Biodiversity Conservation and Ecosystem Service Provision through Urban Food Cultivation

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Introduction

- Urbanization is associated with local and regional biodiversity loss
- Urban community gardens are important reservoirs of biodiversity conservation in urban landscapes, and garden food production relies on pollination and pest control services provided by biodiversity
- Landscape features, local habitat management, and facets of ecological communities provide these crucial services in gardens, but their relationships are complex
- Our research in the California Central Coast asks: ***how do local management and landscape context drive biodiversity and the provisioning of ecosystem services in urban gardens?***

Study System & Methodology

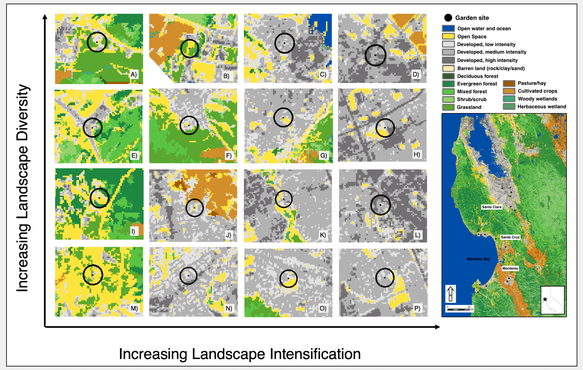


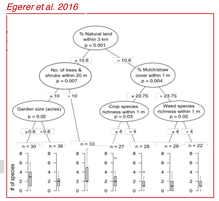
Figure 1. Garden study sites with 200 m buffers vary in surrounding landscape composition and degree of landscape intensification. Dominant land-use classes consist of urban, natural, agricultural, and open space land-uses. Here, gardens are placed in a landscape diversity and intensity matrix (1 km spatial extent).

Figure 2. Our research uses different methods to examine garden biodiversity and ecology. We measure vegetation complexity and ground cover composition (a); we use sentinel pests to measure pest control (b); we identify pests (c), natural enemies (d), and pollinators (e). We visit the gardens monthly from May to September.

Results

a)

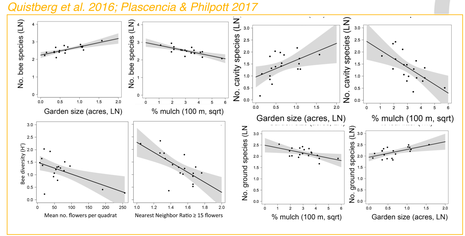
Egerer et al. 2016



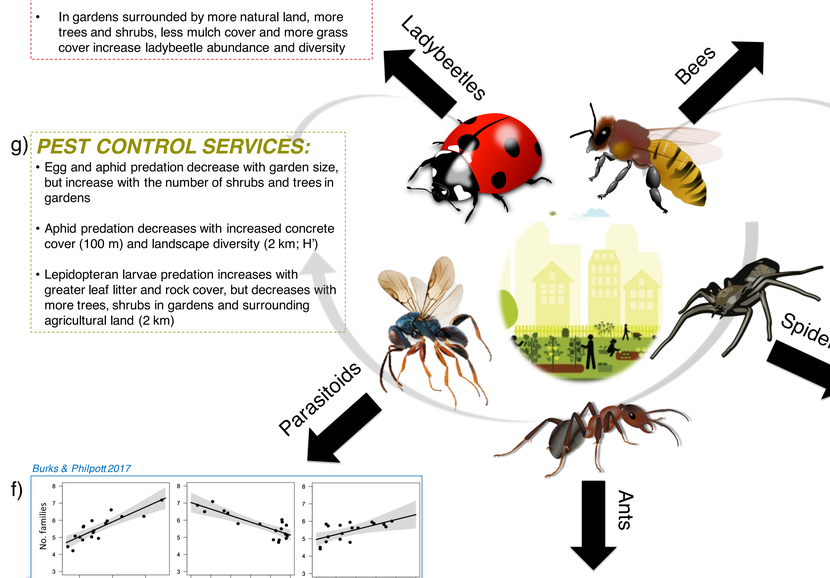
- We have documented 19 species of ladybeetles that provide different pest control services
- Urban land cover drives increases in ladybeetle abundance and diversity
- In gardens surrounded by more natural land, more trees and shrubs, less mulch cover and more grass cover increase ladybeetle abundance and diversity

b)

Quistberg et al. 2016; Plascencia & Philpott 2017



- We have documented over 55 species of cavity-nesting, ground-nesting, and different sized bees
- Bee abundance and diversity increases with garden size and with garden floral abundance
- Yet, larger clusters of flowers, not just abundance or proximity, may be more important for supporting bees
- Bee diversity tends to decrease with more mulch ground cover, but overall bee guilds differentially respond to ground cover management



c)

POLLINATION SERVICES:

- Seed set of sunflowers was lower in gardens surrounded by more urban land
- Fruit weight of jalapeño peppers increased with garden age, flower richness, and bare soil ground cover

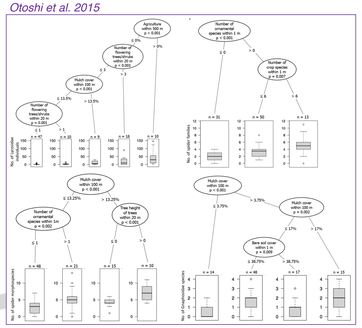
g)

PEST CONTROL SERVICES:

- Egg and aphid predation decrease with garden size, but increase with the number of shrubs and trees in gardens
- Aphid predation decreases with increased concrete cover (100 m) and landscape diversity (2 km; H')
- Lepidopteran larvae predation increases with greater leaf litter and rock cover, but decreases with more trees, shrubs in gardens and surrounding agricultural land (2 km)

d)

Otoshi et al. 2015



- Spider abundance increases in gardens with more trees, shrubs, and flowers
- Spider diversity increases with greater crop diversity
- Spider abundance increases in gardens surrounded by more agricultural land (1 km)

f)

Burks & Philpott 2017

- Parasitoid abundance increases with garden size, mulch ground cover, and urban land cover
- Parasitoid diversity (number of families) increases with herbaceous vegetation height, and tree and shrub diversity, but decreases with urban land cover

e)

- We have documented 7 ant species, and over 10,000 individuals. Yet, 80% were the invasive Argentine ant
- Ant species diversity increases in sites with less mulch ground cover, higher rock and grass cover
- Invasive ants are common in gardens with bare soil ground cover (no mulch or leaf litter) and surrounded by open space and grass

Figure 3. Local and landscape factors that influence ladybeetle species diversity (a), bee diversity (b), pollination services (c), spider diversity (d), ant diversity (e), parasitoid wasp diversity (f), and natural pest control services (g) in urban gardens.

Figure 4. Gardens vary in their local vegetation and ground cover management and their landscape surroundings, which influences pollinators, natural enemies, and pest populations.

Conclusions

- In urban gardens, arthropod groups vary in how they respond to changes in local garden management and in the surrounding urban landscape
  - Ground cover has different effects across and within arthropod groups due to different life history strategies
  - Arthropod groups do not respond uniformly to increasing urbanization, agricultural intensification, or garden size
- Biodiversity and ecological interactions respond differently to changes in local and landscape factors in urban agricultural contexts than in rural agriculture
- Varying responses across groups associate ecosystem services with ecological trade-offs
- Urban conservation strategies and land planning must incorporate diverse strategies to support biodiversity and ecosystem services
- Our future work will explore:
  - Local, landscape, and social characteristics of gardens that influence plant and arthropod functional diversity
  - Gardener motivations and benefits from community garden participation, and how these social dimensions affect garden biodiversity and ecosystem service provision

Acknowledgments

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USDA

The CENTER for AGROECOLOGY & SUSTAINABLE FOOD SYSTEMS