Hedgerow restoration and pollinators: bee communities, costs, and benefits

Photo by R. Long

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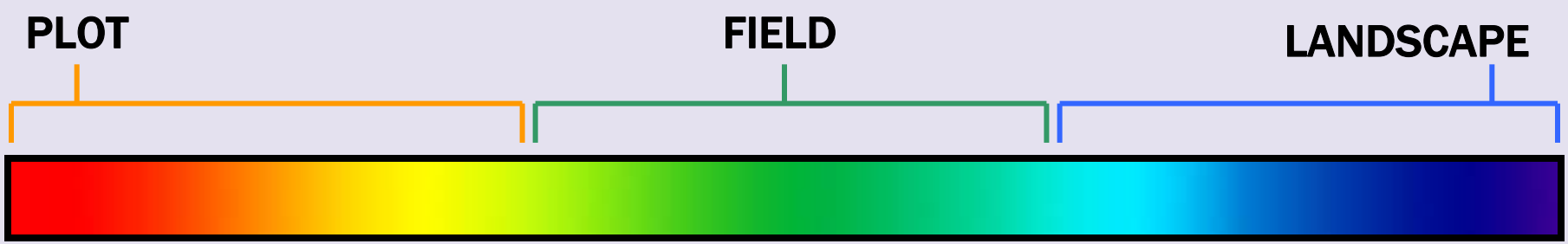
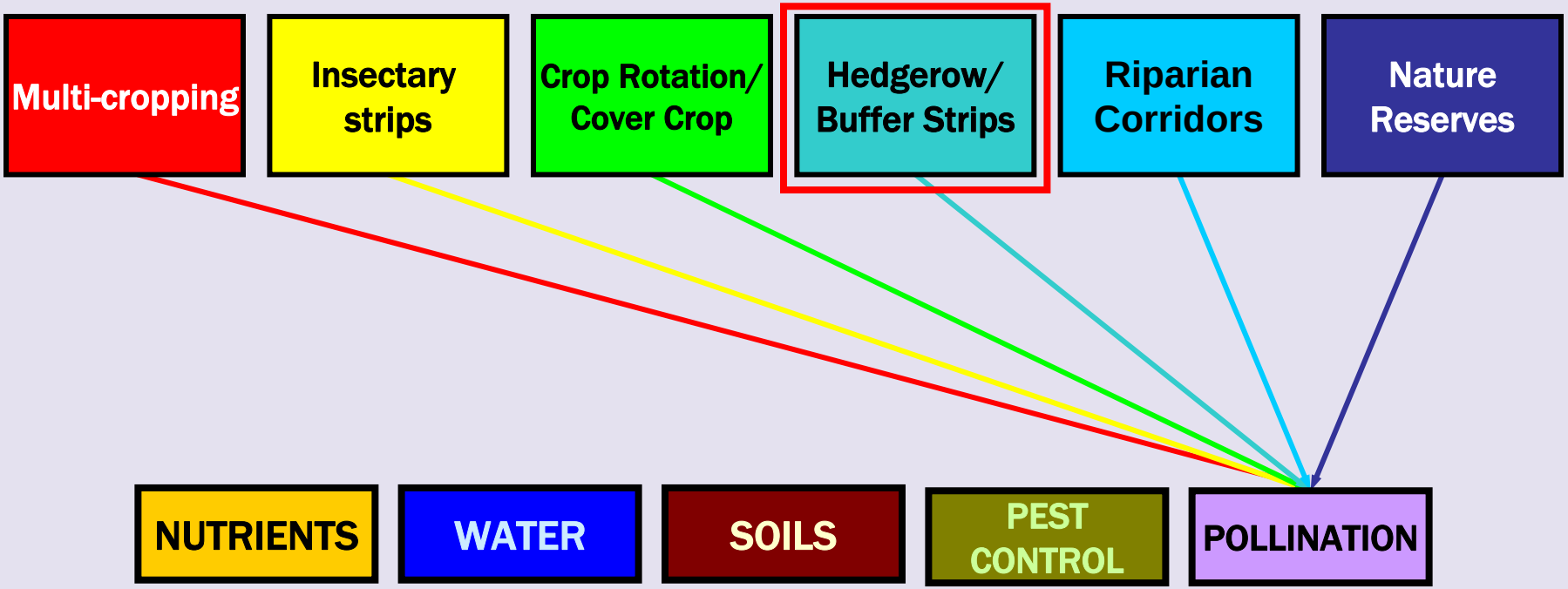
Diversified Farm Systems



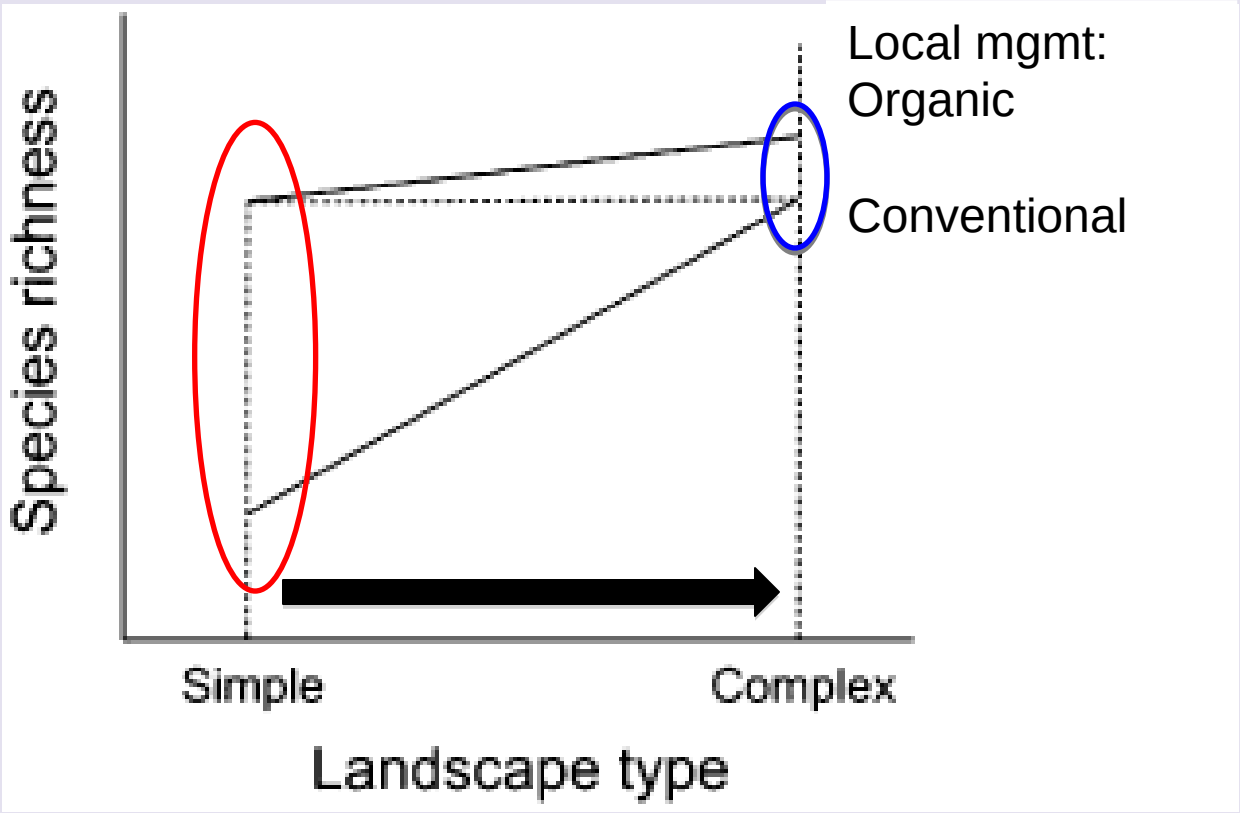
Diversification Methods



Ecosystem Services

Hedgerow Restoration

- Native shrubs, grasses, forbs
- Successive bloom/undisturbed ground (nesting habitat)
  - Habitat for wild bees and natural enemies
  - Could reduce pesticide usage
- Restore ecosystem services in adjacent crops?



Tscharntke et al 2005 Ecol Lett

Studies To Date

- Most studies are from Europe (e.g. Carvell et al 2008, Pywell et al 2005)
  - Field margin forb-mixes
  - Bumblebees

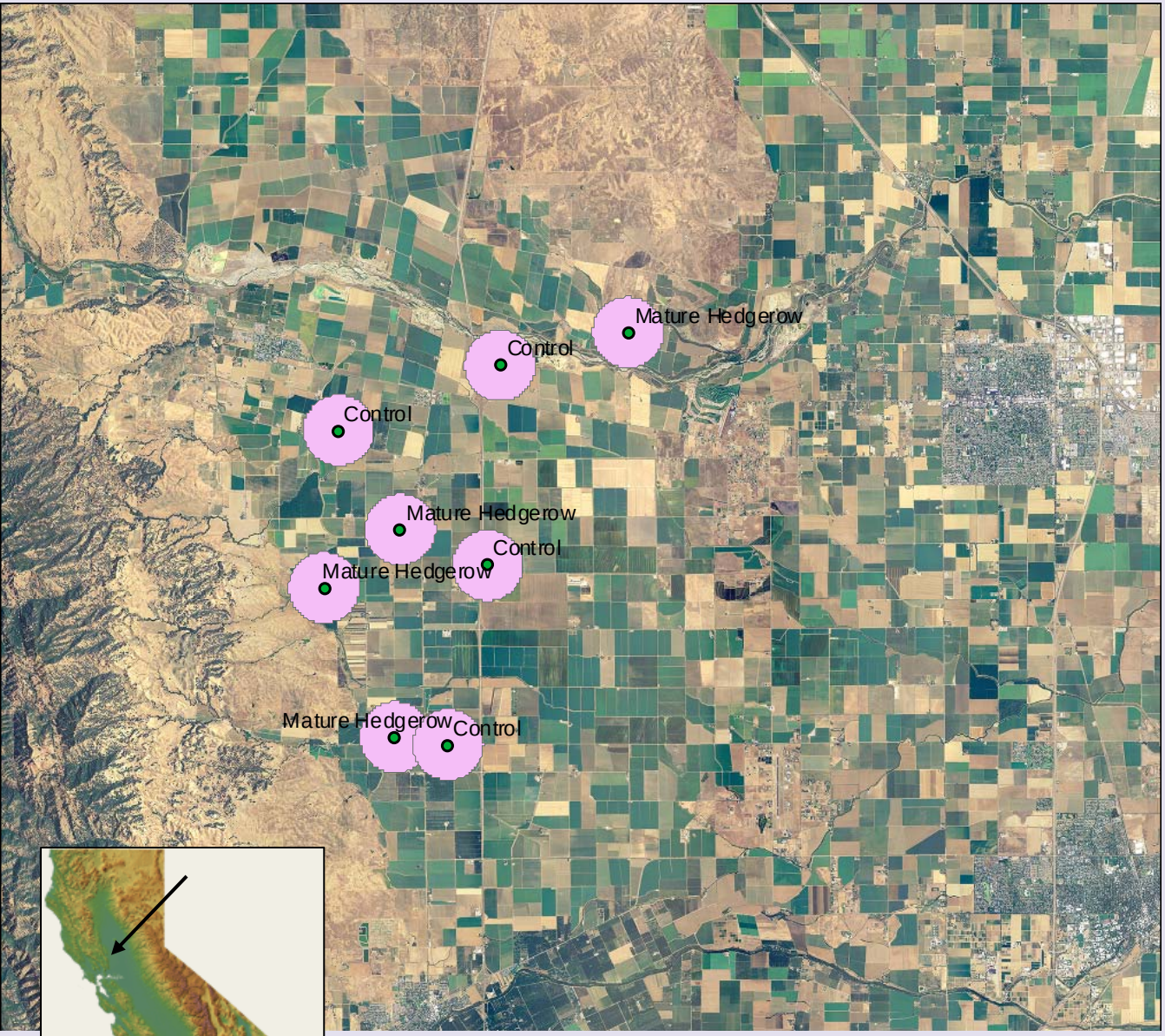
- Only a few studies of HR in US
  - None yet evaluate the effects on pollination function
  - Or separate floral versus nesting effects
  - No cost-benefit analyses of hedgerow enhancement

Questions

1. Do native plant hedgerows increase native bee abundance and diversity in homogeneous agricultural landscapes?

2. Are hedgerows exporting pollinators to adjacent crops or competing with adjacent crops (source or concentrator)?

3. How do hedgerows impact pollination function and how do costs and benefits compare?



Site selection

- All sites in intensively farmed region of landscape
- Paired design
- All sites ≥ 1km apart

Control: unmanaged edge

Hedgerow Sites

4 ‘mature’ hedgerows/yr

- > 10 years
- 4 controls/yr
- Adjacent to Tomato fields

Sampling

4 x per season

Community Sampling:

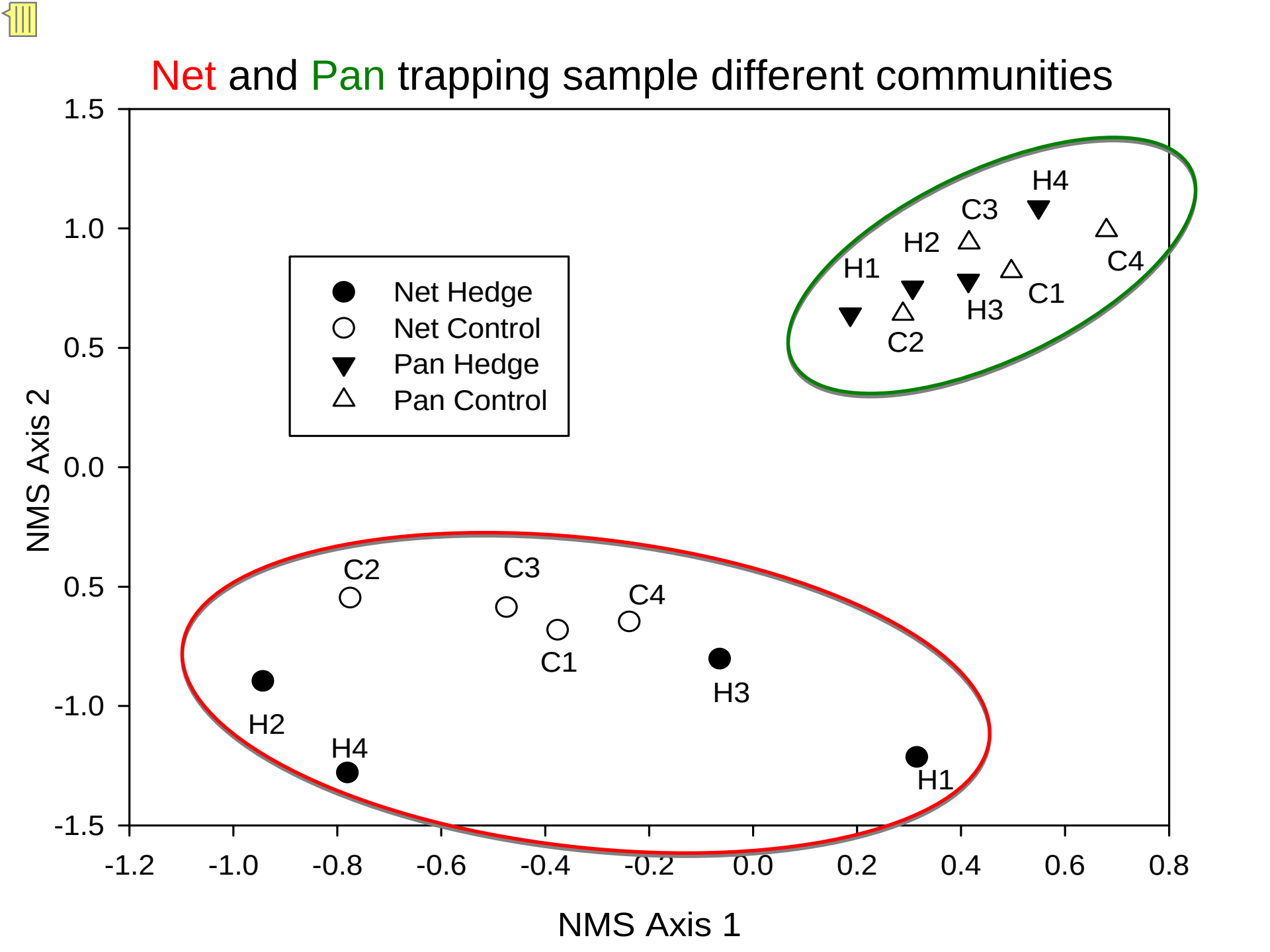
- Pan traps

- Aerial netting

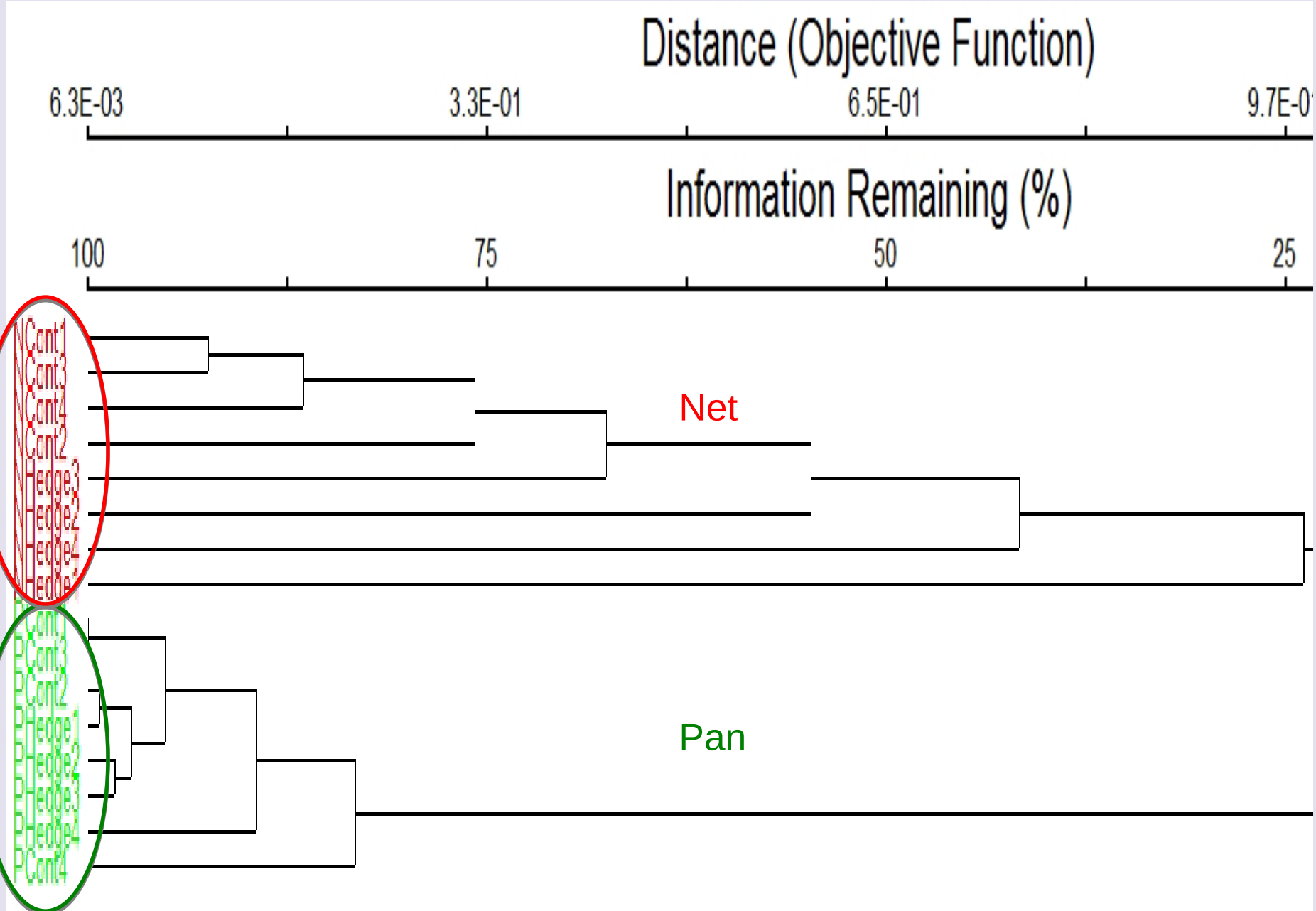
- Visual Observations

Nesting resources assessment

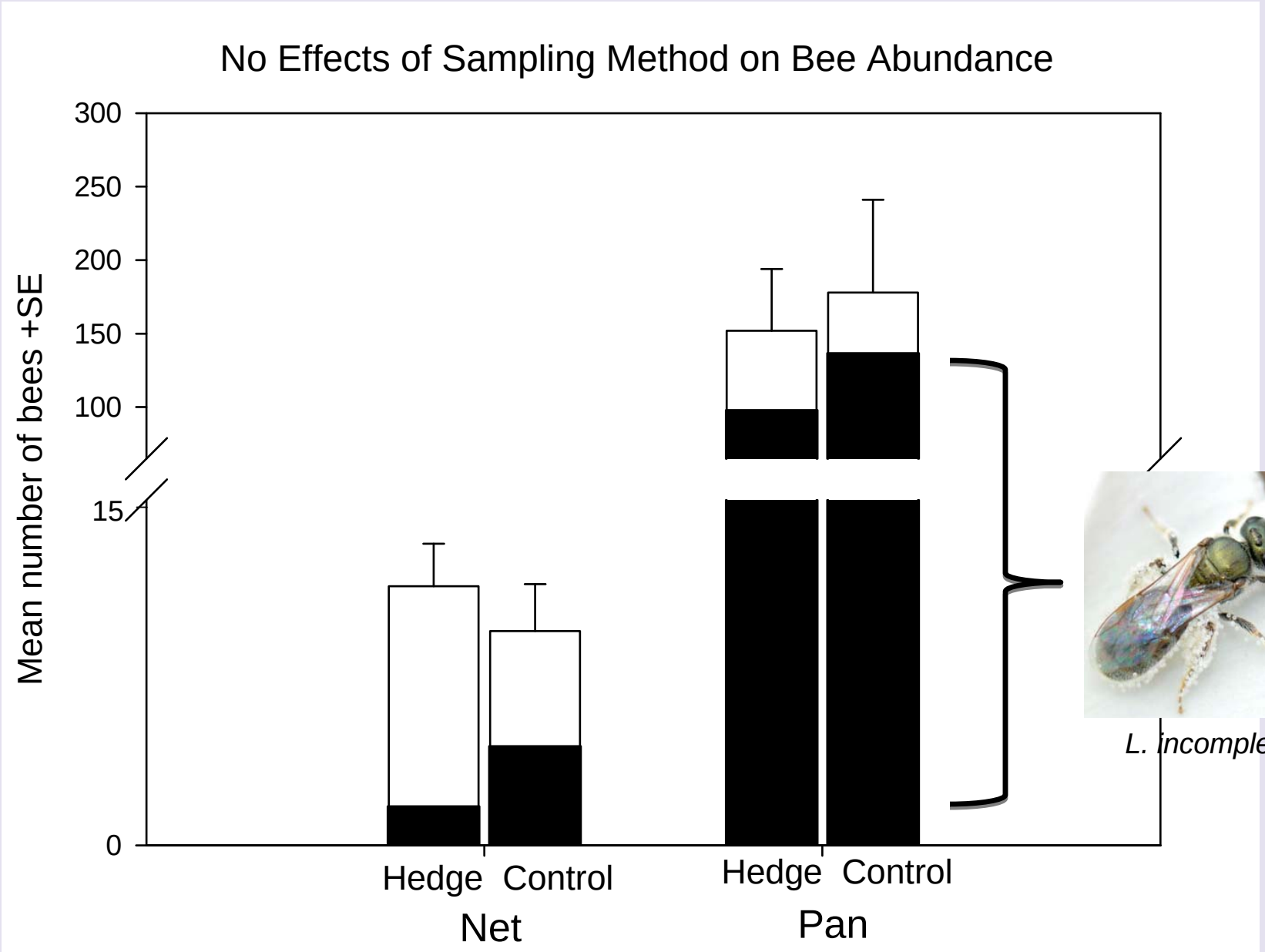
Floral assessment

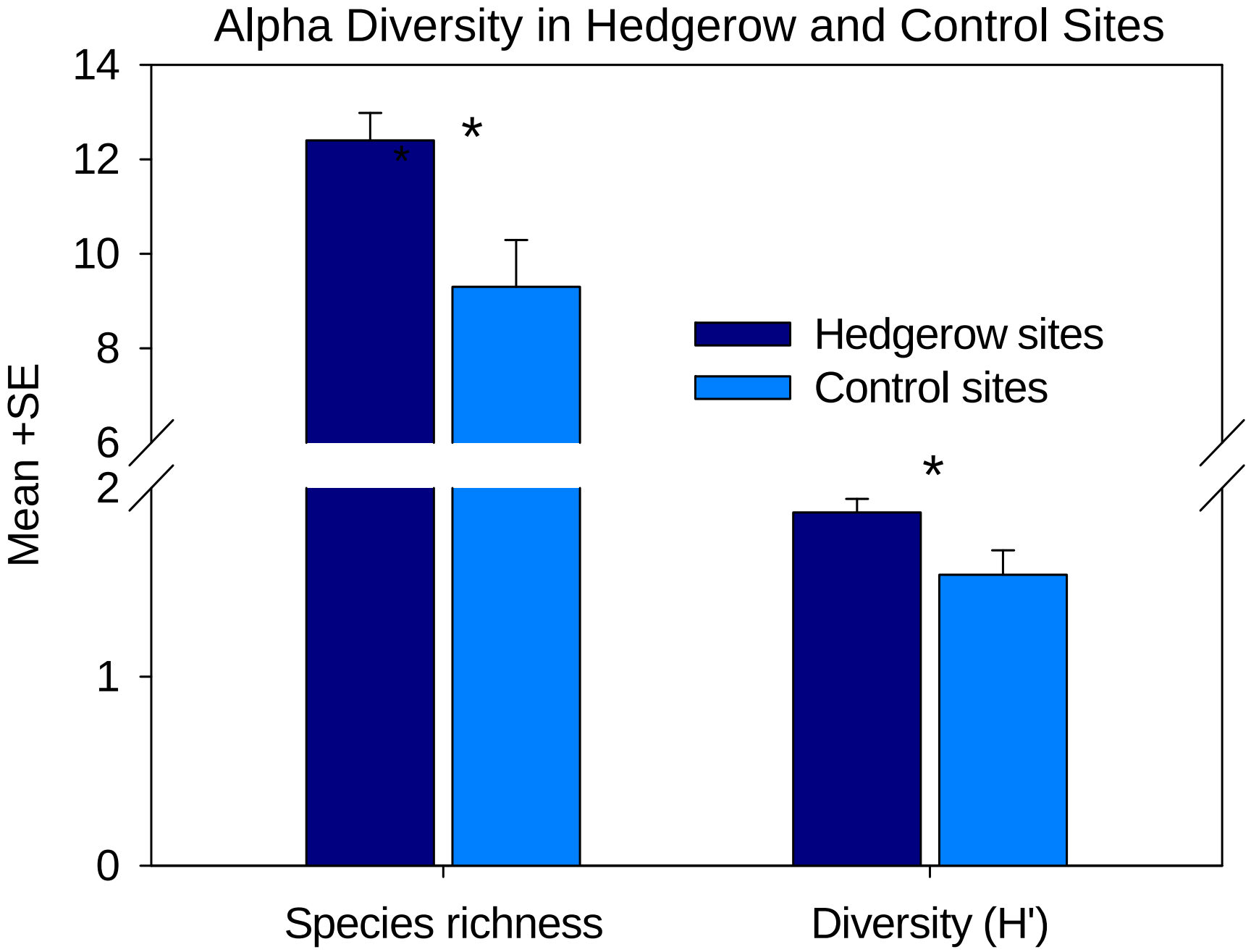

Net and Pan trapping sample different communities
Net Hedge
Net Control
Pan Hedge
Pan Control
H4
C3
H2
C4
H1
C1
H3
C2
C2
C3
C4
C1
H3
H2
H4
H1
NMS Axis 2
NMS Axis 1
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.2
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
0.8

Cluster Analysis: Comparing Sampling Methods

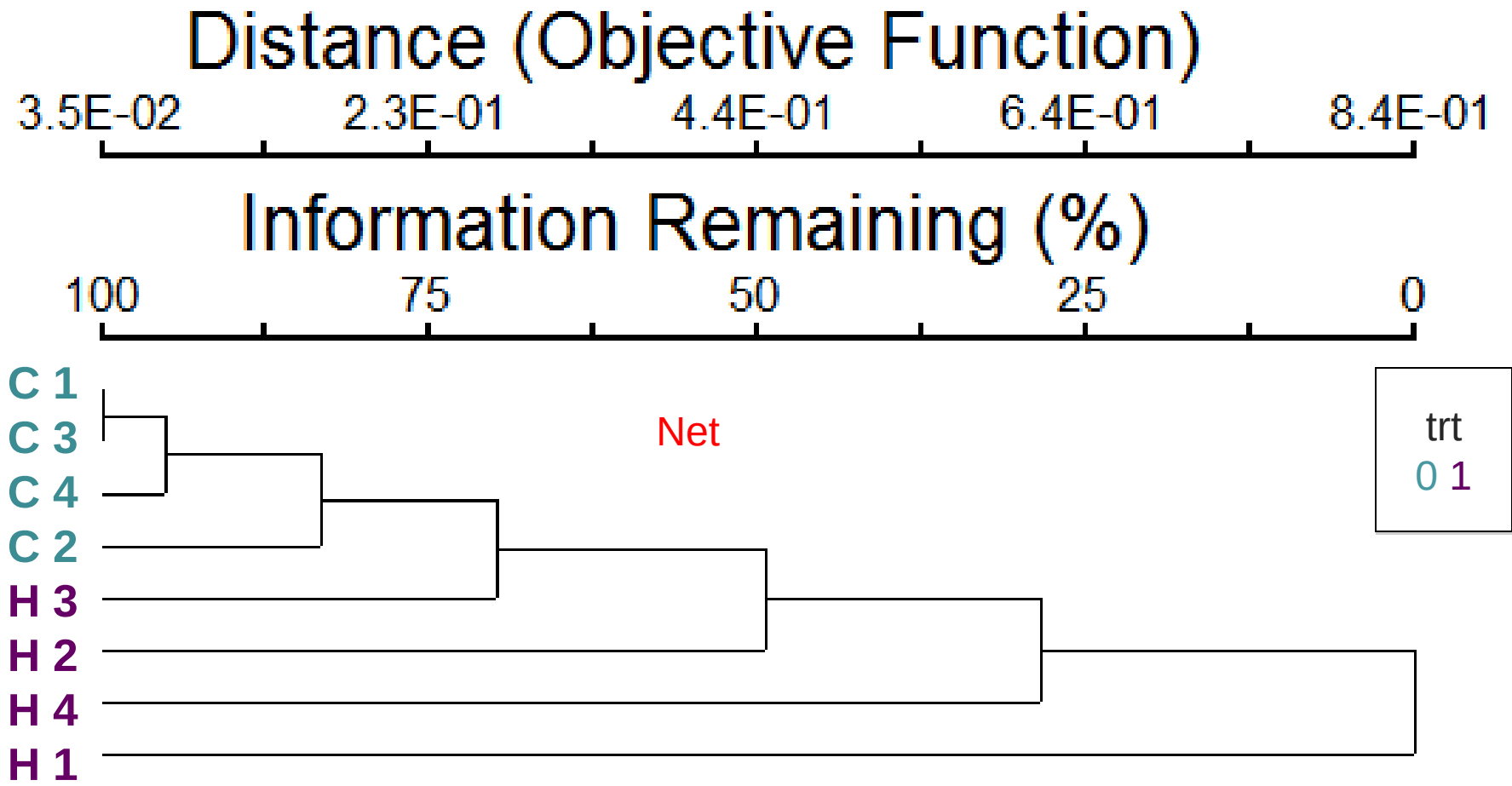


Q1. Do native plant hedgerows increase native bee abundance and diversity in homogeneous agricultural landscapes?




Alpha Diversity in Hedgerow and Control Sites
Mean +SE
14
12
10
8
6
2
1
0
*
*
*
Hedgerow sites
Control sites
Species richness
Diversity (H')

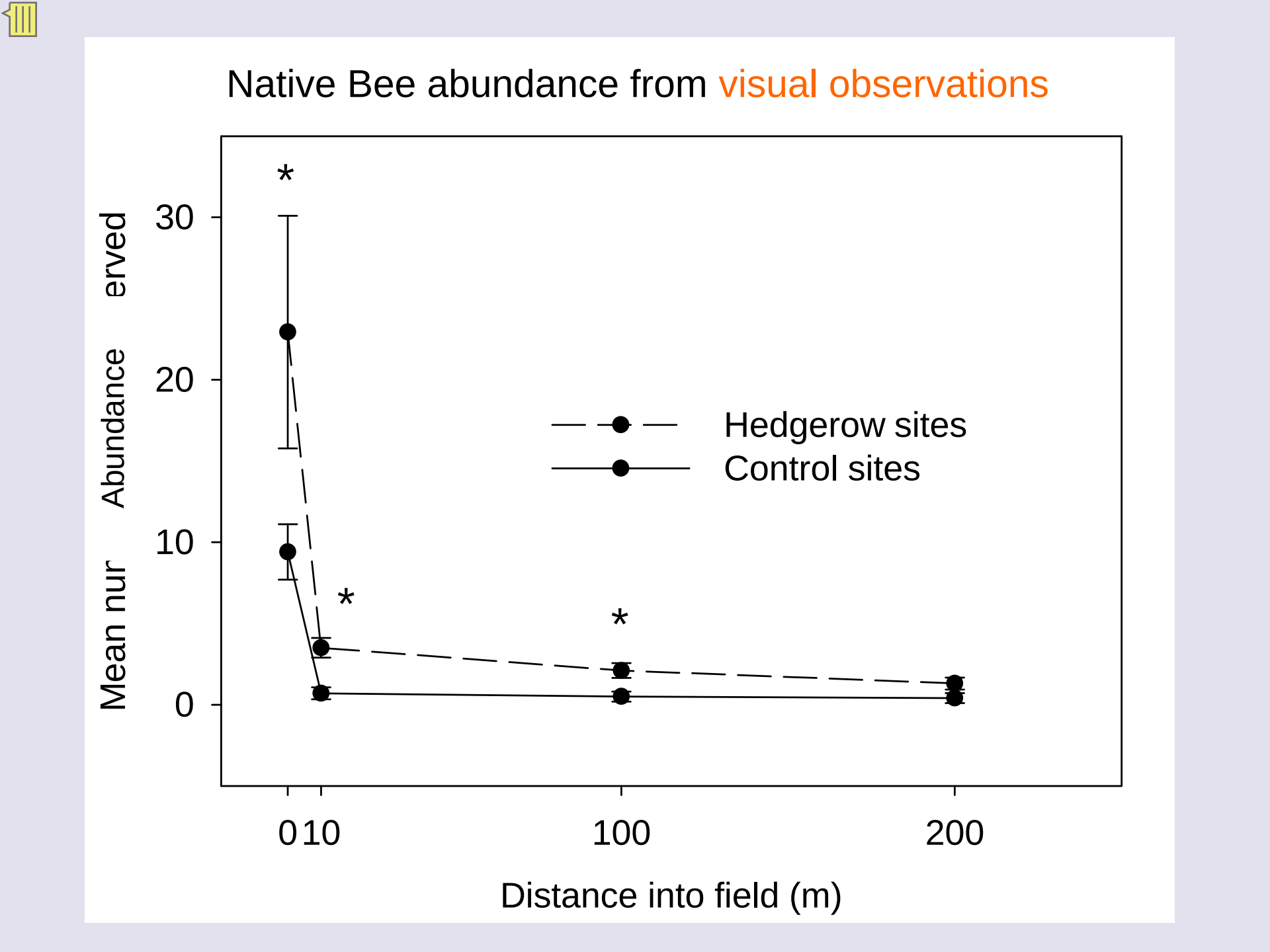
Beta Diversity in Net Samples



Sorensen-Bray Mean Distance

Control = 0.396 **Hedgerow = 0.729**

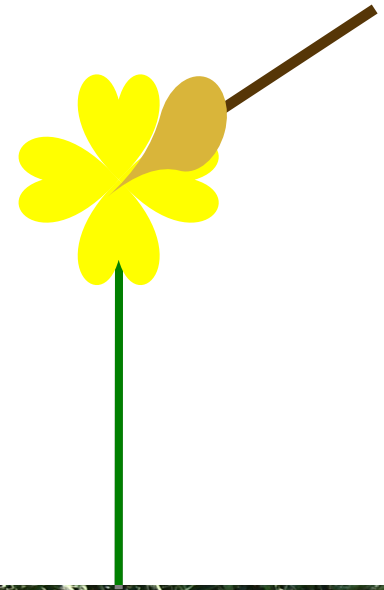
Q2. Are hedgerows exporting pollinators to adjacent crops or competing with them?


Native Bee abundance from visual observations
Mean nur Abundance erved
30
20
10
0
*
*
*
Hedgerow sites
Control sites
0 10
100
200
Distance into field (m)

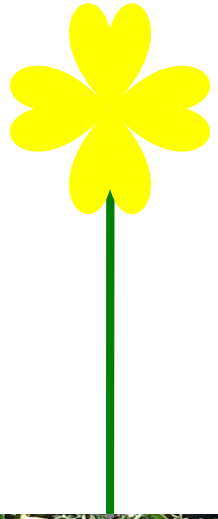
Q3. In progress: Can hedgerows improve pollination services in adjacent crops?

Pollination Treatments

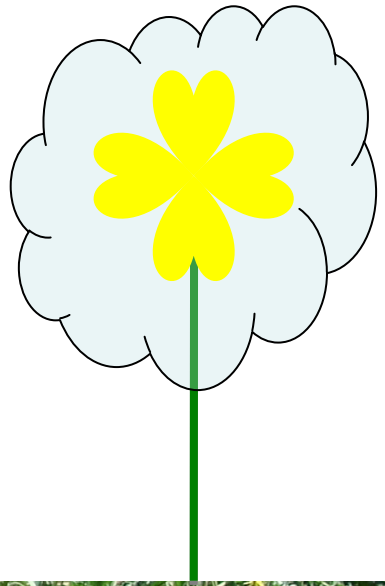
Supplemental



Ambient (Open)



Bagged



Pollen Deficit = Supplemental - Open

Comparison of Pollinator Abundance on *Brassica rapa* between Controls and Hedgerows at three distances

hedgerow
control

Counts

18
16
14
12
10
8
6
4
2
0

0
50
100
150
200
250

distance into field (m)

Proportional Weight Increase of Canola seeds

$$PWC = \frac{1}{n_C}\sum\frac{W_{SC} - W_{OC}}{W_{OC}} - \frac{1}{n_H}\sum\frac{W_{SH} - W_{OH}}{W_{OH}}$$

Mean Pollination Deficit Control

Mean Pollination Deficit Hedgerow

PWC =seed weight increase due to hedgerows

N_C, N_H = # of control or hedge sites

W_S, W_O = Weight canola seeds supplementally pollinated (S) and open pollinated (O)

Profit Increase

$$P_X = (MV - AVC) * Y * PWC$$

P_X = Profit increase due to pollination*

Y = Average yield

PWC = Weight increase from first formula

MV = Market value crop (canola)

AVC = Average variable cost

(potential cost increase due to greater yield)

*P_X: P_P or P_{PC}
P_P = Profit associated with pollination services
P_{pc} = profit increases associated with higher levels of pest control

Example Findings:

Hedgerow

3.8 % yield increase

Market value * yield = $24,192 (1.038) = $25,111

= 13% increase in profit

Control

Market value * yield = $24,192

Net Economic Benefit

$$B_Y = [(Y-3)P_x] - C - (Y-3)U$$

C = Cost of establishment and maintenance for the first three years

U = Annual upkeep after first three years (est. $100/yr)

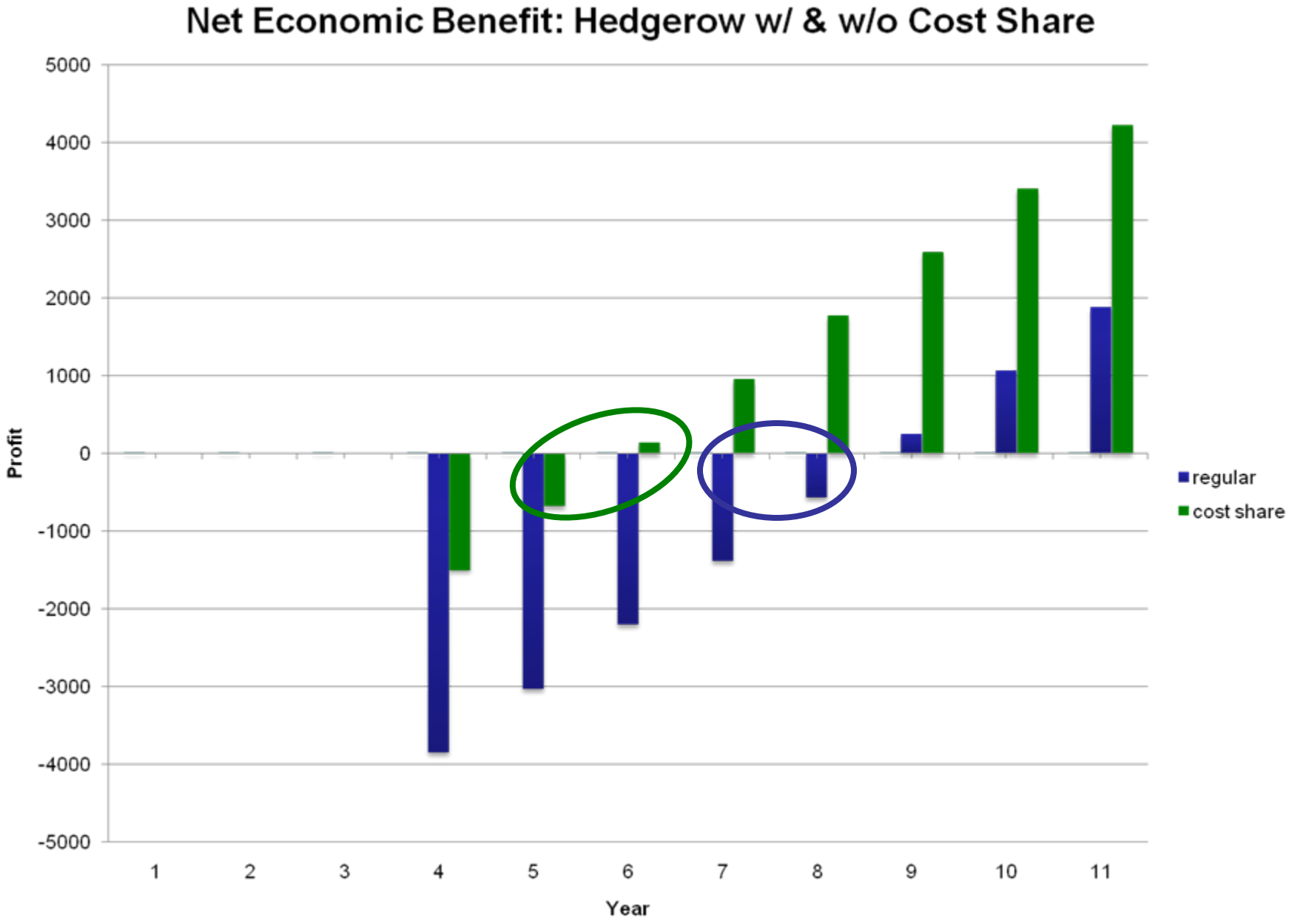
Y = Current Year

Break-Even Point: 8 years after installation, w/ no cost share B_Y = $248

Most have been installed under EQIP with 50% cost share (est. $1500)

Add in benefits from natural enemy pest control = shorter break-even

Flexible formula, can accommodate rotation of pollinator dependent and pollinator-independent crops ➡ longer break-even


Net Economic Benefit: Hedgerow w/ & w/o Cost Share
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
Profit
1
2
3
4
5
6
7
8
9
10
11
Year
regular
cost share

Conclusions

- Pan & Net Sampling Capture Different Portions of the Community
- Hedgerows support higher native bee Alpha & Beta diversity than Controls
- Hedgerows export rather than concentrate bees
- Increased pollination can result in increased yield; hedgerows more than pay for themselves within 7-8 years

Major Partners

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Audubon CALIFORNIA

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