

Integrating Nature-Based Solutions into Long-term Monitoring Methodologies at Reclamation Sites: A Pilot Study

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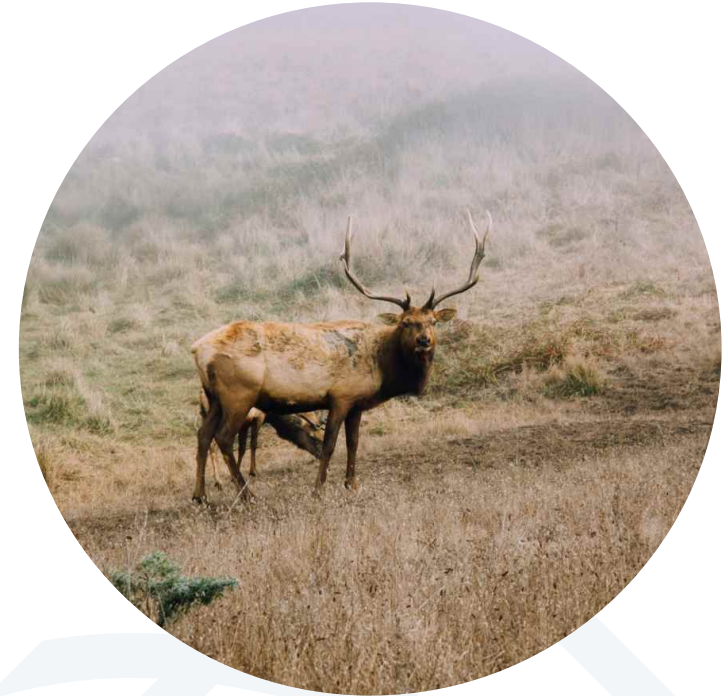
Pilot Project Idea: Reclamation with vegetation rehabilitation



Reclamation sites often have vegetation rehabilitation as part of the remedy to protect the environment and human health.



Following implementation, routine assessments are required to monitor for remedy success, sometime spanning decades.



The process can impact ESG goals for clients including carbon impacts, biodiversity, and community economic value.

Traditional Monitoring and ESG Impacts

E NVIRONMENT

S OCIAL

G OVERNANCE

Boots on the Ground Vegetation Survey

- ▶ Species Diversity
- ▶ Weedy Species
- ▶ Erosion assessment
- ▶ Bare area assessment



- ▶ CO₂ from travel, hotel, flights



- ▶ 500+ field hours
- ▶ Increase exposure to safety risks



- ▶ Financial reserve planning up to \$3M for 10 year OM&M

** ESG impacts are based on example site scale with a 10,000 acre area, not the pilot study location.

Pilot Hypothesis

Can BeeOdiversity's technology using bees as drones serve as a supplement, or compliment, to the current vegetation O&M practices to demonstrate remedy success?



Plant Species Identified		P1	P2	P1+P2
Number of species		19	11	9
Brassica sp.	Cabbages & Mustards	D	D	
Ericameria nauseosa	Rabbitbrush - rubber	D	D	
Trifolium sp.	White clover	D	s	D
Cirsium arvense	Creeping thistle (Asteraceae)	D	s	
Sinapis arvensis	Charlock mustard	D	s	
Chrysothamnus viscidiflorus	Rabbitbrush - yellow & green	D		D
Verbascum thapsus	Great mullein	s	s	s
Helianthus annuus	Common sunflower	s	s	
Bidens cernua	Nodding beggarticks	s	s	
Brassica rapa	Field mustard	s	s	
Taraxacum sp.	Dandelion	s	s	
Taraxacum officinale	Common Dandelion	s	s	
Centaurea stoebe	Spotted knapweed	s		
Helenium autumnale	Common sneezeweed	s		
Liatris sp.	Dense blazing star	s		
Medicago sativa	Alfalfa	s		
Melilotus sp.	Sweet clover	s		

BeeOdiversity Typical Table

Common Name	Scientific Name				
		2006	2009	2012	2013
ACCEPTABLE SPECIES					
Western Yarrow	<i>Achillea lanulosa</i>				x
Crested Wheatgrass	<i>Agropyron cristatum</i>	x	x	x	x
Thickspike Wheatgrass	<i>Agropyron dasystachyum</i>		x	x	x
Tall Wheatgrass	<i>Agropyron elongatum</i>	x	x	x	x
Intermediate Wheatgrass	<i>Agropyron intermedium</i>	m	m	m	m
Western Wheatgrass	<i>Agropyron smithii</i>	x	x	x	x
Slender Wheatgrass	<i>Agropyron trachycaulum</i>			x	
Pussytoes	<i>Antennaria rosea</i>				x
Red Threeawn	<i>Aristida longiseta</i>			x	
Silver Sagebrush	<i>Artemisia cana</i>	x	x	x	x
Fringed Sagewort	<i>Artemisia frigida</i>				
Showy Milkweed	<i>Asclepias speciosa</i>	x	x	x	x
White Aster	<i>Aster falcatus</i>	x	x	x	x
Two-grooved Milkvetch	<i>Astragalus bisulcatus</i>	x	x	x	x
Regar Meadow Brome	<i>Bromus biebersteinii</i>	x			
Smooth Brome	<i>Bromus inermis</i>	x	m	m	m
Prairie Sandreed	<i>Calamovilfa longifolia</i>			x	x
Spurge	<i>Chamaesyce glyptosperma</i>				x
Rubber Rabbitbrush	<i>Chrysothamnus nauseosus</i>	x	x	x	x
Prairie Thistle	<i>Cirsium undulatum</i>				x

"Boots on Ground" Field Table

Pilot Study Goals

Determine the applicability this nature-based solution to supplement or compliment current "boots-on-the-ground" vegetation monitoring standard practices.



Evaluate opportunities for ecosystem enhancement at the site.

Consider site relationship and contribution to biodiversity characteristics in surrounding communities.



Assess ESG impacts and benefits of this alternate monitoring methodology.



Pesticide
Screening

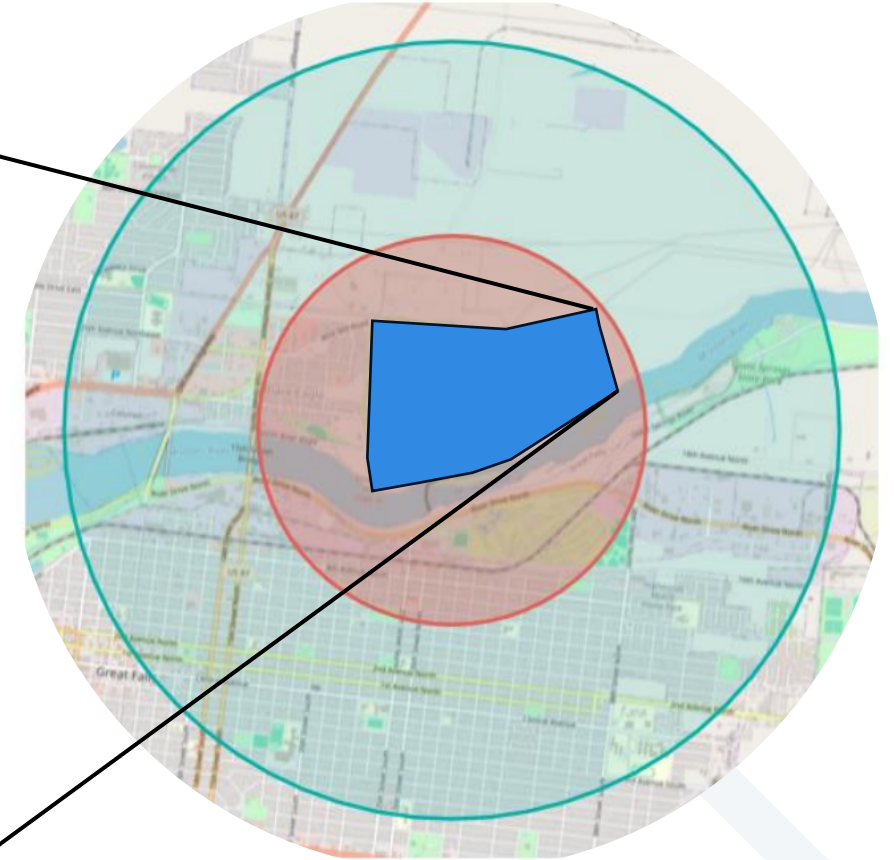


Pollen
Nutritional
Value



Site Selection

A remediation site in Montana was selected for the pilot study for multiple reasons:



- Contemporaneous, planned vegetation monitoring assessment that could be used for data comparison.
- Data collection beneficial to serve as baseline and enhanced information to assess ecosystem impacts for an upcoming remedy alternatives analysis.

Pilot Approach

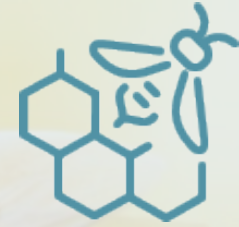


Train Local Beekeepers on
BeeOdiversity technology



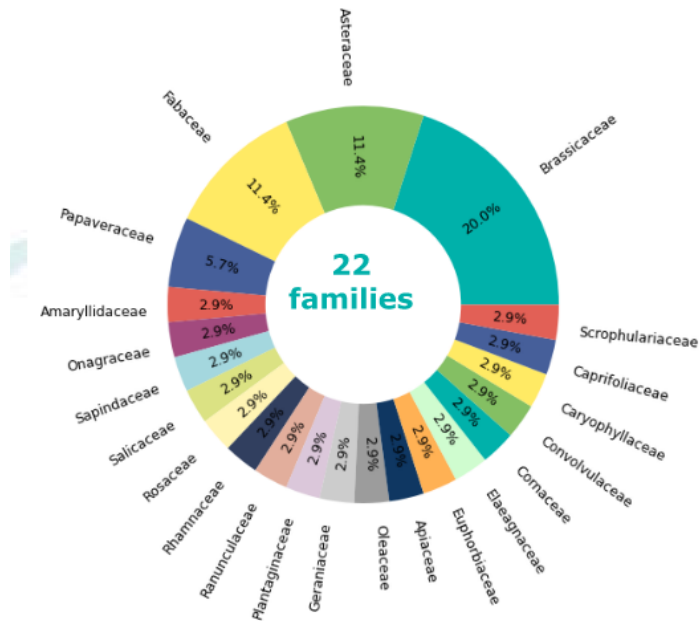
Place hives

- 3 locations
 - Multiple hives at each location for redundancy
 - US0033 – near river
 - US0035 – west
 - US0037 – east
- 4 sample events
 - Used to span seasons of growth
 - Assess pesticide season
 - Quantify nutritional value of food sources across seasons

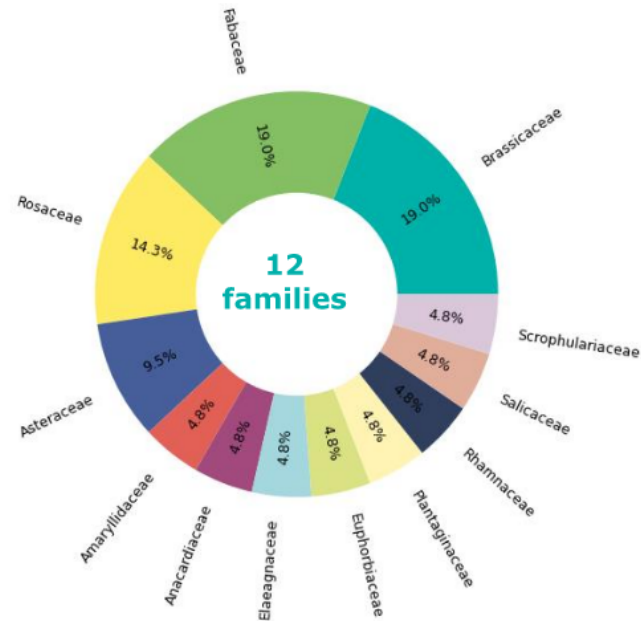


Assess samples
Compare field data

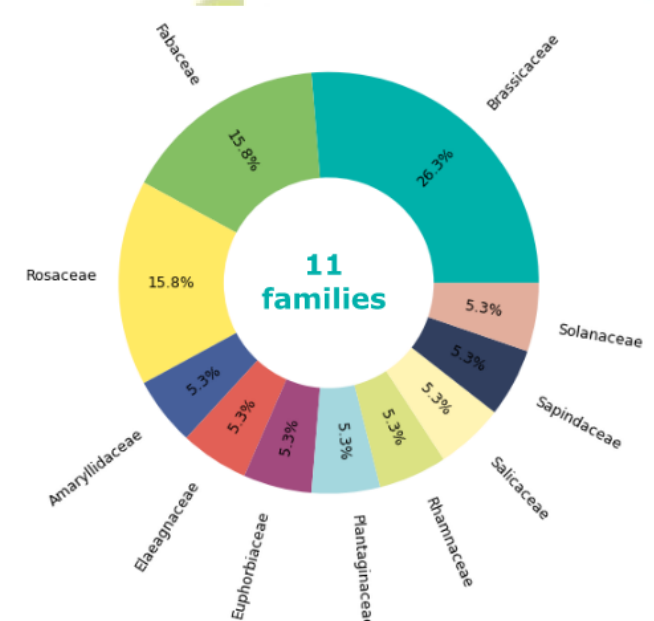
Results: Biodiversity



US0033



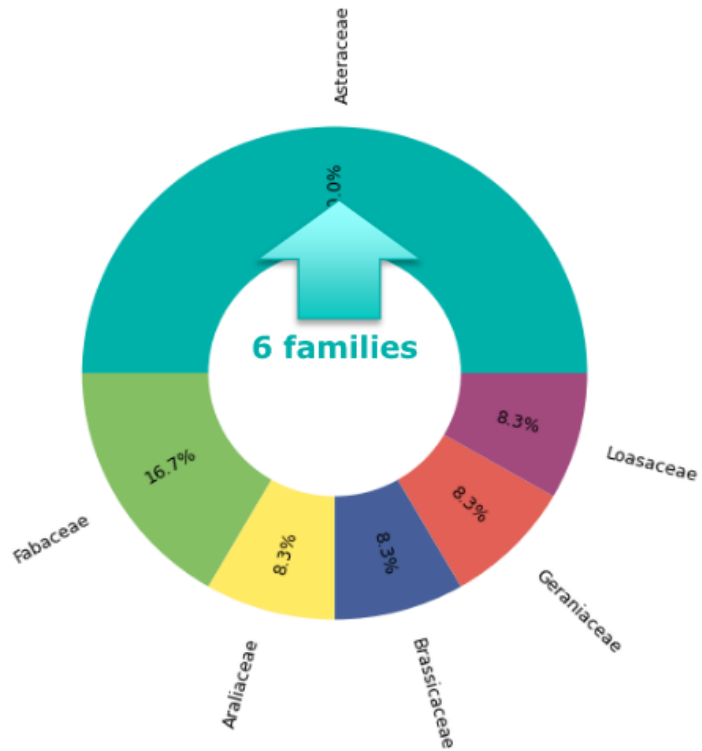
US0035



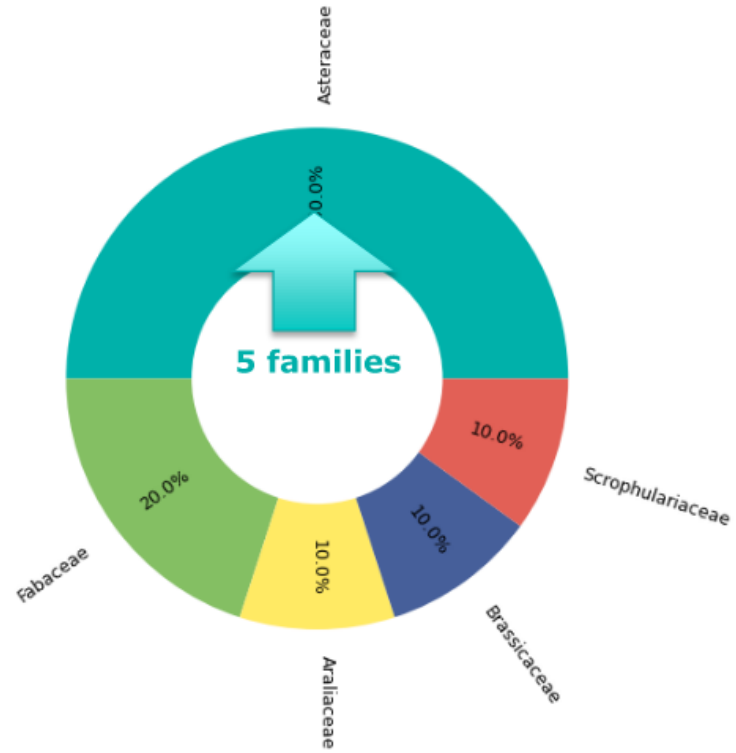
US0037

Period 2 Results (end of May – mid-July)

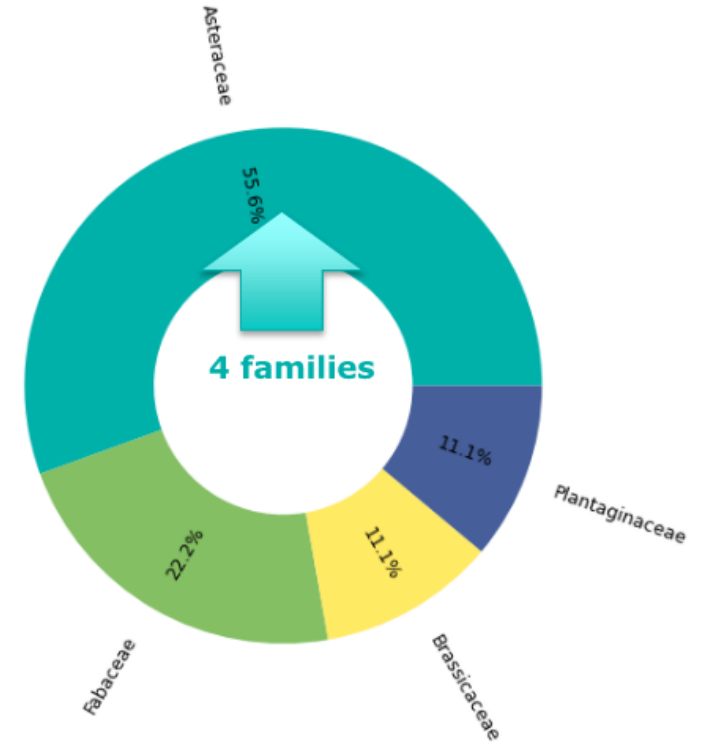
Results: Biodiversity



US0033



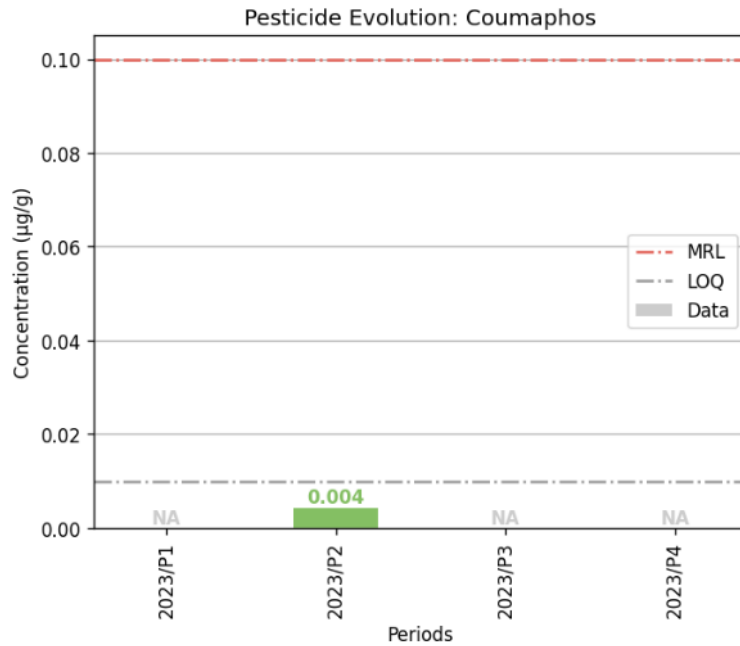
US0035



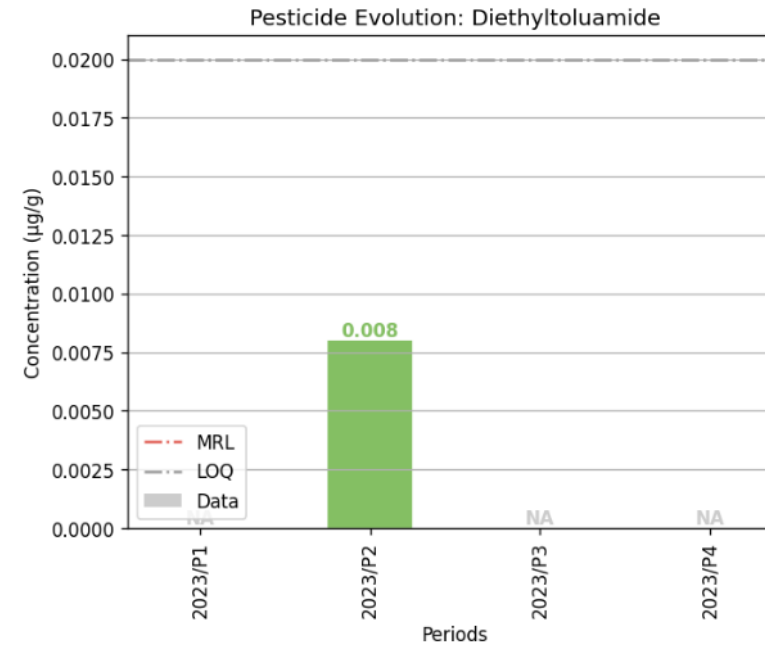
US0037

Period 4 Results (end of August – mid-October)

Results: Pesticide Analysis

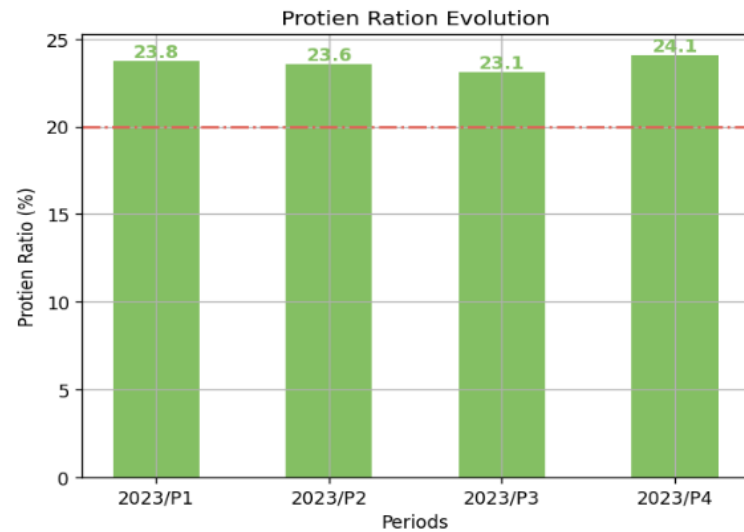


	Coumaphos
Labels	Insecticide
Application Examples	
Product Examples	

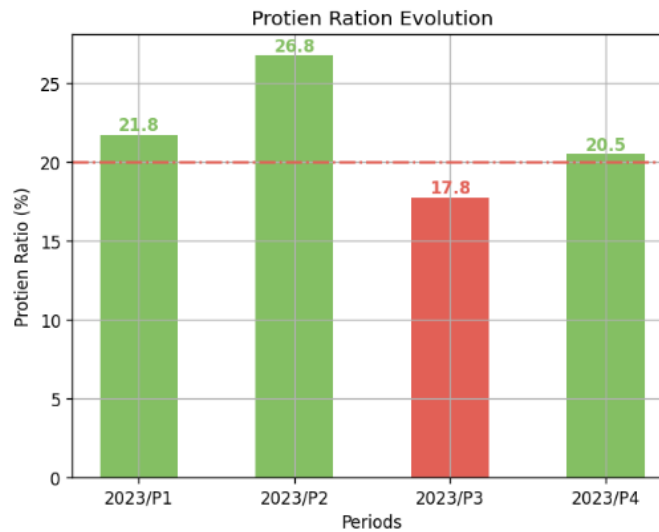


	Diethyltoluamide
Labels	Insecticide, Repellent, Synthetic
Application Examples	Clothes, Human skins
Product Examples	Deet

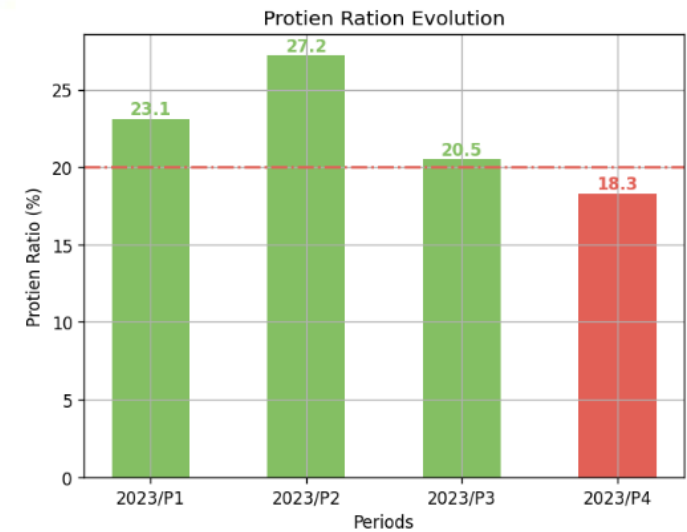
Results: Pollen Nutritional Value



US0033



US0035



US0037

Pilot Approach

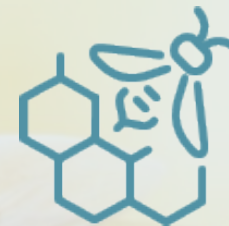


Train Local Beekeepers on BeeOdiversity technology.



Place hives

- 3 locations
 - US0033 – near river
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- 4 sample events
 - Used to span seasons of growth
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Assess samples
Compare field data

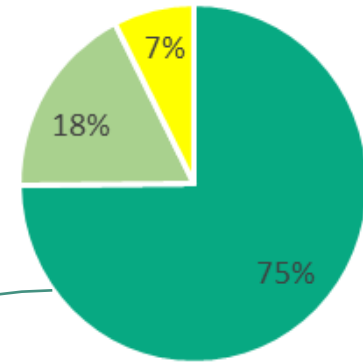


How do they compare?

Project Results: Data Comparability

- 133 BeeOdiversity species results
- 110 Vegetation Survey species results
- 18% Overlapping genus results
- 7% Overlapping species results

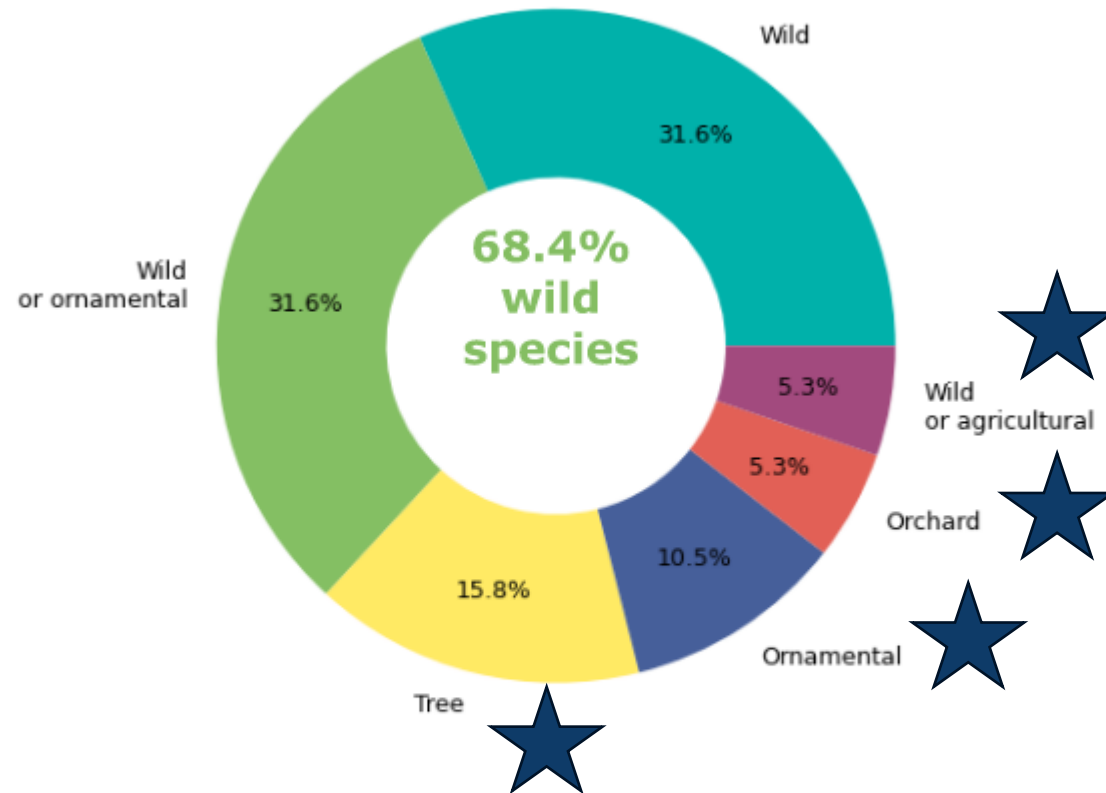
Data Overlap



- Total Number of species in vegetation survey
- Overlapping genus results (Veg Survey and BeeOdiversity)
- Overlapping species results (Veg Survey and BeeOdiversity)

What about the other 75%?

Project Results: Data Comparability

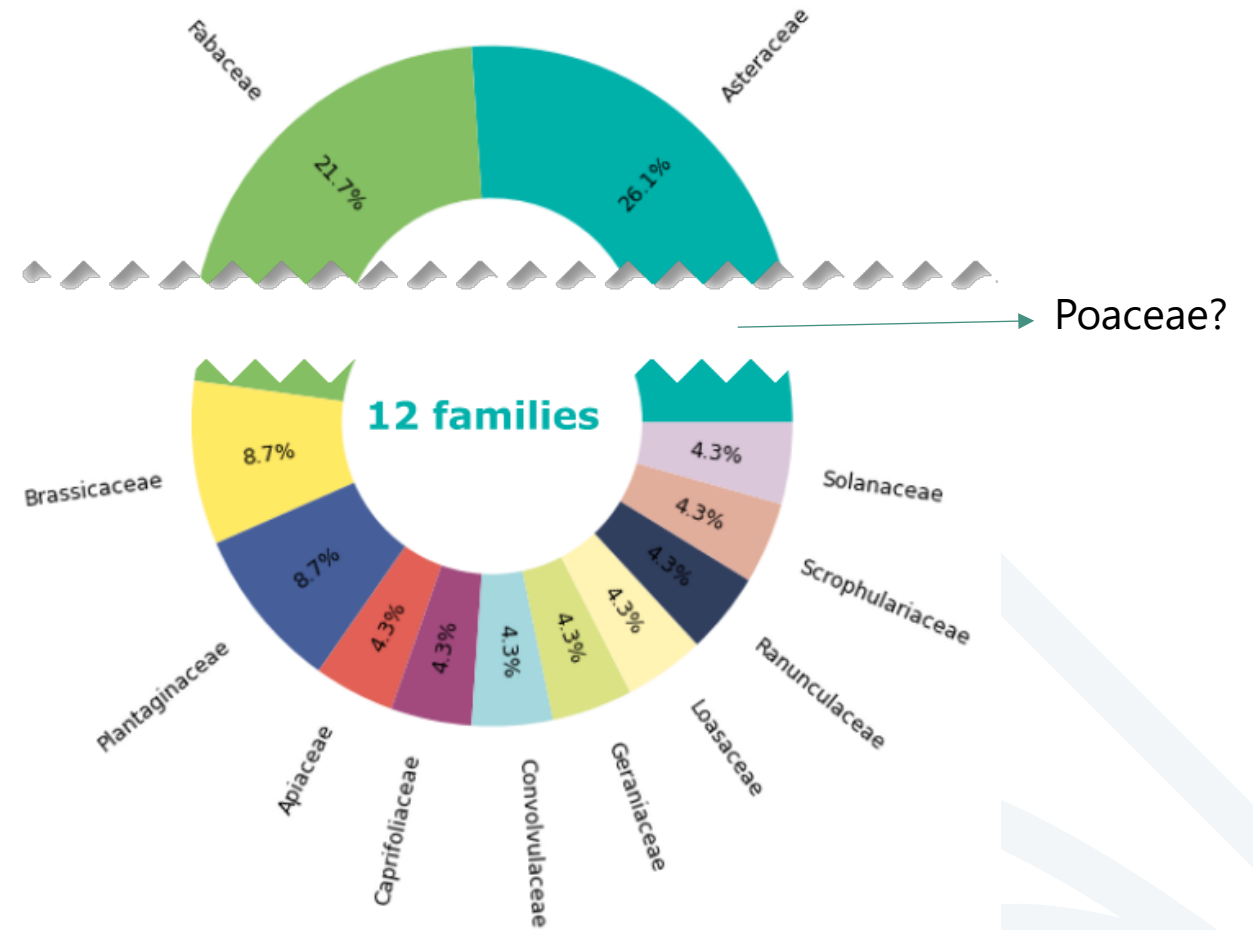


US0037

Project Limitations: Bee Behaviour

"Russian wildrye (*Elymus junceus*) and intermediate wheatgrass (*Agropyron intermedium*) occur as the dominant species in nearly all of the areas. Western wheatgrass (*Agropyron smithii*) and smooth brome (*Bromus inermis*) are also commonly encountered. These species tend to account for most of the vegetation cover."

- 2018 Vegetation Survey





Project Limitations: Data Comparability

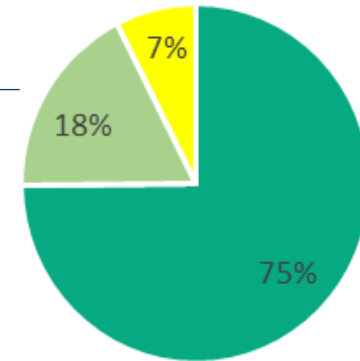
❖ Many of these categorized as “undesirable” or “noxious weeds”

- 7 noxious weeds
- 9 undesirable



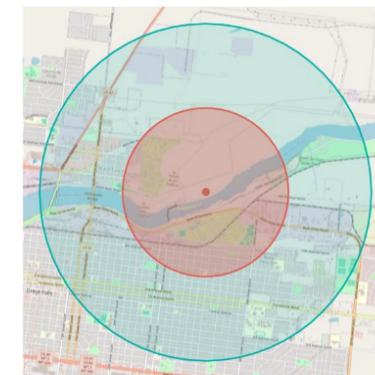
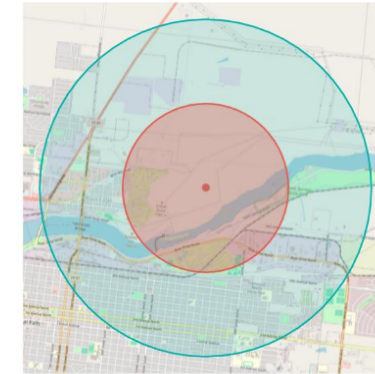
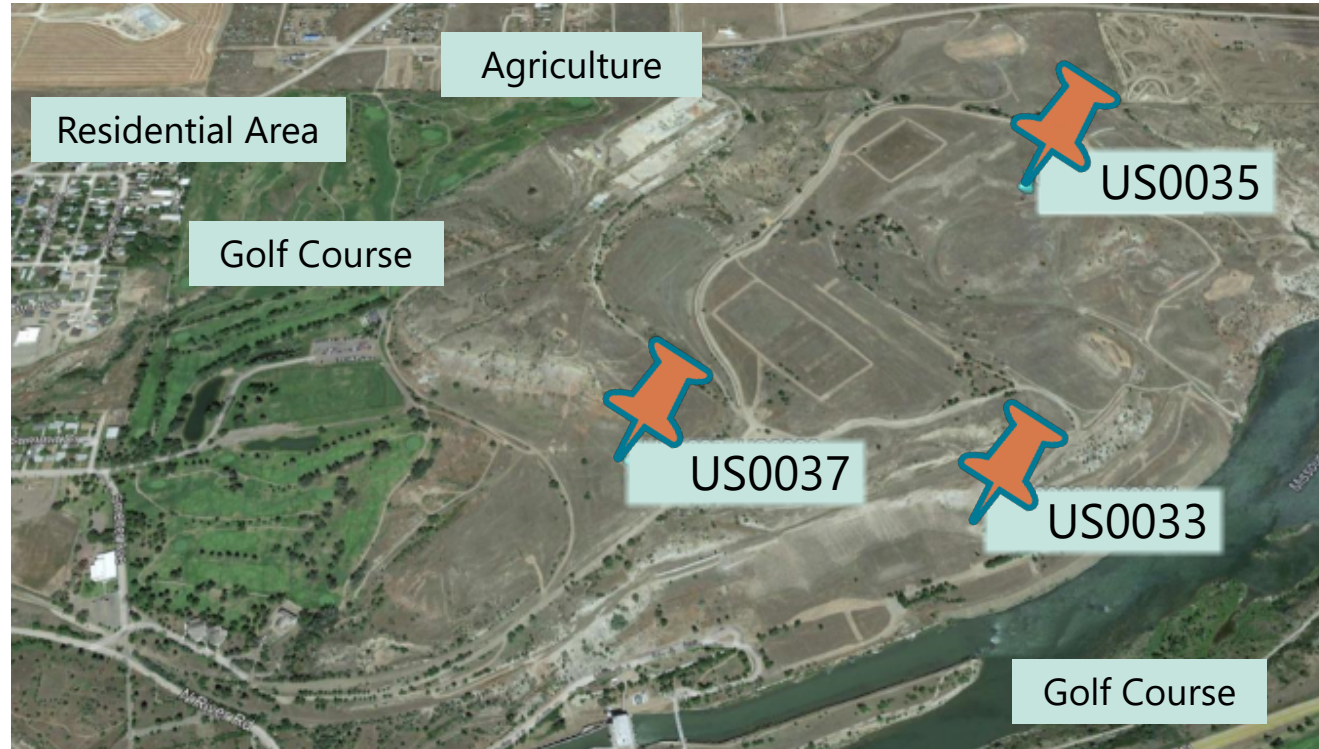
Dalmatian toadflax

Data Overlap



- Total Number of species in vegetation survey
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- Overlapping species results (Veg Survey and BeeOdiversity)

Project Limitations: Site Boundary



Project Strengths

- ❖ Measuring **“effective” diversity**
- ❖ **Large areas** covered
 - Identify species of interest
 - Identify potential threats
- ❖ **Continuous sampling** throughout the season vs punctual visits
- ❖ **Large number of samples** collected - 4 billion flowers visited on average
- ❖ **Reduced cost and manpower**



Pilot Study Goals

Determine the applicability this nature-based solution to supplement or compliment current "boots-on-the-ground" vegetation monitoring standard practices.



Unlikely to supplement, but BeeOdiversity technology could complement boots on the ground

Evaluate opportunities for ecosystem enhancement at the site.

Consider site relationship and contribution to biodiversity characteristics in surrounding communities.



Useful technology for evaluating ecosystem enhancement from biodiversity perspective



Questions?

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