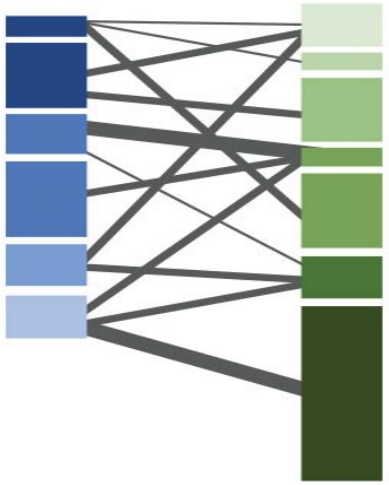
Ecological networks, management shifts, and ecosystem services in urban agroecosystems



Stacy Philpott, Brenda Lin, Heidi Liere, Shalene Jha

UC Santa Cruz, CSIRO, Lewis & Clark College, UT Austin

Urban Agroecosystems

Provide 15-20% of global food supply

Key physical and mental health benefits

Important greenspaces for biodiversity conservation

Lack of ecological knowledge about the drivers of key ecosystem services such as pollination, pest control

Hodgson et al. 2011, Smit et al. 1996, Wakefield et al. 2007, Lin et al. 2015, Gregory et al. 2016, Oberholtzer et al. 2014

Biodiversity and Ecosystem Services

Increases in species richness link to higher pest control and pollination services often, but not always

Provisioning of ecosystem services may <u>also</u> depend on species effect traits or on representation in ecological networks

Tscharntke et al. 2005, 2012, Cardinale et al. 2006, Lavorel & Garnier 2002, Schleuning et al. 2015, Perović et al. 2018

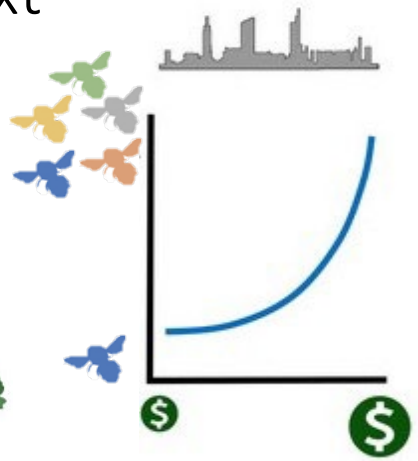
Research Framework

Garden management

Local

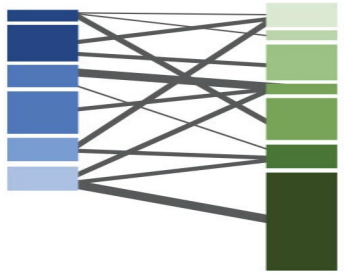
Landscape

Social Context



Species and trait filtering

Shifts in species- and trait-based networks

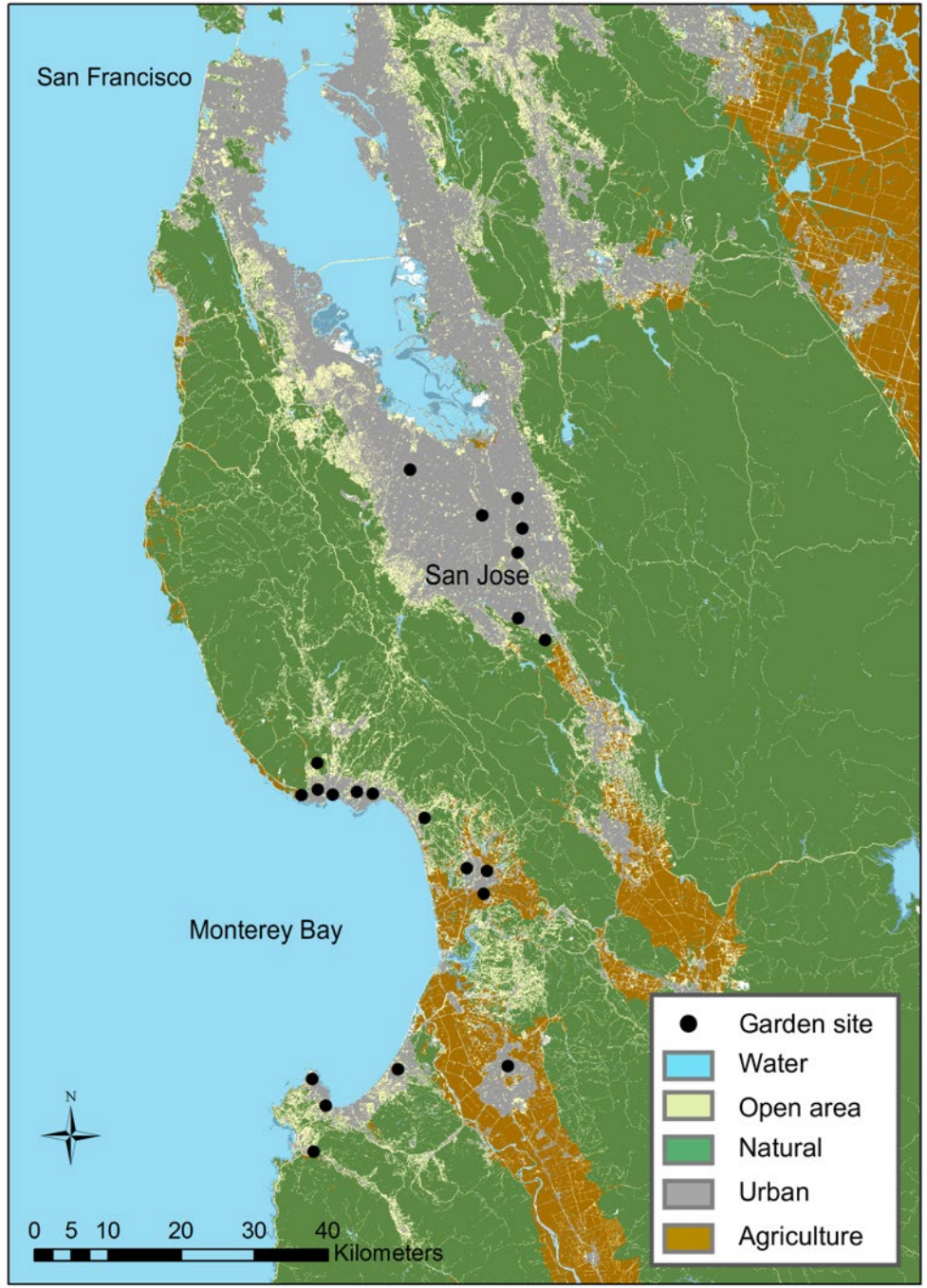


Changes in ecosystem services

Urban agroecosystems

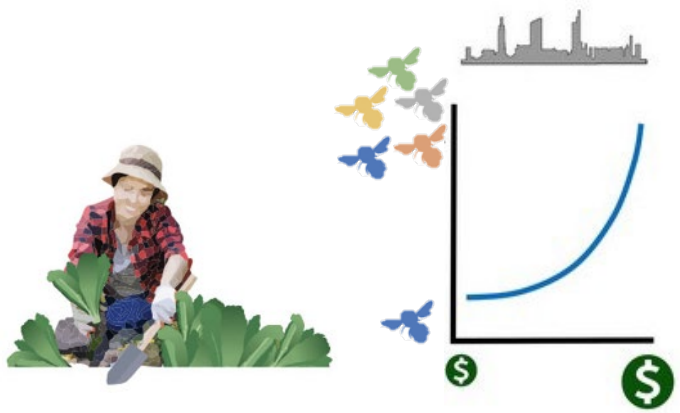
23 gardens in the California SF Bay and Central Coast Regions

We acknowledge our presence on the traditional, unceded, and seized territories of the Tamien Nation, Amah Mutsun Tribal Band, Awaswas, Ohlone, Patwin, Rumsen, Esselen, Wappo

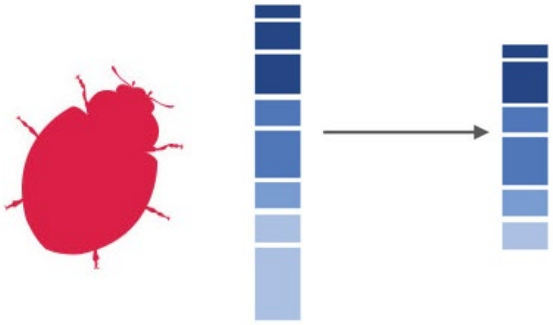


Research Questions

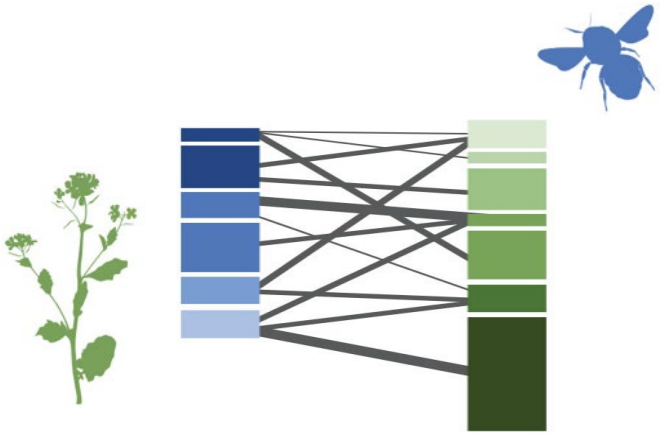
How does social context of gardens influence plant diversity and traits?



How do local and landscape filters influence natural enemy abundance and richness?



How do local and landscape factors influence plant-pollinator networks?



Social context, plant richness and traits

11 traits, 88 species (75% plant cover)

Plant Structure - growth form, plant volume

Plant Defense - SLA, spines, trichomes, EFNs

Floral Attraction - flower number, height, color

Floral Access - flower shape, flower volume

Compiled species, functional richness, community weighted mean values for individual traits

Philpott et al. 2023

Social context, plant richness and traits

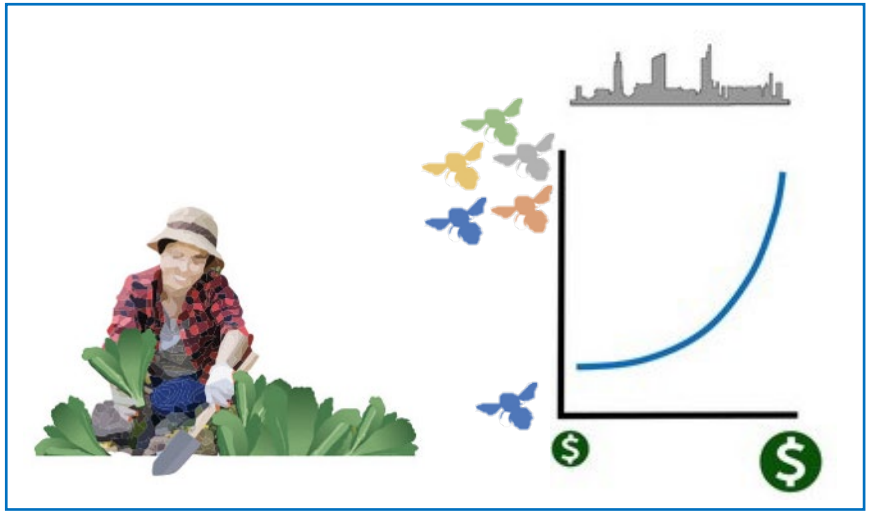
Land ownership

Land tenure security

Median property value

Percent owner occupied housing units

Median household income

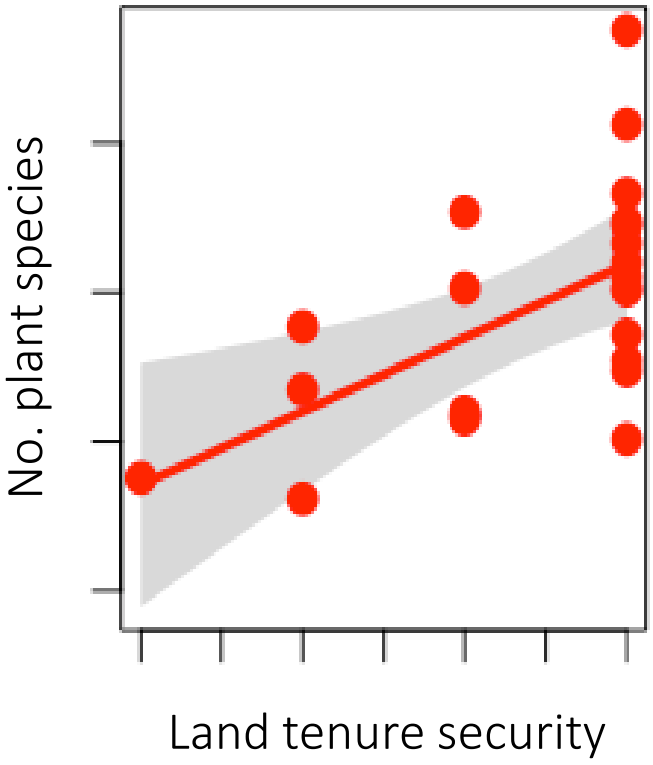


Examined relationships between plant species richness, functional richness, trait values and social variables

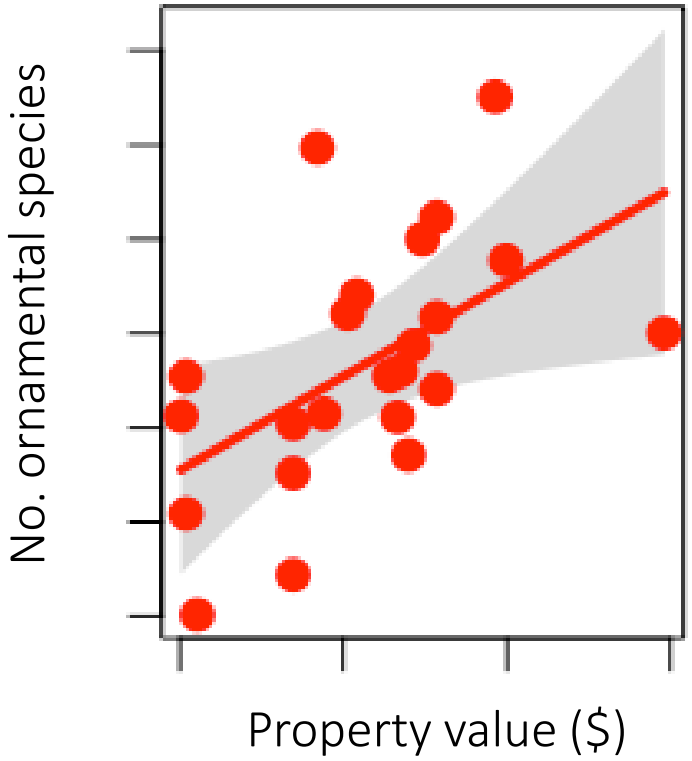
Philpott et al. 2023

Social context, plant richness and traits

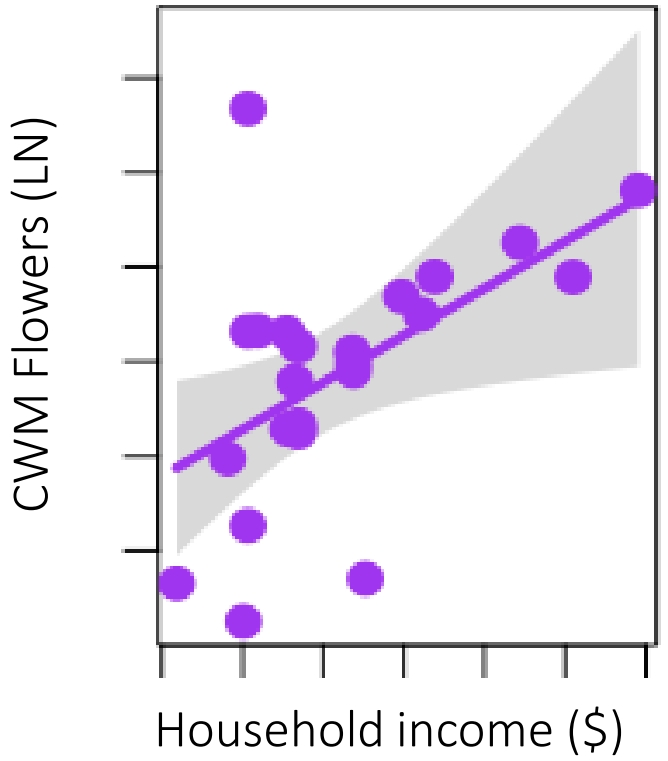
Higher plant, crop species richness with more secure land tenure



More ornamental plant species with higher property values



More flowers per plant with higher incomes

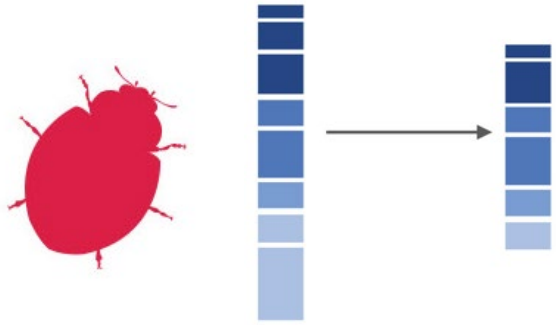


Philpott et al. 2023

Research Questions

How does social context of gardens influence plant diversity and traits?

How do local and landscape filters influence natural enemy abundance and richness?



How do local and landscape factors influence plant-pollinator networks?

Local and landscape filters of natural enemies

Crop, weed, ornamental richness

Tree, shrub abundance

Floral abundance, richness

Other plant traits

Ground cover

20x20m and 1x1m plots in each garden

Philpott et al., in prep

Local and landscape filters of natural enemies

% natural habitat, urban developed, agriculture, and open area within 2km

National Landcover Database, 30 m resolution

Philpott et al., in prep

Local and landscape filters of natural enemies

Visual surveys of brassica and cucurbit plants

Collected all predators and parasitoids

Identified to species or morphospecies

Classified to feeding guild, measured several traits

Philpott et al., in prep

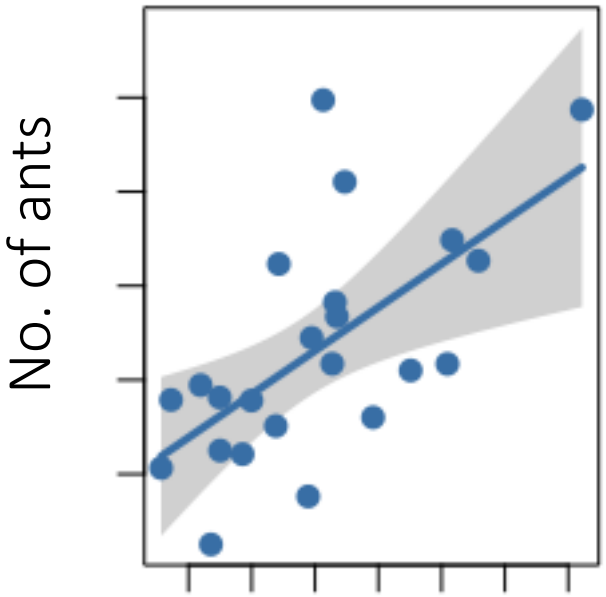
Local and landscape filters of natural enemies

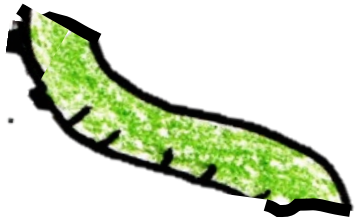
- Garden size
- Grass cover
- Extrafloral nectaries (CWM)
- Number of flowers (CWM)
- Flower volume (CWM)
- Plant size (CWM)
- Growth form trees (CWM)
- Functional richness (FRic)
- Landscape-level urban cover

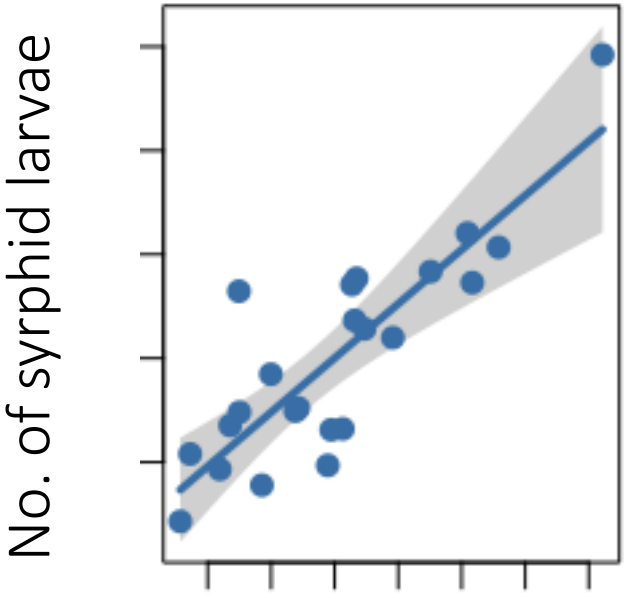
- Ant abundance and richness
- Spider abundance and richness
- Syrphid fly larva abundance
- Parasitoid abundance and richness
- Ladybug abundance and richness

Philpott et al., in prep

Local and landscape filters of natural enemies



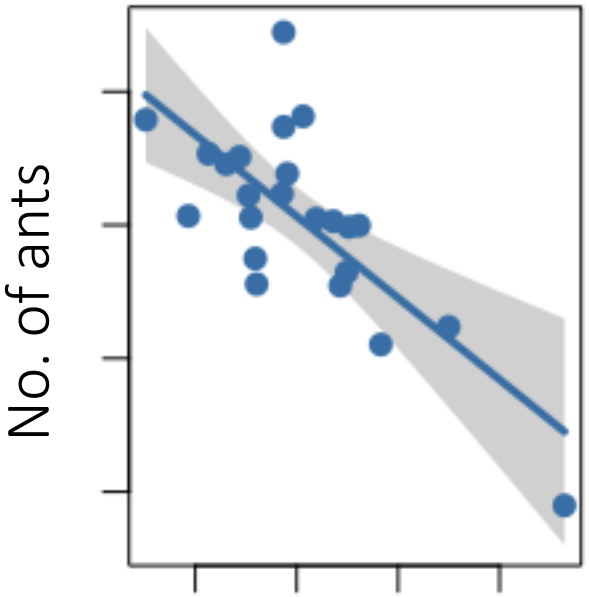


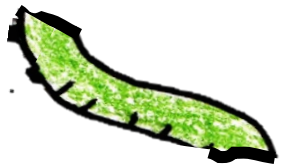


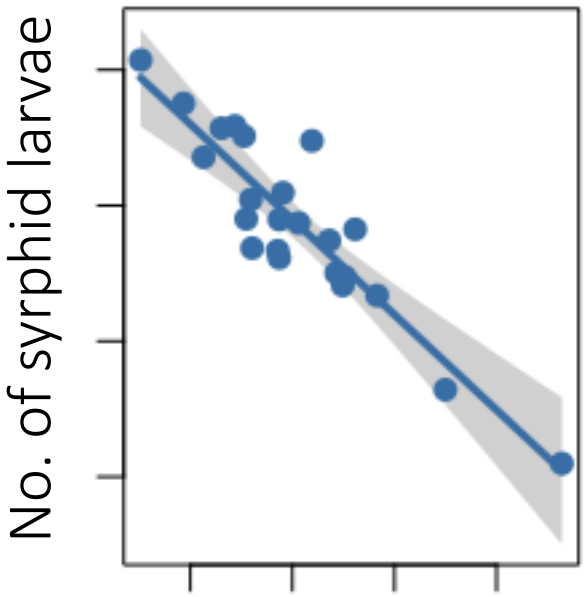
Extrafloral nectaries

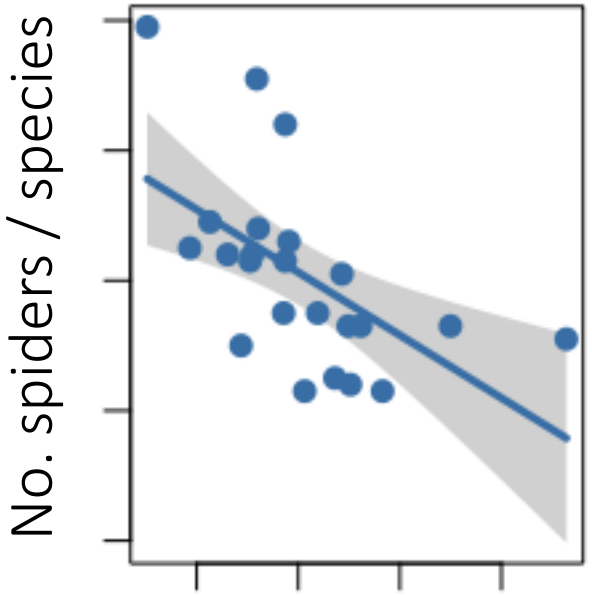
Philpott et al., in prep

Local and landscape filters of natural enemies





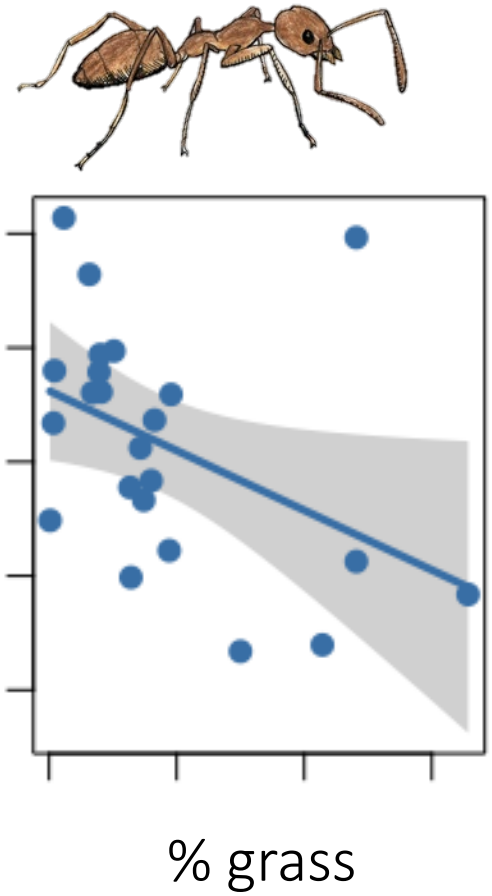


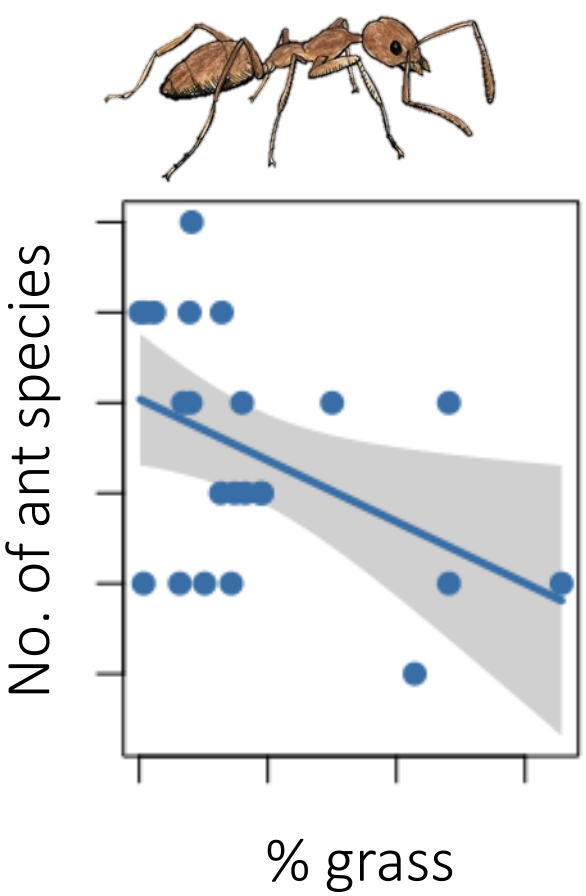


Flower volume

Philpott et al., in prep

Local and landscape filters of natural enemies

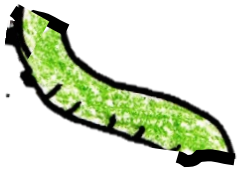


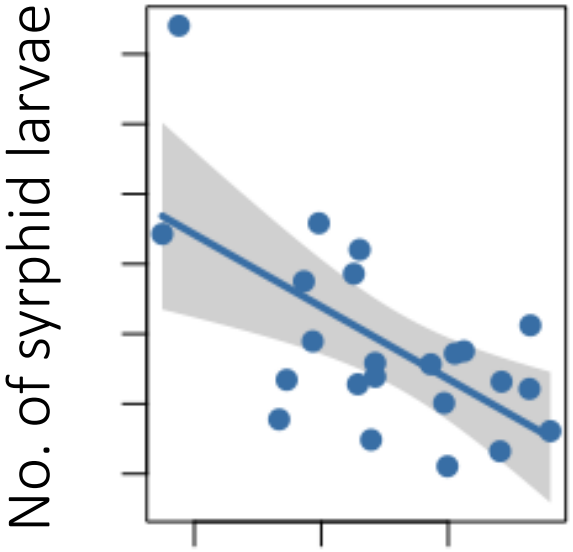


Grass cover

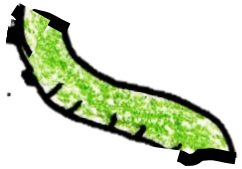
Philpott et al., in prep

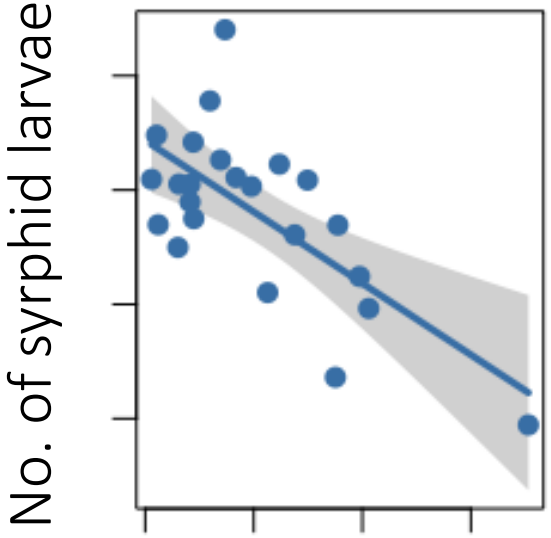
Local and landscape filters of natural enemies



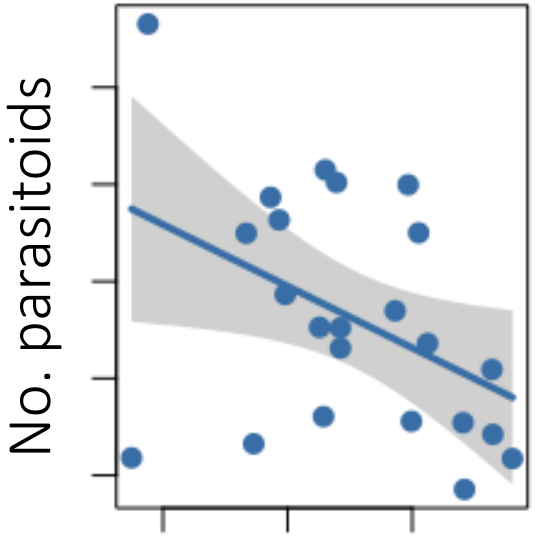


Plant Size
(cm^2, CWM)





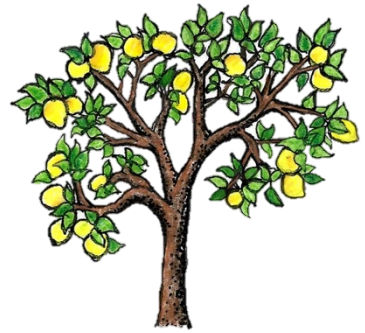
Trees, shrubs
(CWM)



Plant Size
(cm^2, CWM)

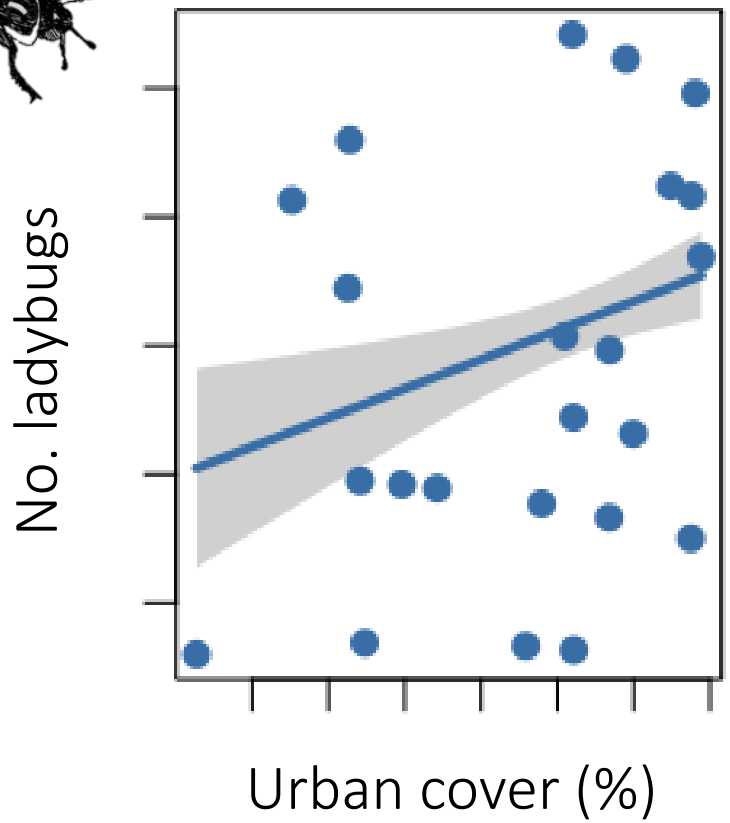
Plant size

Trees, shrubs

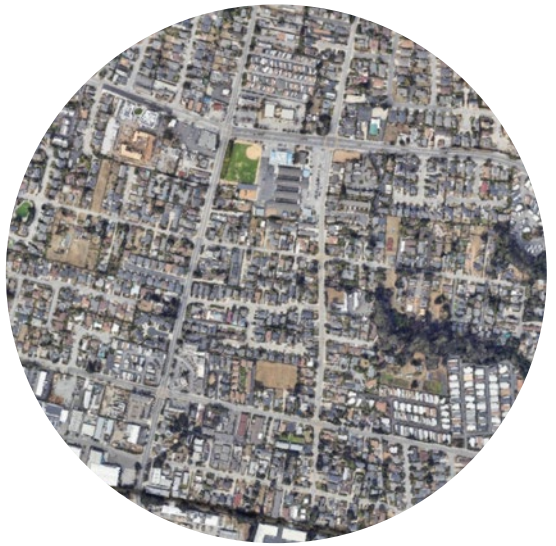


Philpott et al., in prep

Local and landscape filters of natural enemies



Landscape-level urban cover



Philpott et al., in prep

NE results and interpretation

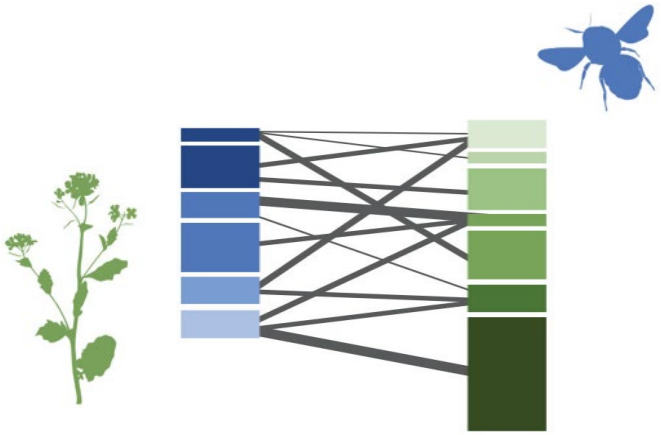
	EFN	Flower Volume	Grass cover	Plant Size	Growth Form Tree	Urban Cover
Ants 	+	-	-			
Spiders 		-				
Syrphid larvae 	+	-		-	-	
Parasitoids 				-		
Ladybugs 						+

Research Questions

How does social context of gardens influence plant diversity and traits?

How do local and landscape filters influence natural enemies?

How do local and landscape factors influence plant-pollinator networks?



Plant-pollinator networks

Hand netted pollinators (from flowers) for 4 hours per site

Identify pollinators (bees, flies, butterflies and moths) to species

Measured 4 ecological network metrics:

Connectance, Interaction Evenness, Nestedness, Specialization




Philpott et al., in review

Plant-pollinator networks

1450 pollinators from 97 species

3 species account for >50% of visits

Apis mellifera (32.0%)

Bombus vosnesenskii (13.8%)

Halictus tripartitus (7.0%)

Plant-pollinator networks

1450 plants visited from 43 families and 159 species

5 species account for ~30% of pollinator visits

Cilantro (7.9%)

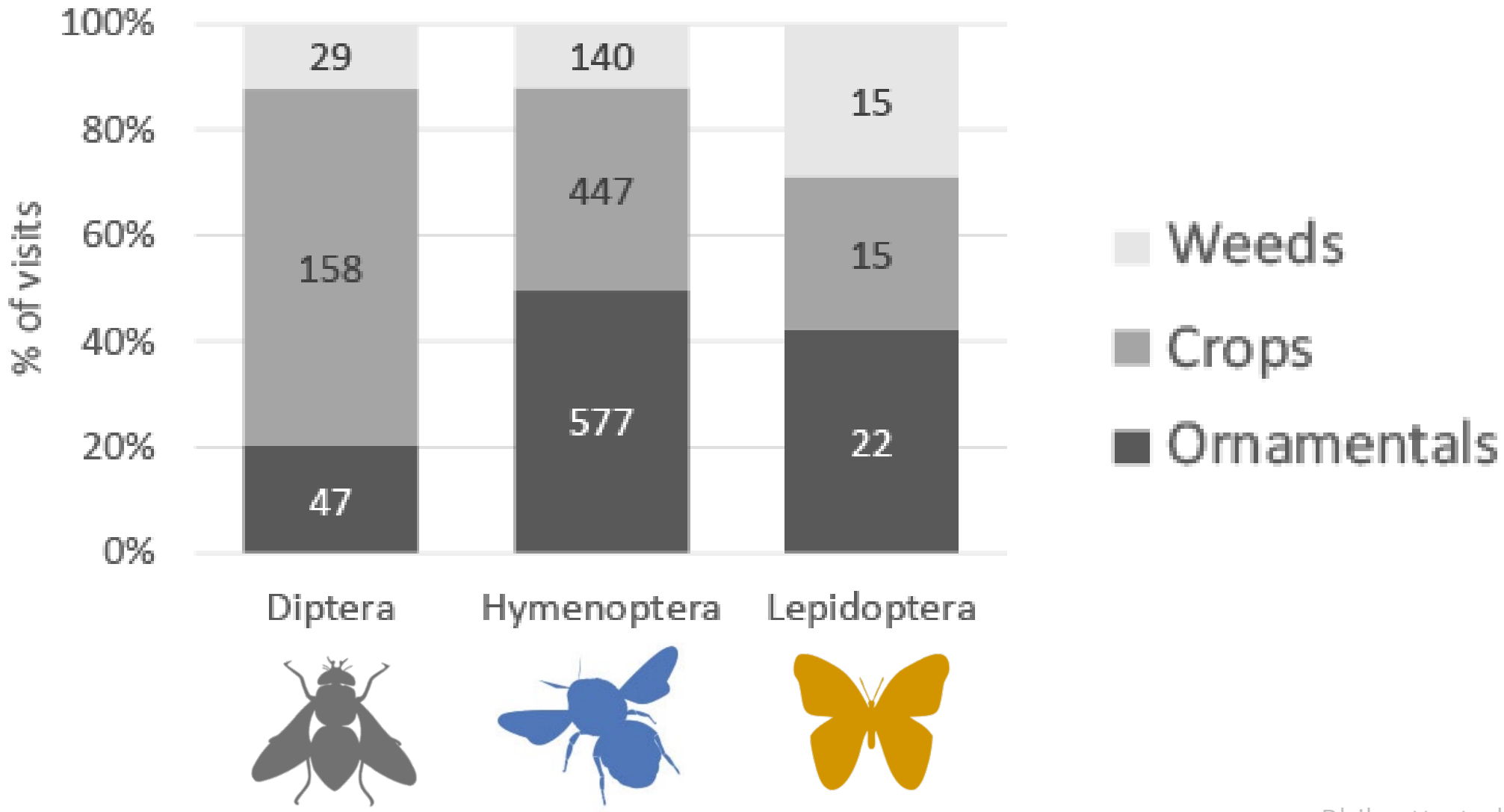
Lavender (6.3%)

Tomatillo (6.1%)

Borage (4.8%)

Squash (4.6%)

Plant-pollinator networks



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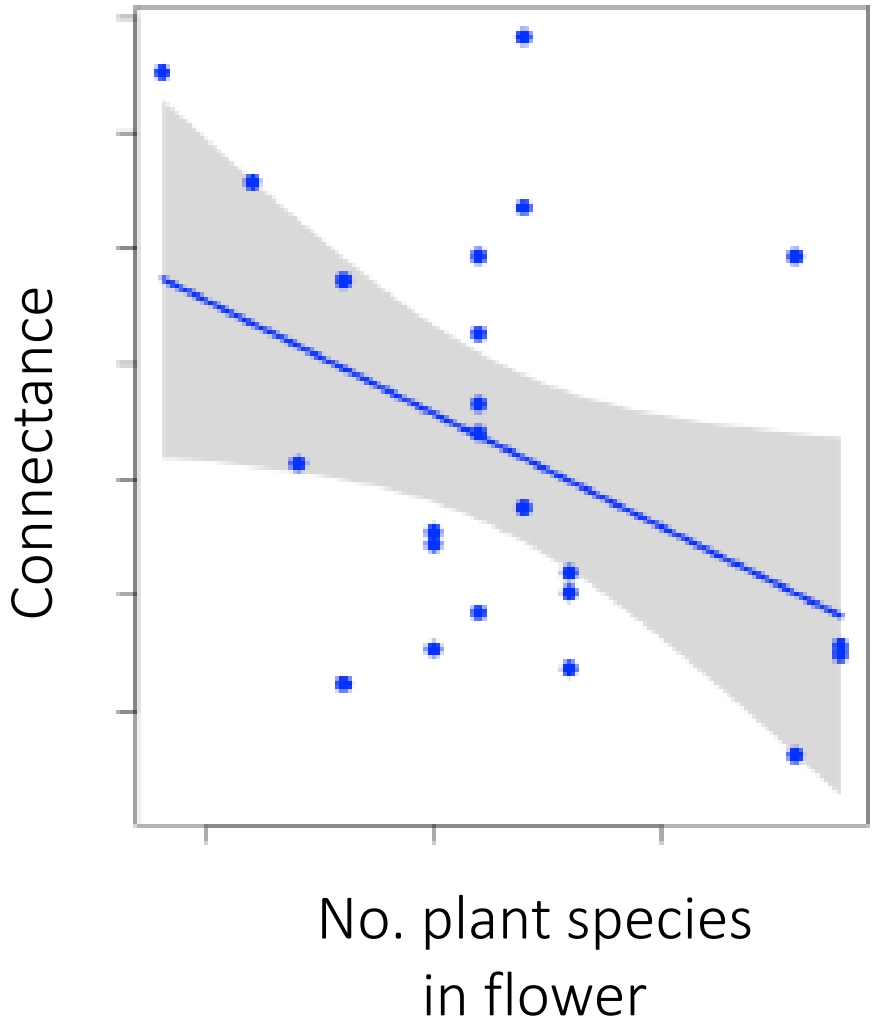
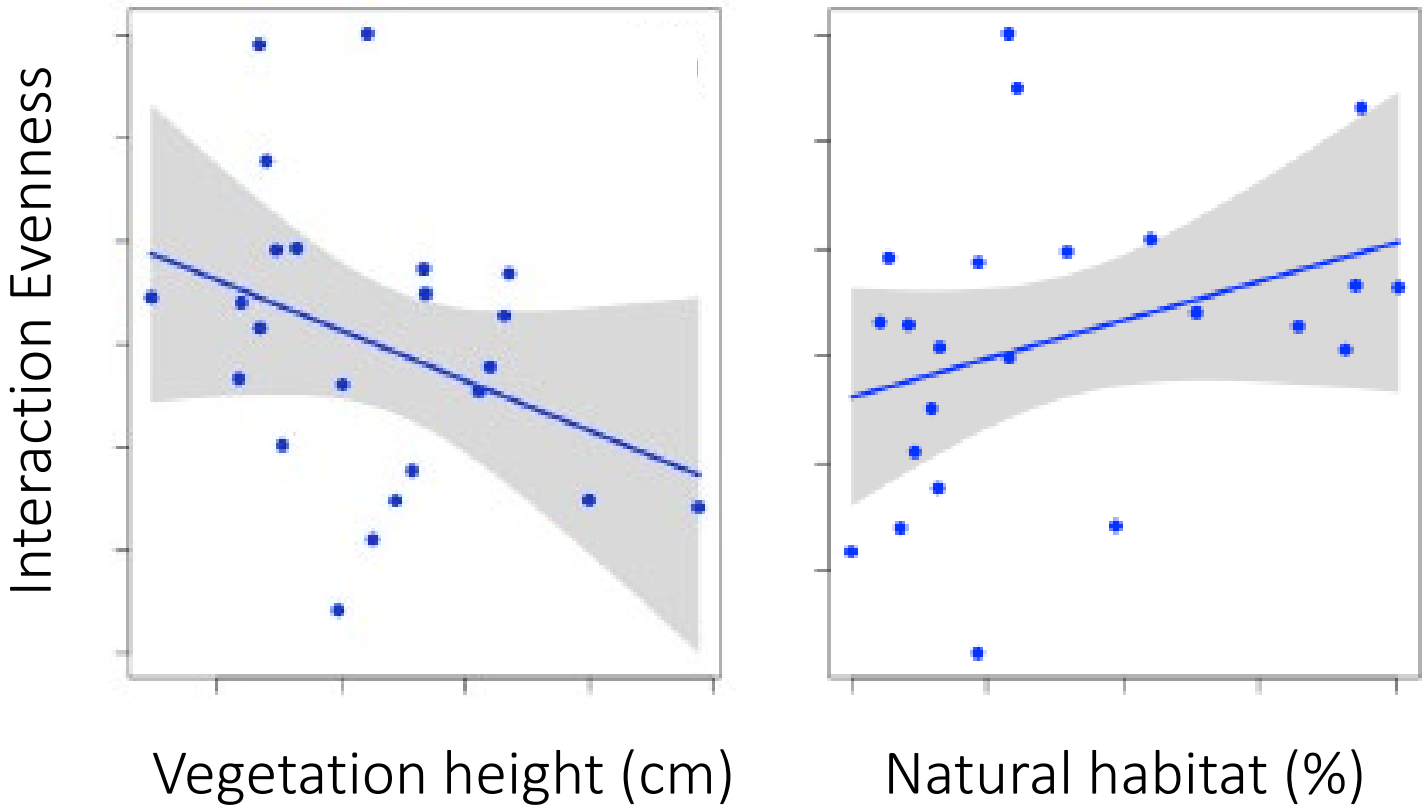
Plant-pollinator networks



Fewer realized interactions with higher flowering plant richness

Philpott et al., in review

Plant-pollinator networks

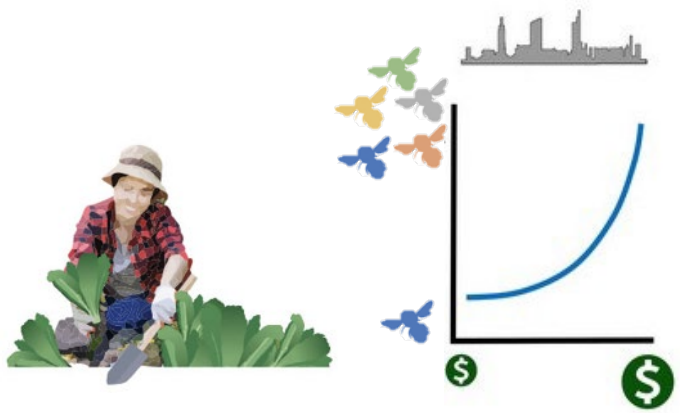


More uneven network interactions with taller vegetation and less natural habitat in the landscape

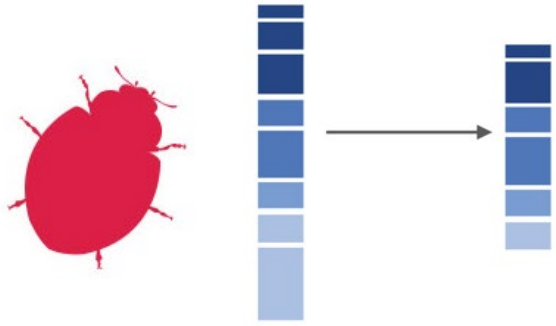
Philpott et al., in review

Take home messages

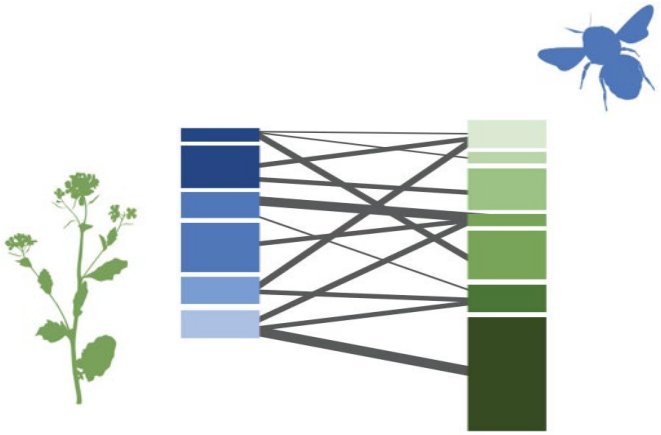
Garden land tenure and ”luxury” influence plant diversity and traits



Dispersal-trait-dependent impacts of local and landscape filters on natural enemies



Plant size, type, richness, landscape surroundings influence pollinators and networks



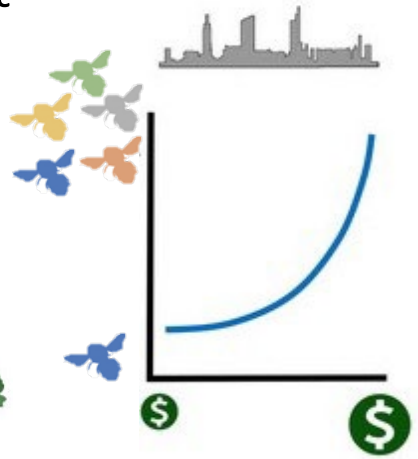
Next Steps

Garden management

Local

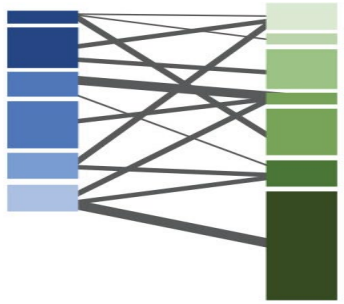
Landscape

Social Context

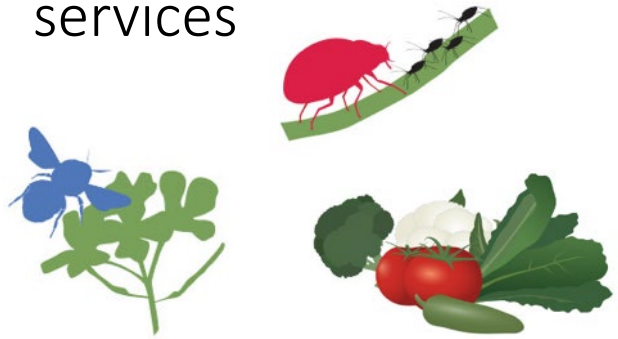


Species and trait filtering

Shifts in species- and trait-based networks



Changes in ecosystem services



Thanks!

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