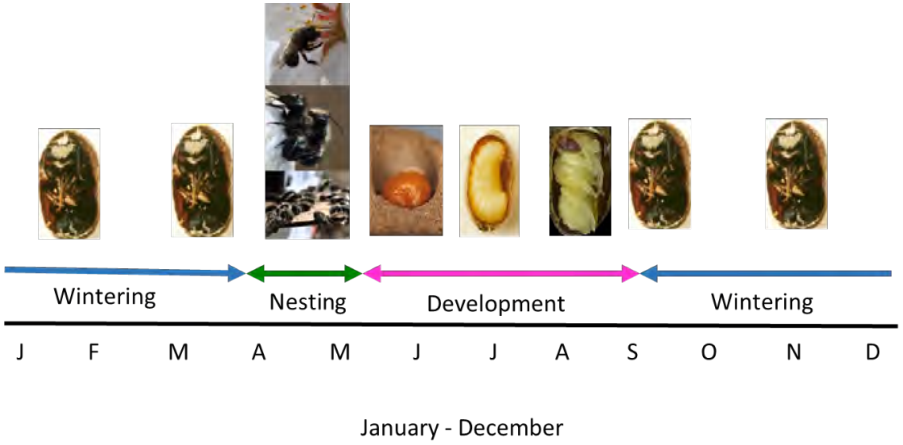


MAJOR THREAT TO BEES?

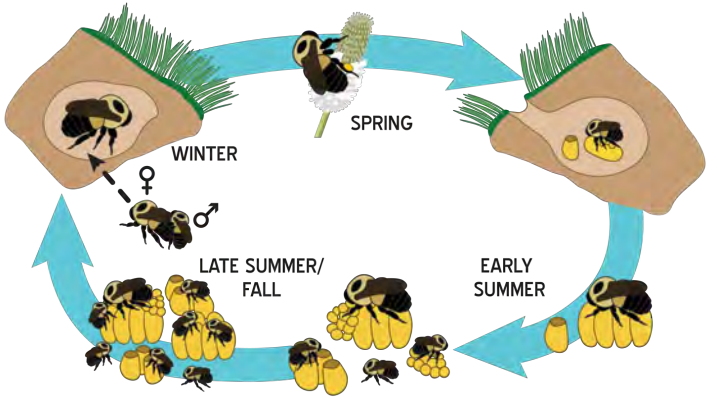
Are impacts of climate change compounding stress from the reduction in floral resources?

- NASS Honey report- United States honey production down 14 % in 2021
- Increased annual loss of honey bee colonies in 2020, 2021 (and 2022??), especially in western states reporting data to Bee Informed Partnership
- Potential link of climate change (increased temperatures and drought) to declines in the Western Bumble Bee (*Bombus occidentalis*) (being considered for EAS listing)
- Concern for all bee species
- Need to create more “bee pasture”, especially for honey bee colonies

Solitary bees

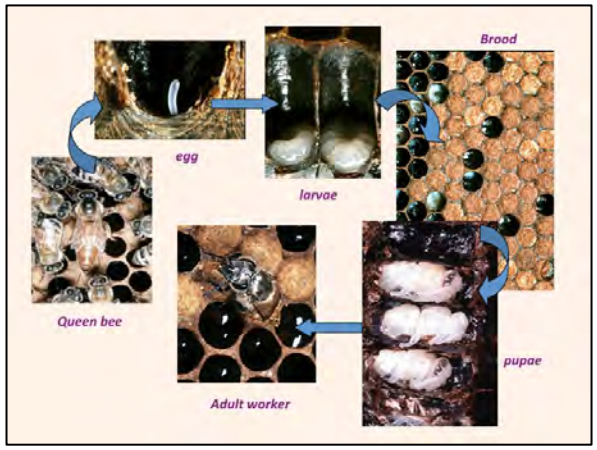


Bumble bees



https://wisconsinbumblebees.entomology.wisc.edu/about-bumble-bees/life-cycle-and-development/

Honey bees



Diversity in Life Histories– common need for pollen and nectar

Benefits for bee health and diversity from drought-tolerant plantings ("bee pasture") for drought-stricken areas in the West

Principal Investigators:

Kevin Jensen, Alexander Hernandez, Craig Rigby

Forage and Range Research Lab, Logan, Utah

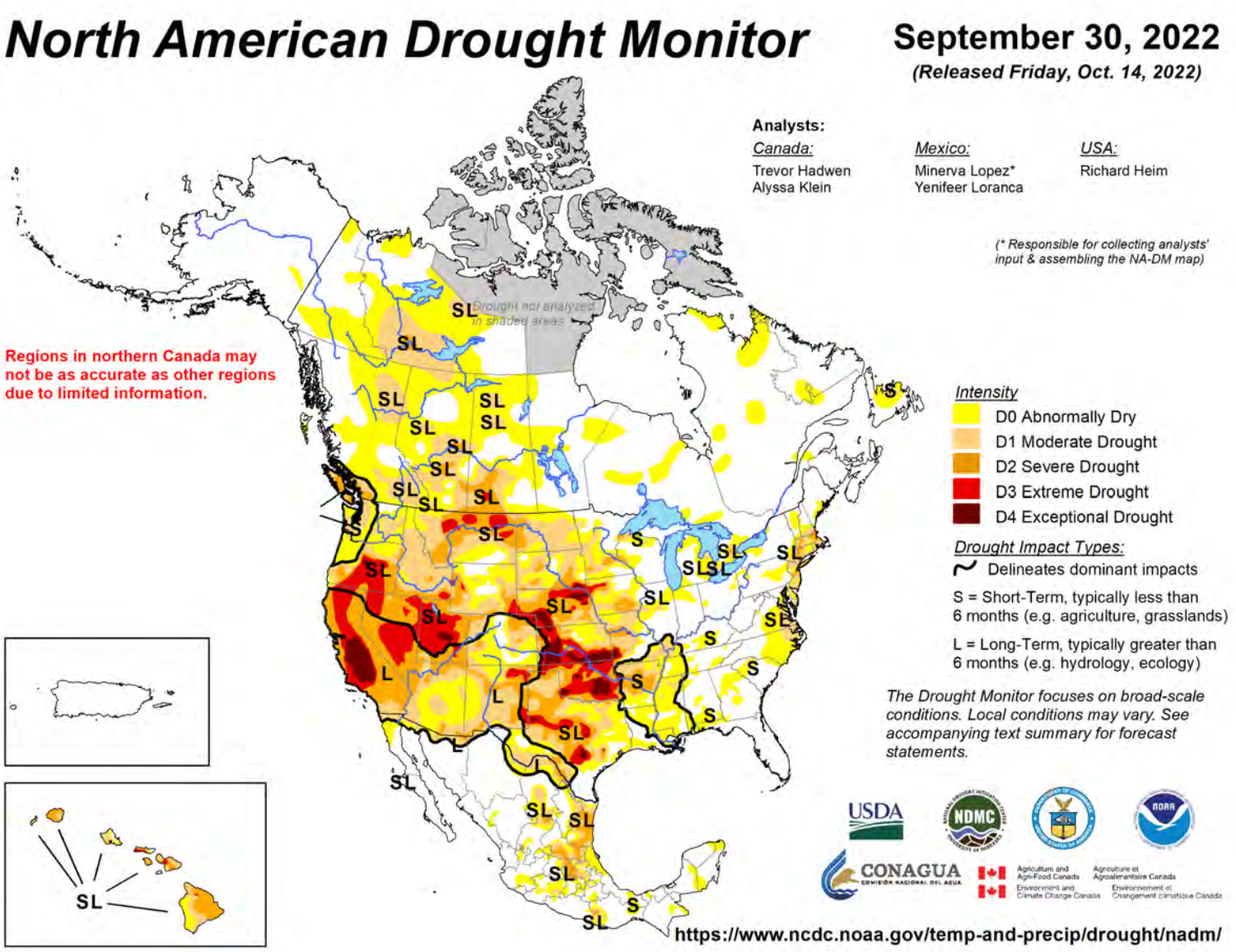
Diana Cox-Foster, Kelsey Graham, and Byron Love

Pollinating Insect Research Unit, Logan, Utah

Project *Apis m.*

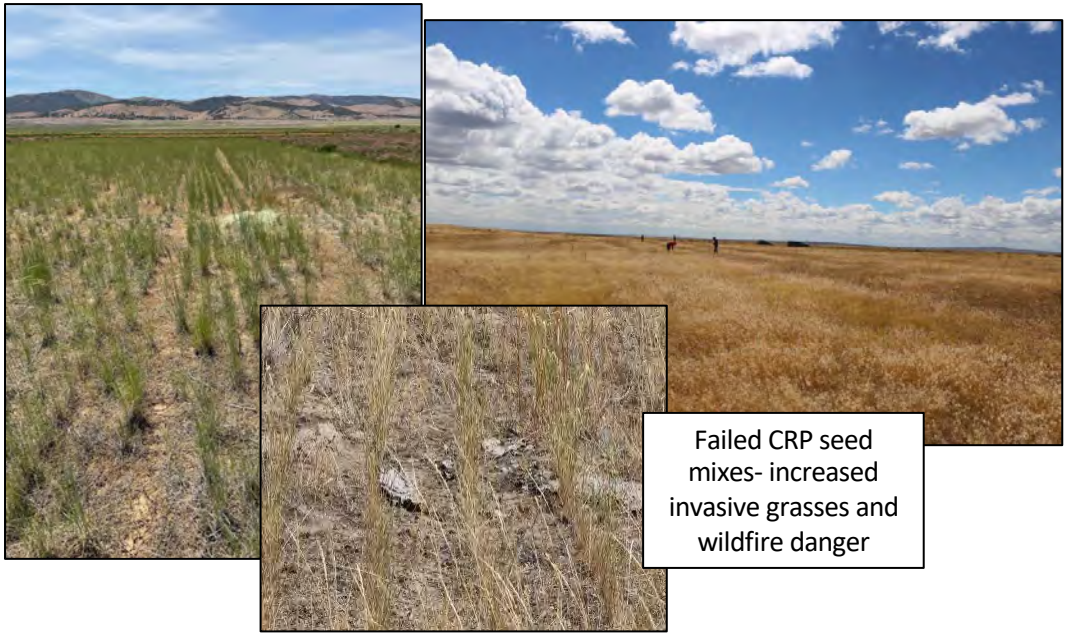
COSTCO WHOLESALE

”Drought of the Century” in North America



CHEATGRASS

An invasive grass responsible for wildfires in the Great Basin Region



Failed CRP seed mixes- increased invasive grasses and wildfire danger

June 2022- floral and pollinator survey in Nephi, UT. Successful planting of FRR native and introduced pollinator seed mix, planted 2017 and 2018

Can this seed mix and planting methods be modified for other areas to support all types of bees?

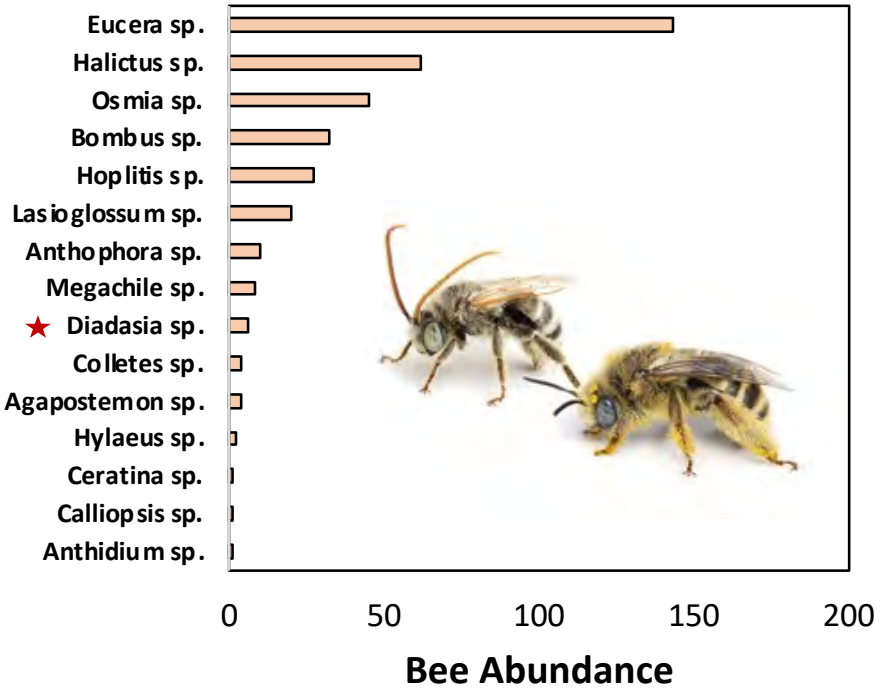
The need for "Bee Pasture"

- Finding drought-tolerant seed mixes and planting methods to sustain healthy pollinators (biodiversity) and potentially be used to support honey bee colonies
- Potential added benefits- soil conservation, nitrogen fixation, active plant growth (CO_2 sequestration)

Drought Tolerant Plantings- Nephi, UT (June 2022)

***Apis mellifera* (Honey bees) = 304**

Wild bee community (~ 30 species)



Benefits for bee health and diversity from drought-tolerant plantings ("bee pasture") for drought-stricken areas in the West

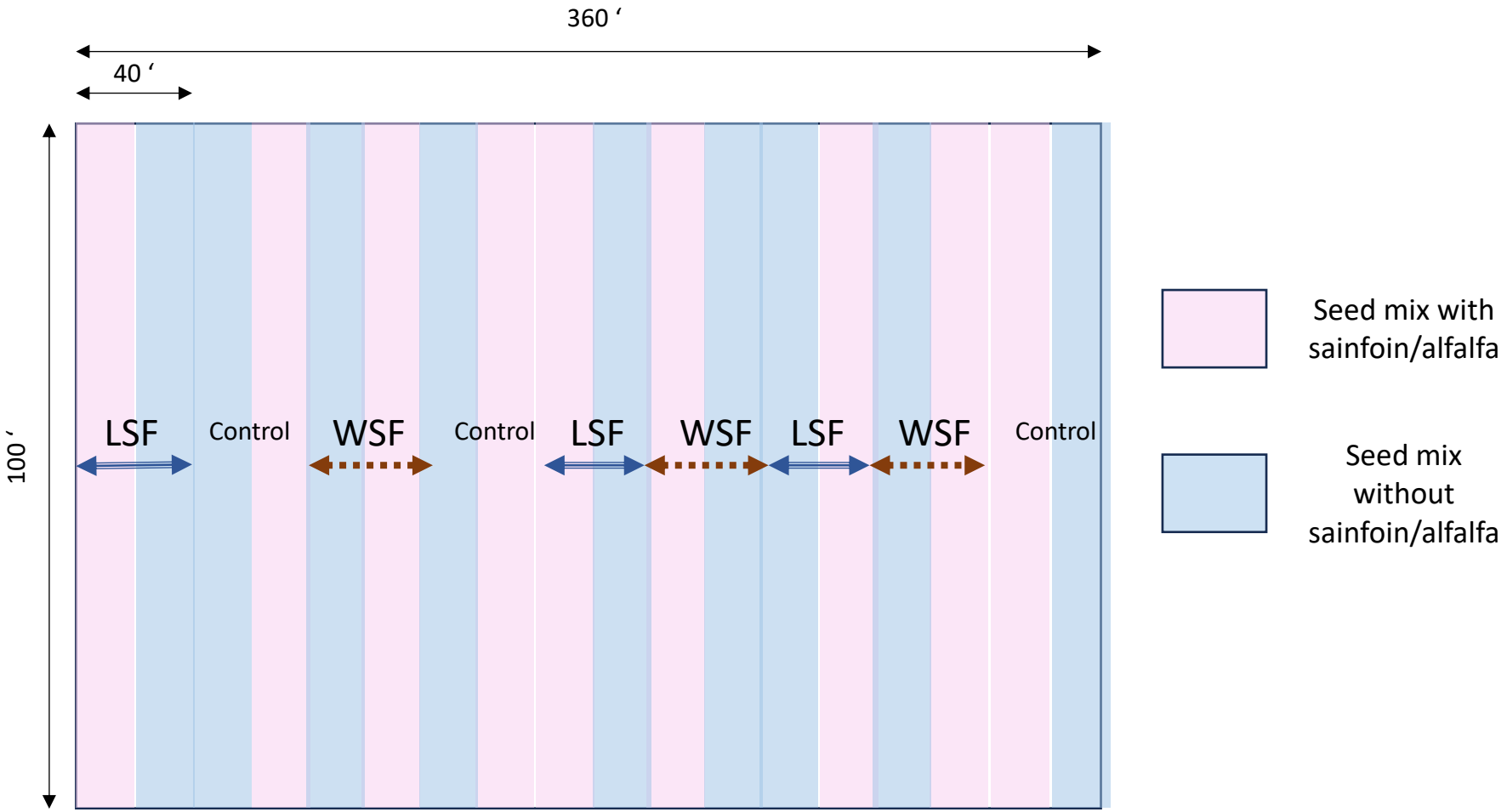
Objectives:

- Can a native/introduced pollinator seed mix be modified to have bloom throughout a season from spring to fall?
- Do wind/snow breaks offer added moisture for pollinator plants and aide in the establishment of floral resources?
- Are all the floral resources of benefit to pollinators as floral resources?

Creating an ideal plant list…

Common name	Scientific name	S=seeding; F=fence	Blooming							Annual Precip.			Seeding rate (lb\acre
			April	May	June	July	August	September	October	7-9 inches	9-12 inches	12-15 inches	
Grasses													
Intermediate WG	*Thinopyrum intermedium*	S									x	x	2
Meadow brome	*Bromus riparius*	S									x	x	2
Siberian WG	*Agropyron fragile*	S								x	x	x	2
Basin wildrye	*Leymus cinereus*	F								x	x	x	
Pollinator species													
Eastern Mohave Buckwheat	*Eriogonum sp.*	F				x	x	x		x	x		
Rabbitbrush	*Ericameria spp.*	F					x	x	x	x	x	x	
Wyoming Big Sagebrush	*Artemisa tridentata ssp. Wyomingensis*	F						x	x	x	x		
Curleycup gumweed	*Grindelia squarrosa*	F				x	x	x		x	x		
Firecracker penstemon	*P. eatonii*	F	x	x	x						x	x	0.5
Sainfoin	*Onobrychis viciifolia*	S		x	x	x					x	x	2
Alfalfa	*Medicago sativa*	S		x	x	x						x	1
Hoary tansyaster	*Machaeranthera canescens*	S					x	x	x	x	x	x	0.5
Utah sweetvetch	*Hedysarium boreale*	S		x	x							x	0.5
Goldenrod	*Solidago spp.*	S			x							x	0.5
Silverleaf phacelia	*Phacelia hastate*	S			x	x	x				x	x	0.5
Annual sunflower	*Helianthus annus*	S				x	x	x		x	x	x	1
Rapeseed	*Brassica napus*									x	x	x	0.5
Blue flax	*Linum perenne*	S		x	x	x					x	x	0.5
Purple Prairie clover	*Echinacea purpurea*	S				x	x	x				x	0.5
white mustard	*Sinapis alba*	S								x	x		0.5
Yellow sweet clover	*Melilotus officinalis*	S			x	x				x	x	x	0.5
Baasalt milkvetch	*Astraglus filipes*	S		x	x					x	x		0.5
												Total	15.5

Planting scheme- test snow fence types and plant mixtures



Does wind/snow fencing have an impact?

None, mechanical, planted snow fence, or combination (mechanical/planted snow fence)

Mechanical fence (4 ft high)

Basin wildrye transplants

Curley gum weed transplants

Rabbit brush transplants

Sagebrush transplants

<u>Planted snow fence</u>

Basin wildrye
Wyoming Big Sagebrush
Rabbitbrush
Eastern Mohave Buckwheat
Curlycup gumweed
Firecracker penstemon

Eastern Mohave Buckwheat transplants

Penstemen sp. transplants

Reality strikes on seed availability…..

- Report released January 2023
- Found that an insufficient supply of seeds for native plants is a major barrier to ecological restoration and other revegetation projects across the United States.

Common Name	Variety	lbs/acre
Intermediate Wheatgrass	Rush	2
Meadow Brome	Cache	2
Siberian wheatgrass	Vavilov II	2
Sainfoin	Eski	2
Alfalfa	Ladak II	1
Dalea Searlse	Fanny	0.5
Utah Sweetvetch		0.5
Curlycup gumweed		0.3
Yarrow	Yakima	0.5
Annual sunflower		1
Rapeseed		0.5
Blue flax	Appar	0.5
Purple prairie clover		0.5
firecracker penstemon		0.5
yellow sweetclover		0.5
Basalt milkvetch	NBR-1	0.5
TOTAL		14.8

Planted seed mix restricted by seed availability (additional plants in living snow fence)

Determining impacts on bee populations

- Sampling endemic bees in plantings
- Ask if bees can reproduce using sentinel colonies and be nests

Want to learn more?
Check out the Project Apis m. website and YouTube channel

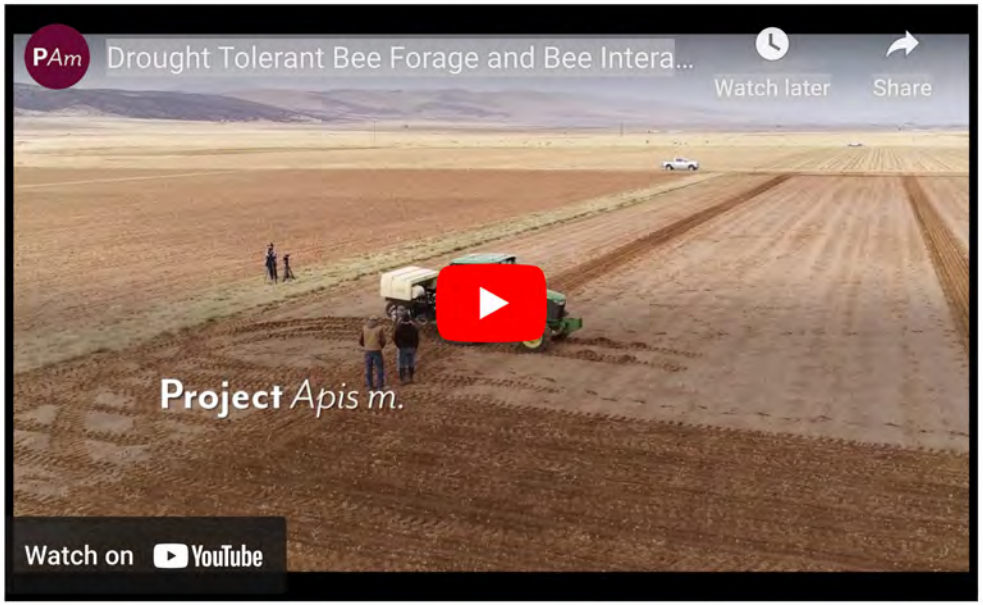


Photo: Nancy Adamson

Pollinator plantings along side blueberry fields- the hazards for bees due to pesticides

Kelsey K. Graham, PhD

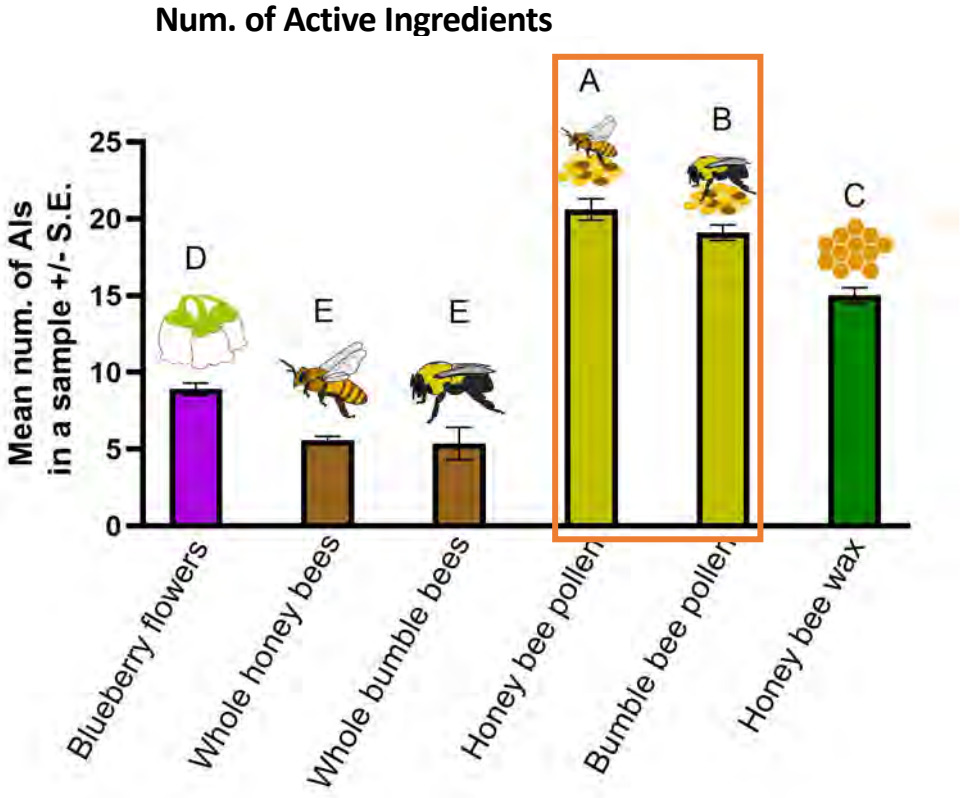
USDA ARS Pollinating Insect – Biology, Management, Systematics Research Unit, Logan, UT

Pesticide exposure of managed honey bees and bumble bees during blueberry pollination

- Pesticide applications known for all 15 blueberry growers
- Collected blueberry flowers, whole bees, pollen, and wax at 15 farms in 2 years.
- Screened for 291 active ingredients at Scott McArt's lab at Cornell.

Graham et al. 2021, *Scientific Reports*
Graham et al. 2022, *Scientific Reports*

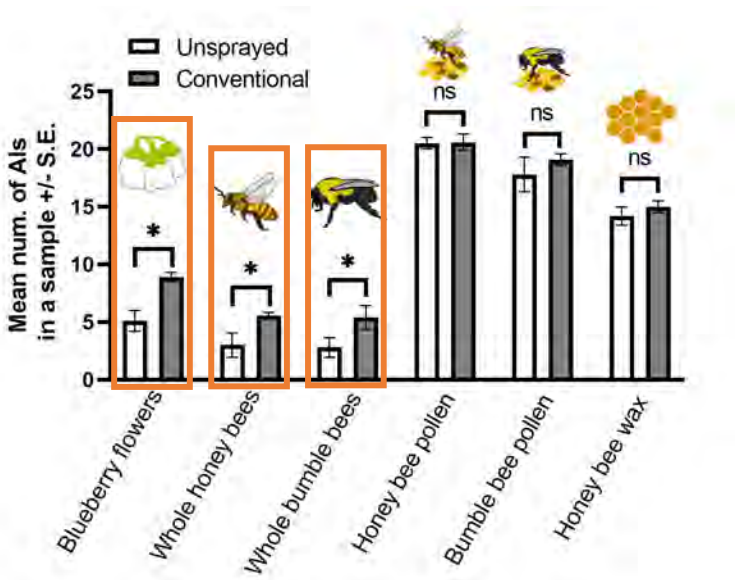
Pollen had significantly more AIs than other sample types

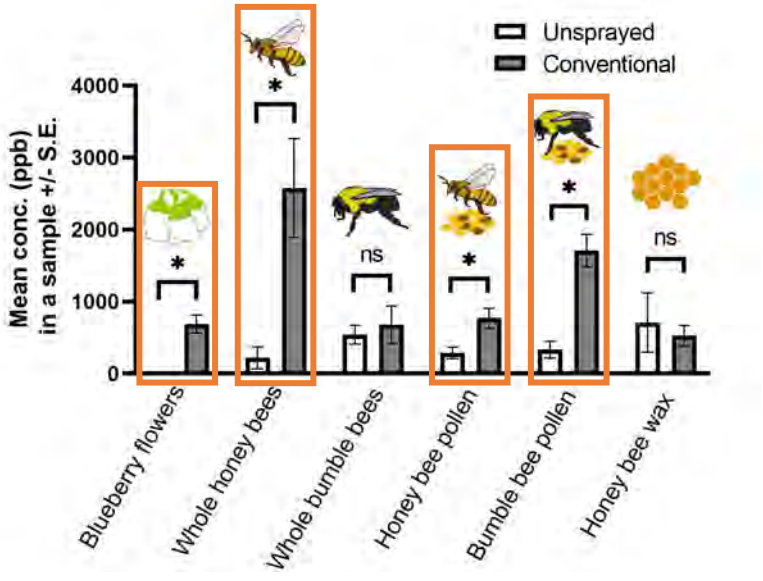


*conventional farm data

Graham, et al. 2021, *Scientific Reports*

Farm management affected number of AI's and concentrations in flowers, whole bees, and bee collected pollen





Graham, et al. 2021, *Scientific Reports*

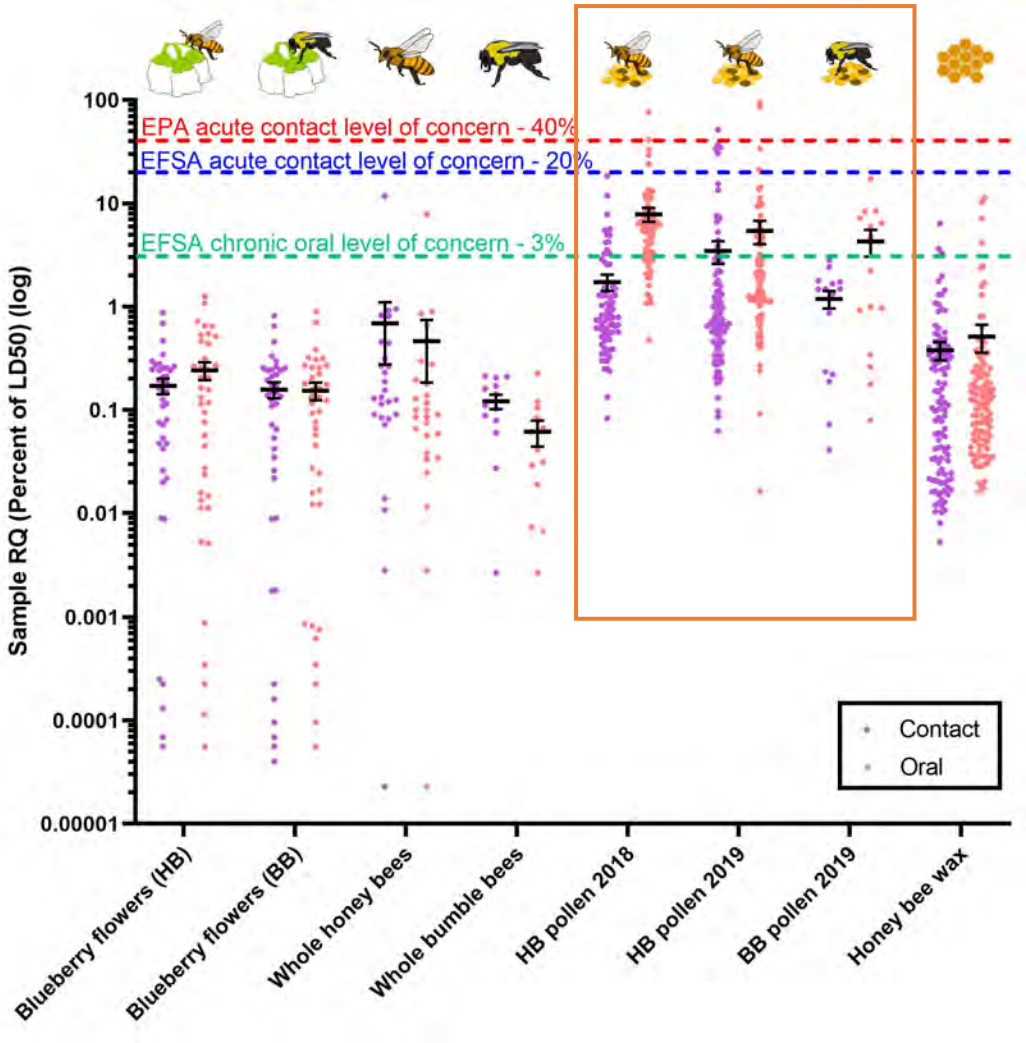
Graham, Milbrath, Zhang, Baert, McArt, and Isaacs, *in review*

Exposures through bee collected pollen represented the highest risk to bees

Pollen samples had an average of 22 AIs, and a minimum of 12 AIs

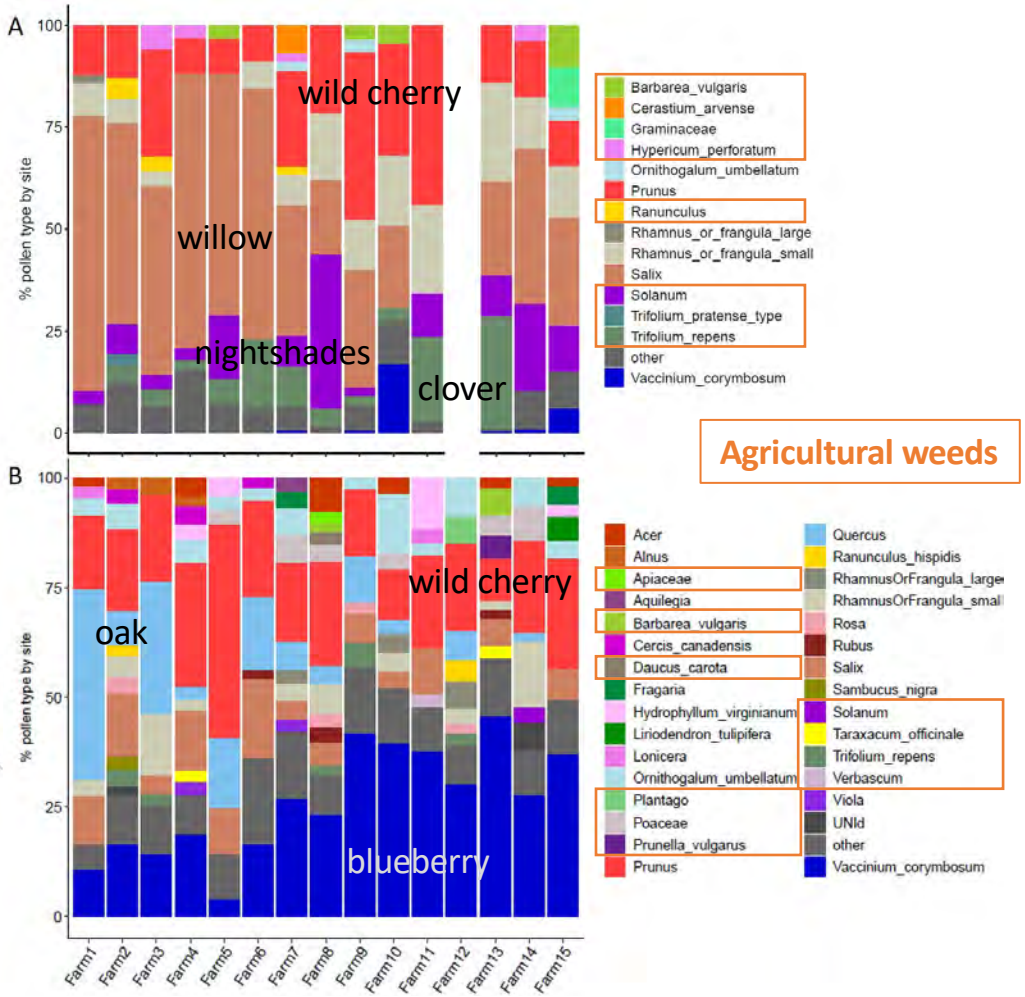
Most pollen samples were above the EFSA LOC for chronic oral exposure – 3% of the LD50

Graham et al., 2022 *Scientific Reports*



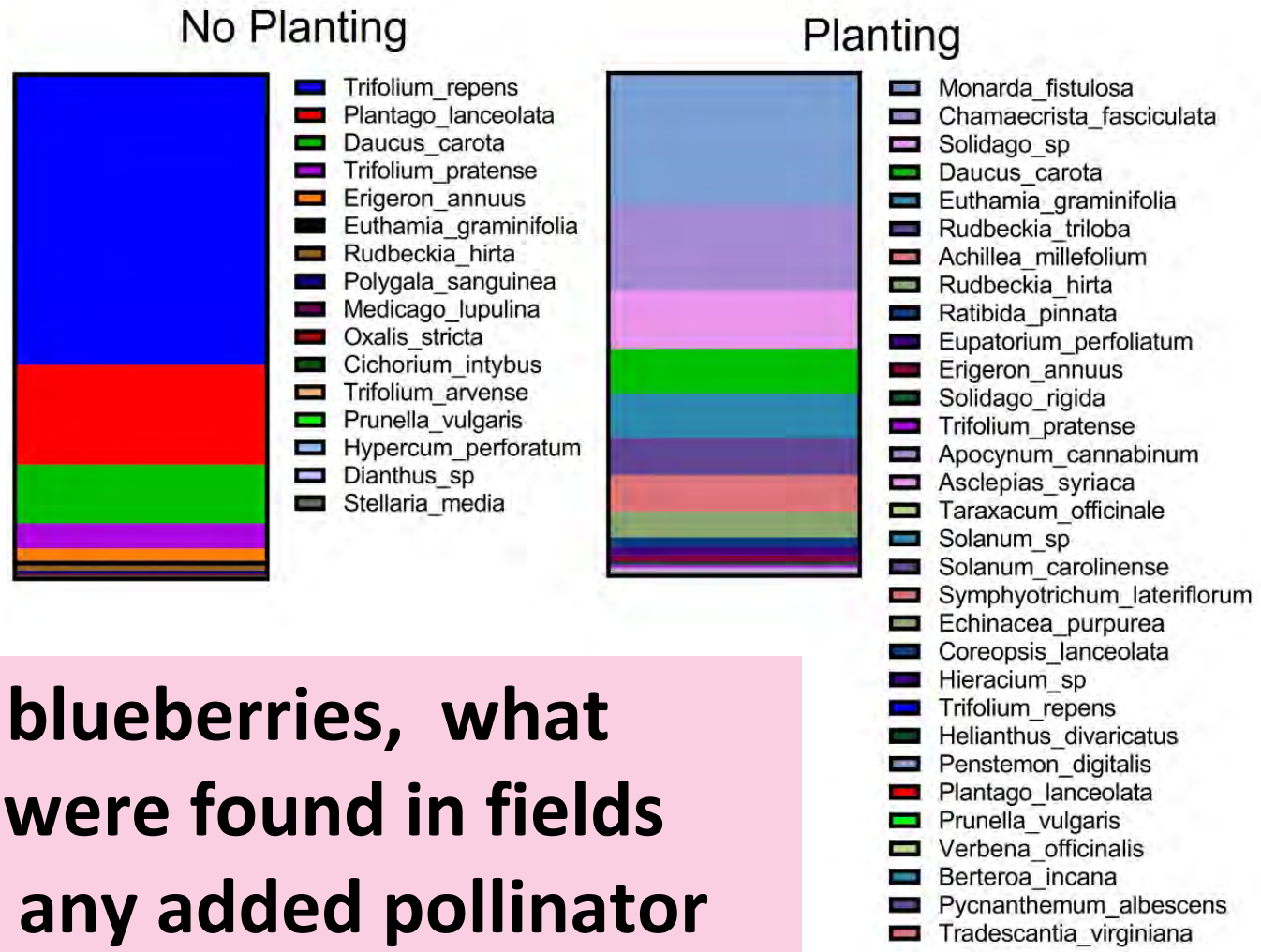
Honey bees and bumble bees forage at different plants

Sources of high-risk exposure are likely weeds in agricultural fields



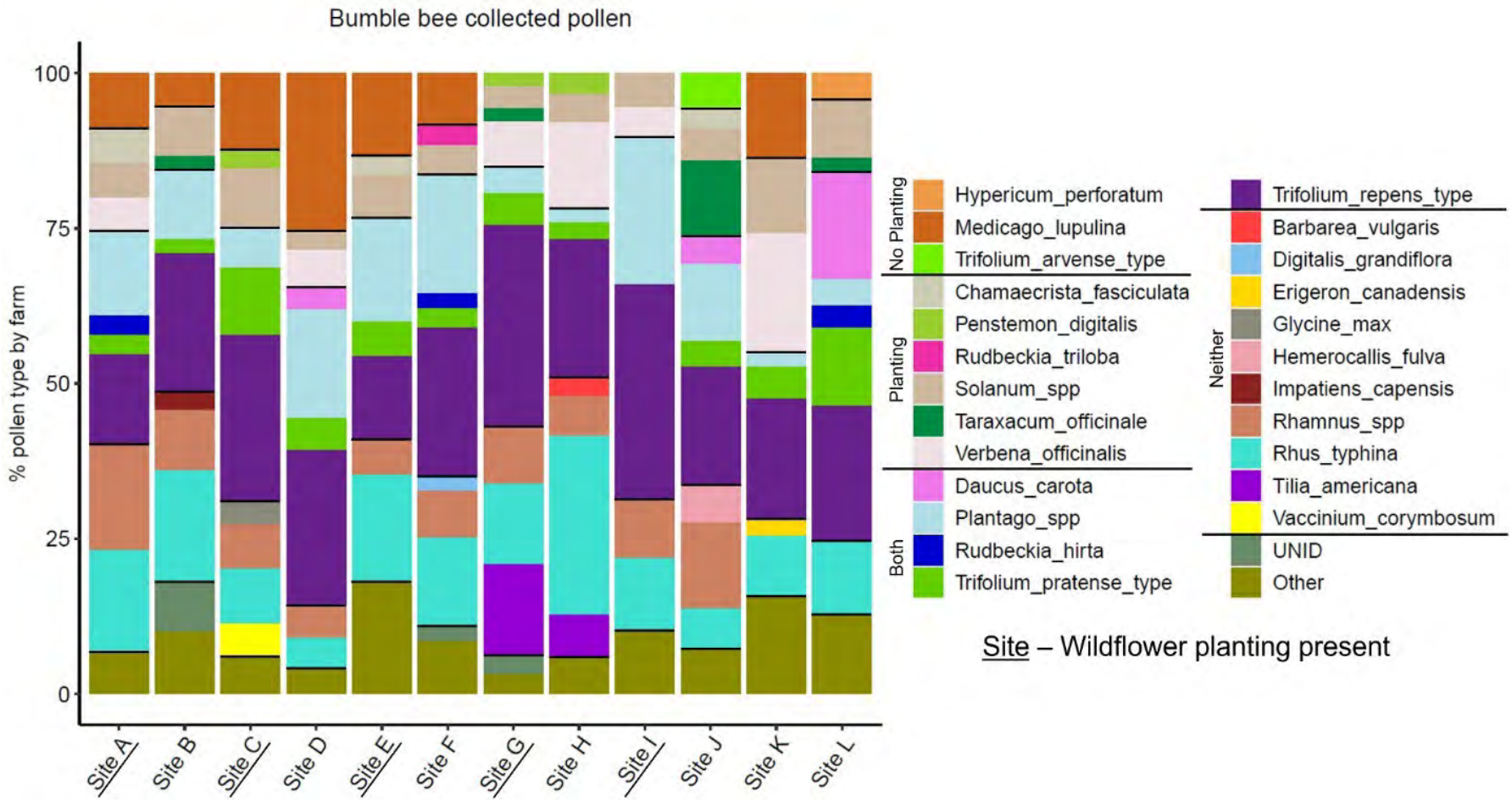

Wildflower planting on a commercial
blueberry farm

Native Wildflowers
Wildflower planting on a commercial
blueberry farm

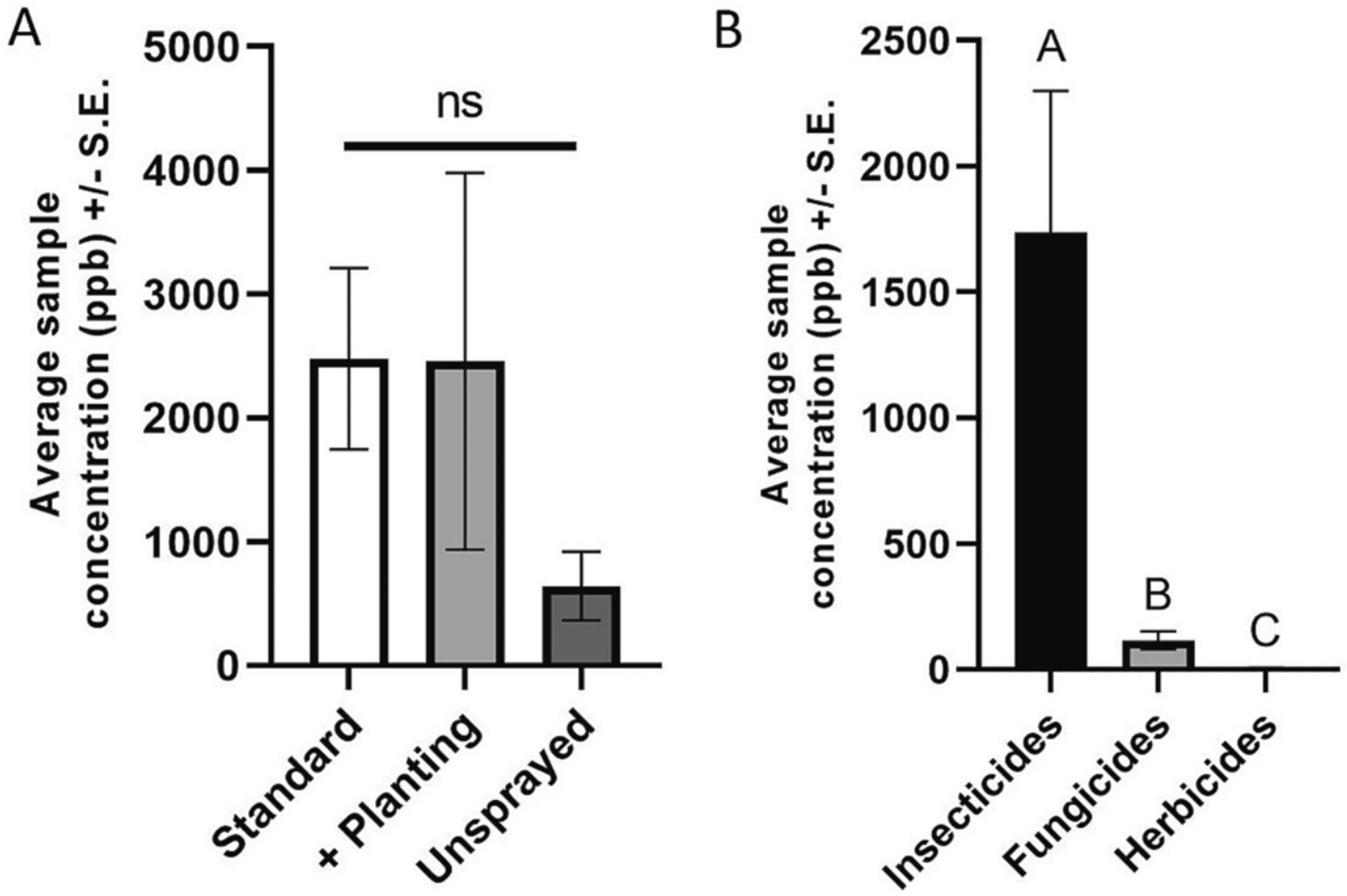


Besides blueberries, what flowers were found in fields without any added pollinator plantings vs. those with?

Bumble Bees gathered pollen from plants across the landscape and not from pollinator plantings



Pollinator plantings did not reduce the exposure to pesticide if near conventional orchards as detected in BB pollen

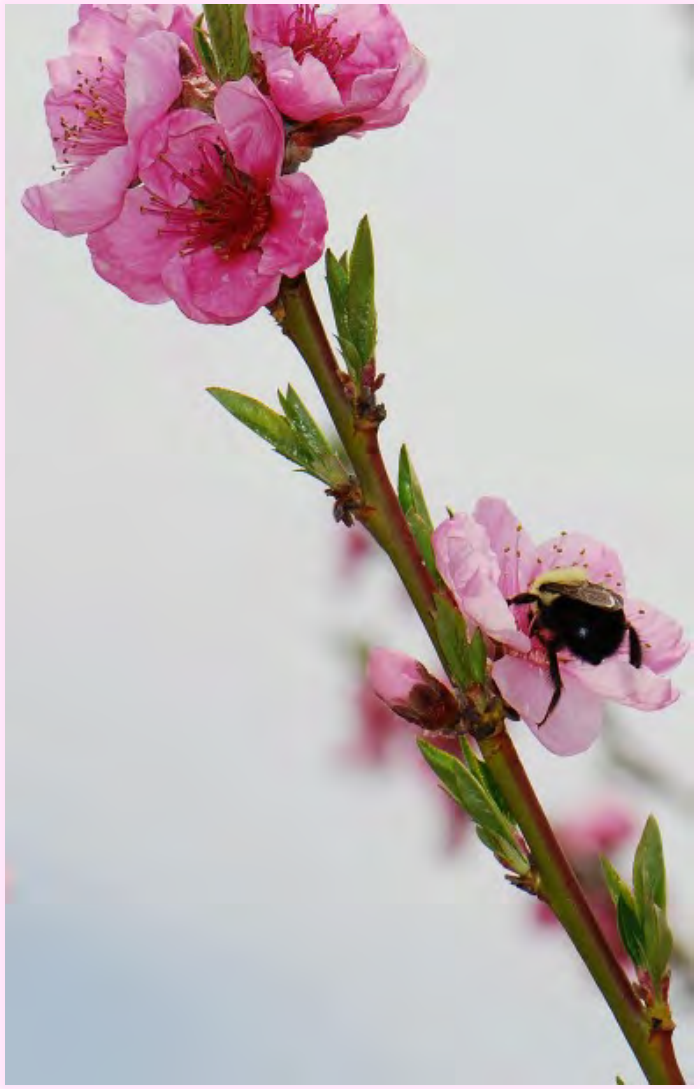


Pollinator plantings next to blueberry field--

- We tested if pollinator plantings by crops are safe havens from pesticide exposure.
- Flower, soil, and bee-collected pollen samples were analyzed for pesticides.
- Pesticide residues and risk were similar at farms with and without plantings.
- Pesticide drift should be minimized near attractive flowering plants.

Graham References--

- Graham KK, Gibbs J, Wilson J, May E, Issacs R. (2021) Resampling of wild bees across fifteen years reveals variable species declines and recoveries after extreme weather. Agriculture, Ecosystems, & Environment, 317. https://doi.org/10.1016/j.agee.2021.107470
- Graham KK, McArt S, Isaacs R. (2024) High pesticide exposure and risk to bees in pollinator plantings adjacent to conventionally managed blueberry fields. Sci Total Environ. 922:171248. doi: 10.1016/j.scitotenv.2024.171248.
- Graham KK, Milbrath MO, Killewald M, Soehnlen A, Zhang Y, Isaacs R. (2023) Identity and diversity of pollen collected by two managed bee species while in blueberry fields for pollination. Environmental Entomology, 52(5): 907-917. https://doi.org/10.1093/ee/nvad072
- Graham KK, Milbrath MO, Zhang Y, Baert N, McArt S, Isaacs R. (2022) Pesticide risk to managed bees during blueberry pollination is primarily driven by off-farm exposures. Scientific Reports, 12(1): 1-16. https://www.nature.com/articles/s41598-022-11156-1
- Graham KK, Milbrath MO, Zhang Y, Soehnlen A, Baert N, McArt S, Isaacs R. (2021) Identities, concentrations, and sources of pesticide exposure in pollen collected by managed bees during blueberry bloom. Scientific Reports, 11(1): 1-13. https://www.nature.com/articles/s41598-021-96249-z



Thank you for inviting me!

Questions or want additional details–

Diana.Cox-Foster@usda.gov