Biodiversity in Organic Vineyards

Case Studies from California's North Coast Region

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Outline

- **Brief introduction to Bonterra/Fetzer**
- **Why consider biodiversity in winegrape production?**
- **Practices used to conserve or enhance biodiversity in organic vineyards**
- **Five case studies - effects of biodiversity in vineyards**

Vineyards in California: Biodiversity?

Some are obviously monocultures, nearly void of biodiversity

In other areas, vineyards have considerable biodiversity

Learning from Pioneers:
Sharing Successful Experiences

Fetzer is recognized as a pioneer in "sustainable" practices in the winery. **Sales - approx 3.3 mill Cases/yr**

Bonterra: Made from 100% certified organic grapes. Largest producer in this category in the US. **Sales -approx. 300,000 cases/yr**

Spreading innovation & information We collaborate with Sustainable Winegrowing Programs, university scientists & many others

Biodynamic Wine from the Home ranch of Bonterra Vineyards -“The McNab”

Approx 900 cases per year

Background on Fetzer and Bonterra Vineyards

- **Founded**: in 1968 in Hopland, Mendocino County, California
- **Pioneer**: Developed sustainable practices in winery and vineyards over 2 decades.

  Bonterra Brand started in 1990
- **Current Size**: 960 acres farmed sustainably and organically in Hopland, CA – largest organic winegrape grower in CA; used for Bonterra Brand
- **Scope**: Also buy grapes from about 75 growers in California, including organic growers in Mendocino and Lake counties

A comprehensive sustainability approach at Fetzer & Bonterra

Vineyards & Ecosystem: Sustainable grape growing, water quality, conserving soil, water, & biodiversity , etc. (Bonterra)

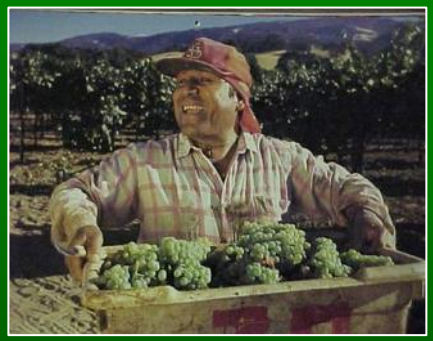
Winery: energy & water conservation, 100% green energy, achievements in waste management, packaging innovations, etc.

Social responsibility: employee safety & health , education, housing, support to community, etc.

NUMEROUS EMPLOYEES AT FETZER ARE INVOLVED!

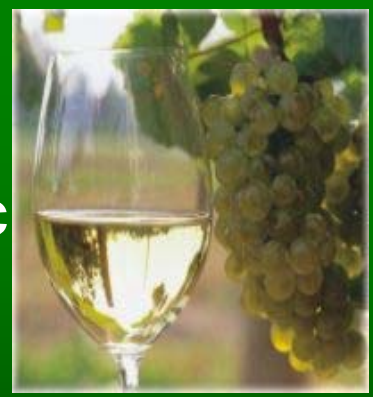
Fetzer's Commitment to Sustainability

Environmental
Responsibility



Social
Equity

Economic
Viability



Examples: Renewable energy & GHG/carbon studies at Fetzer

1. **Renewable Energy** - Fetzer was first CA winery to purchase 100% renewable energy for winery electricity in 1998
2. **Solar Panels on Admin. Building - 1999**
   - 40 kW photovoltaic system; **55,000 kWh a year** – generates the majority of the building's energy needs
3. **Solar Panels on bottling facility - 2006**
   - 899 kW photovoltaic system **2nd largest in CA wine industry**
4. Joined Climate Action Registry in 2006; annual GHG inventory; collaborated with L. Jackson et al (UC Davis) for unique analysis of carbon stocks in vineyards and wildlands/habitat 2008-09

Basic Approaches for Growing Winegrapes Sustainably & Organically – Bonterra Vineyards

- Building the health of the soil (using cover crops, compost)
- Integrated systems approach
- Elimination of synthetic pesticides & fertilizers
- Conservation of natural resources, including water, watersheds, soil, energy, and natural habitat
- Conservation & Enhancement of biodiversity
- Protecting health & safety of employees and communities
- Improving quality of grapes (balance)

We provide education and information to other growers about sustainable & organic viticulture

Biodiversity in Vineyards

- **Biodiversity in vineyards refers to all plant and animal organisms (crops, other vegetation, animals, insects, fungi, soil flora and fauna, etc.) present in and around the vineyard.**
- **Biodiversity exists at several levels in agricultural systems (including vineyards):**
  - **Genes - i.e., genetic resources**
  - **Plant and animal species and varieties**
  - **Communities**
  - **Ecosystems**
- **Biodiversity is both above and below ground**
  - **(For example, each teaspoon of soil has millions of microorganisms)**

(Thrupp, 1998)

Why be concerned about biodiversity?

Functions of biodiversity in agriculture:

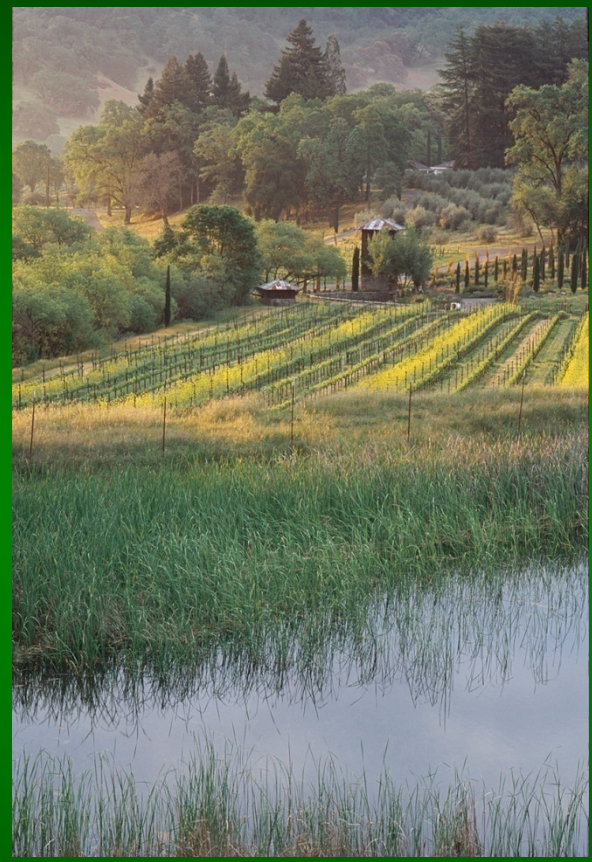
- **Avoids ecological vulnerability in monoculture system**
- **Increases crops' defenses against pests and diseases**
- **Soil biodiversity helps increase soil health (in soils)**

On the other hand, the loss of biodiversity in farming systems has disadvantages. A monoculture and non-diverse farming system becomes more vulnerable to:

- **pests and diseases**
- **climatic fluctuations** ***(Clements & Shretha, 2004)***

What is known about biodiversity in vineyard systems?

Categories of Biodiversity in California vineyards



- **Planned Biodiversity** **includes crops and other species purposefully included in a vineyard by a grower**

- **Associated Biodiversity** includes all flora and fauna that colonize the agroecosystem from surrounding environment

Practices used to conserve or enhance Biodiversity in CA Vineyards

(Examples of planned biodiversity)

- Planting diverse **varieties and clones**
- Planting **cover crops** (mowed or tilled/incorporated)
- Conserving **vegetation/habitat or trees**
- **Habitat Corridors** or hedgerows/trees in vineyard
- Building **structures** to attract beneficial birds
- Using **compost** to enhance diversity in soil
- Introducing grazing **animals** in vineyards
- Integrating other “cash” crops (unusual)

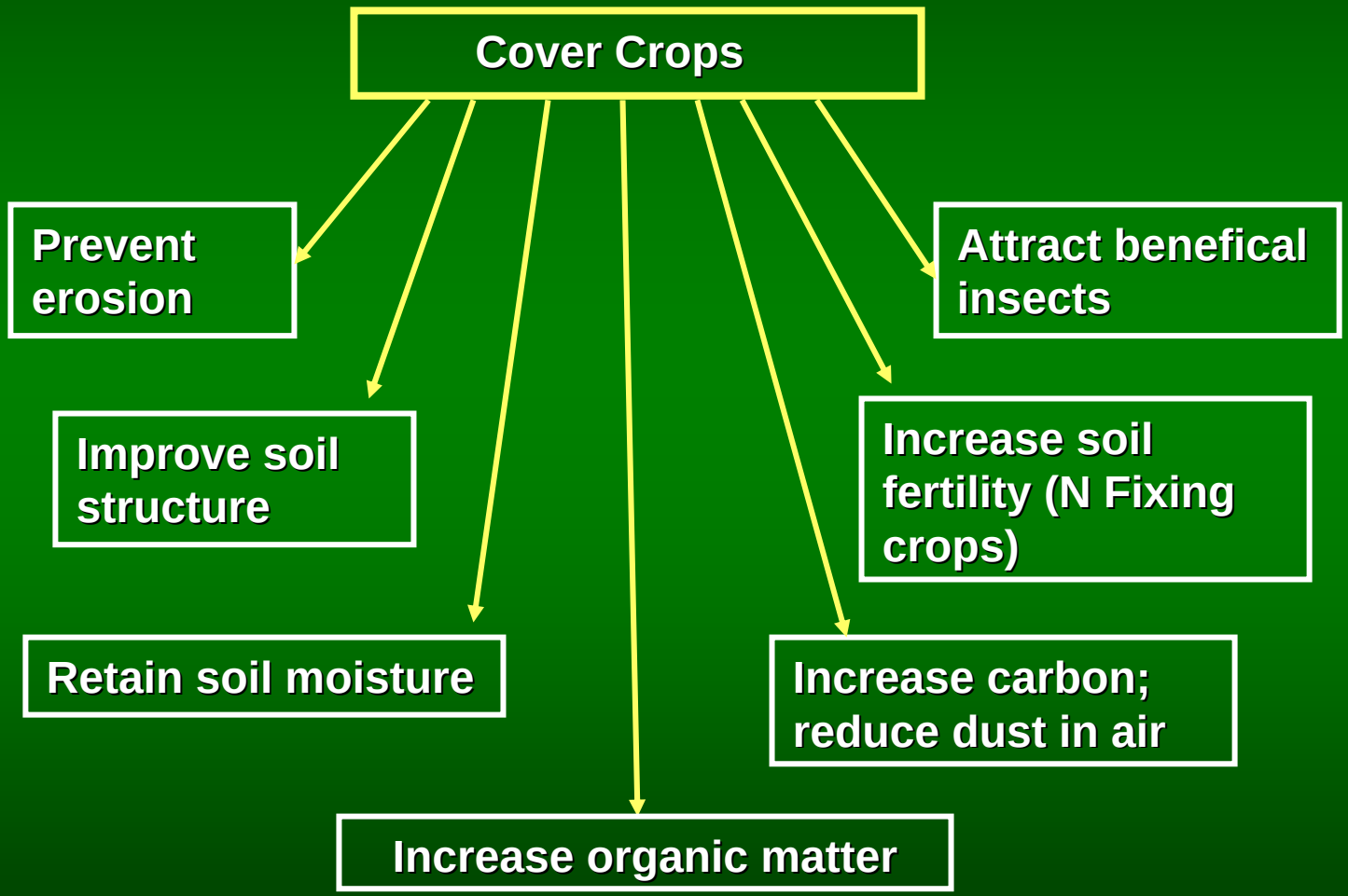
All of these practices are used at Bonterra/Fetzer vineyards

Compost

- **Made mostly from grape seeds, stems & skins, from our winery**

Cover Crop mixes with different purposes

Cover crops and their multiple benefits in vineyards

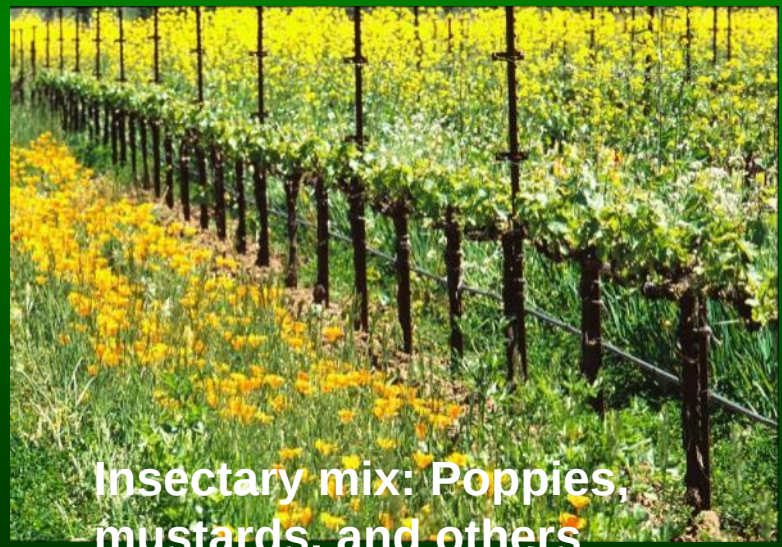


Thrupp, 1998, adopted from UNDP

Cover Cropping: A common practice with multiple proven benefits in vineyards (aka, ecosystem services)

Alyssum – insectary plant

Fertility mix (clovers)



Insectary mix: Poppies, mustards, and others

Examples of commonly-used cover crops that attract beneficial insects (examples from Bonterra)

Examples of Biodiversity in the broader landscape/ecosystem:

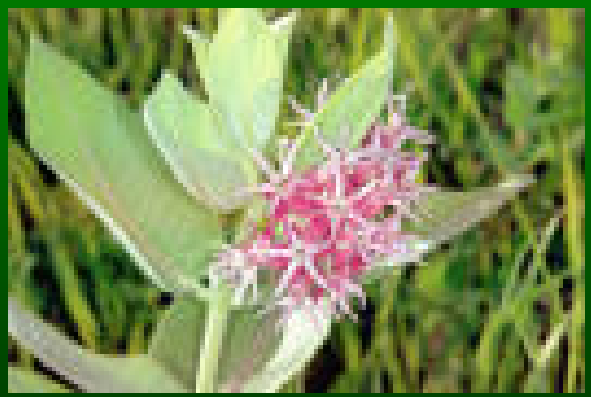
Natural habitat, Planted habitat corridors, hedgerows,

This includes planting flowers or other insectary plants near or in vineyards

alyssum

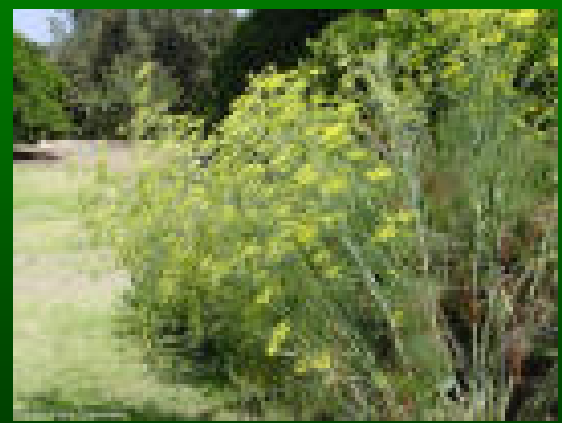
poppies (with lupen)

yarrow



milkweed

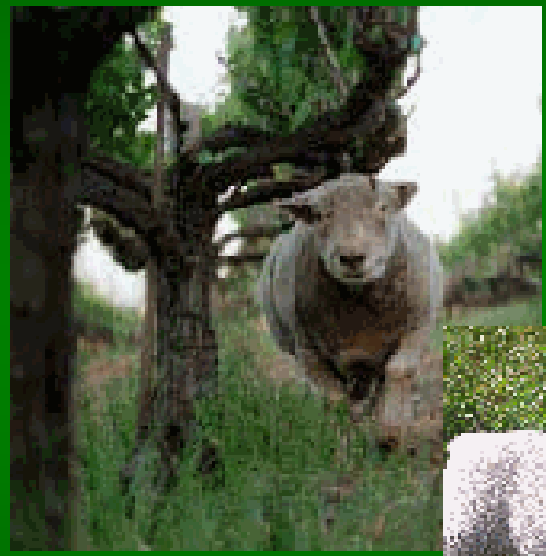
lavender



fennel

Add Animal Biodiversity – McNab ranch Bonterra Vineyards

Chickens graze between vines: eat cutworms, beetles and weeds, scratch/loosen soil, leave manure



Sheep used for weed management, especially effective in hillsides

It's often considered "common knowledge" that habitat biodiversity benefits vineyards

- **But research and data are lacking…**
- **Therefore, in 2007, the CA Sustainable Winegrowing Alliance designed a project with 2 main objectives:**
  - **Document and demonstrate the effects of biodiversity and habitat protection in CA Vineyards, focused on insect and plant diversity**
  - **Disseminate information about "best practices" and effects of biodiversity conservation in vineyards through workshops and website resources**

Grant support from the National Fish and Wildlife Foundation

Thanks to Collaborators in the Project

- **Case study sites – Grower Collaborators**:
  - Bonterra Vineyards
  - Fetzer Vineyards (Sundial)
  - Milovina Vineyards
  - Benziger Vineyards
  - Preston Vineyards
- **Researchers and coordinators**
  - CA Sustainable Winegrowing Alliance (Thrupp,Browde)
  - UCCE (McGourty, Papper)
  - Cal Poly SLO (Costello, Welch, Church)
  - With advice from researchers at UC Davis & UC Berkeley

Vineyard sites illustrate a spectrum of practices for biodiversity conservation

Native riparian habitat → *Mix of native & non-native plants* → *Least diverse*

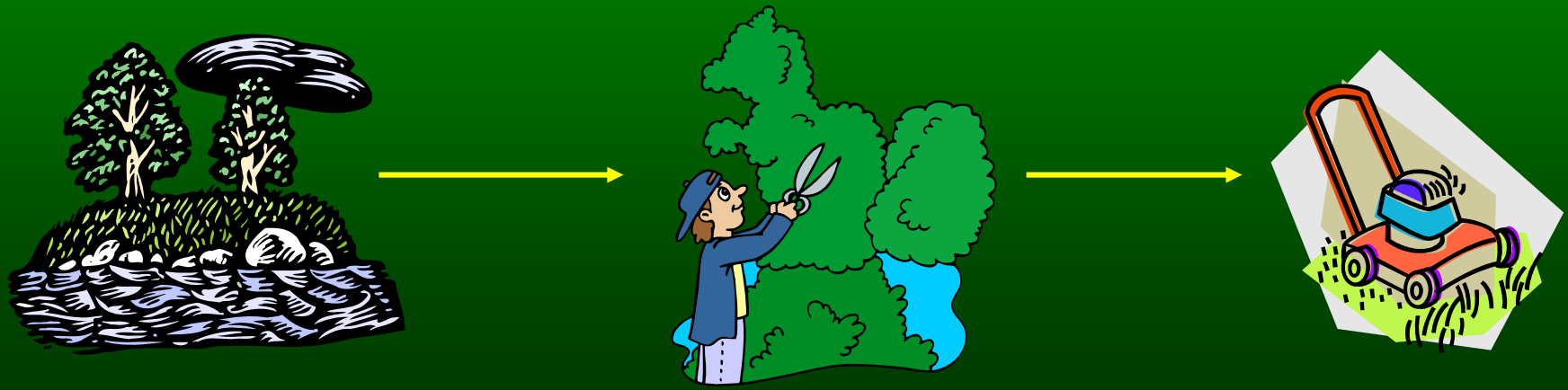
Fetzer
Riparian habitat by Russian River

Bonterra
Planted habitat corridor & riparian habitat

Preston
Planted hedgerows & alyssum every 10th row

Benziger
Planted habitat island - insectary

Milovina
More managed vegetation; few nature oak trees



Potential Effects of Habitat Corridors & hedgerows being included in the study

Do these practices:

- Attract beneficial insects & how far is the effect into the vineyard?
- Do these beneficials help reduce insect pest populations (ie, mites and leafhoppers) in vineyards?
- Attract birds (eg, raptors) that predate gophers/voles?
- Attract small mammals and birds? (what species)

Factors analyzed in the study
(research by UCCE and Cal Poly collaborators)

- Plant species in habitat/hedgerow
- Plant species in the vineyard
- Insect species -- both beneficials and main pests (leafhoppers & mites) in vineyard
- Bird species in habitat and vineyard
- Small Vertebrate species in the habitat and in the vineyard

Timing: Started in summer 2006, continuing in Spring & summer 2007

Case 1: Fetzer Vineyards Sundial -Riparian habitat (Adjacent to Russian River)

Plants Up to 6 feet in height:

- **Himalayan Black Berry (*Rubrus procerus*)**
- **Wild Rose (*Rosa multiflora*)**
- **Teasel (*Dipsacus sylvestris*)**
- **Snow berry (*Symphoricarpos albus*)**
- **Poison Oak (*Rhus diversiloba*)**
- **Poison Hemlock (*Conium maculatum*)**

Plants from 6 feet to 100+ feet in height :

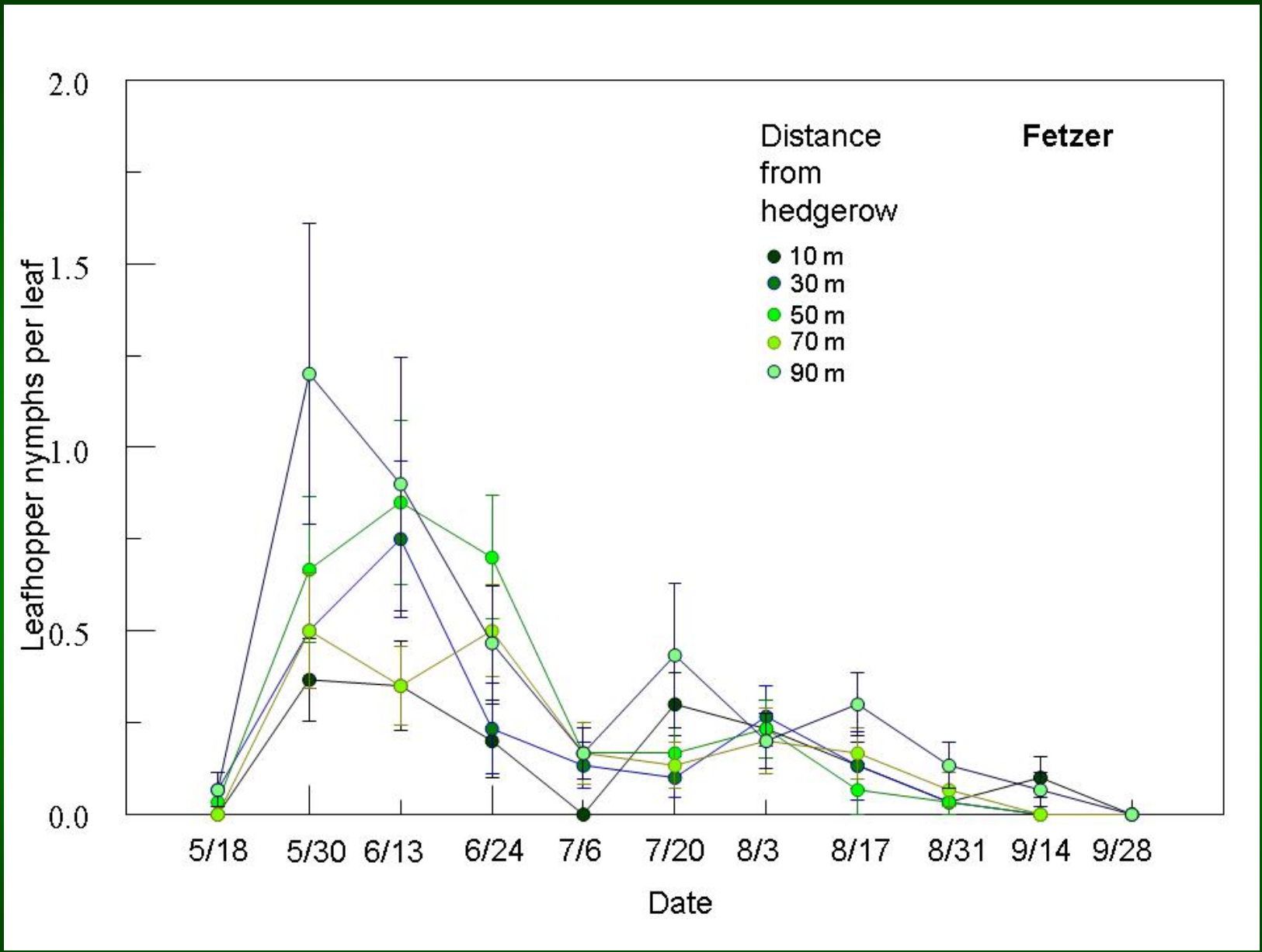
- **Box Elder (*Acer negundo*)**
- **Red Willow (*Salix exigua*)**
- **Valley Oak (*Quercus lobata*)**
- **Northern California Black walnut (*Juglans hindsii*)**
- **Grey Willow (*Salix sp.*)**
- **Oregon Ash (*Fraxinus latifolia*)**
- **Fremont Cottonwood (Populus fremontii)**

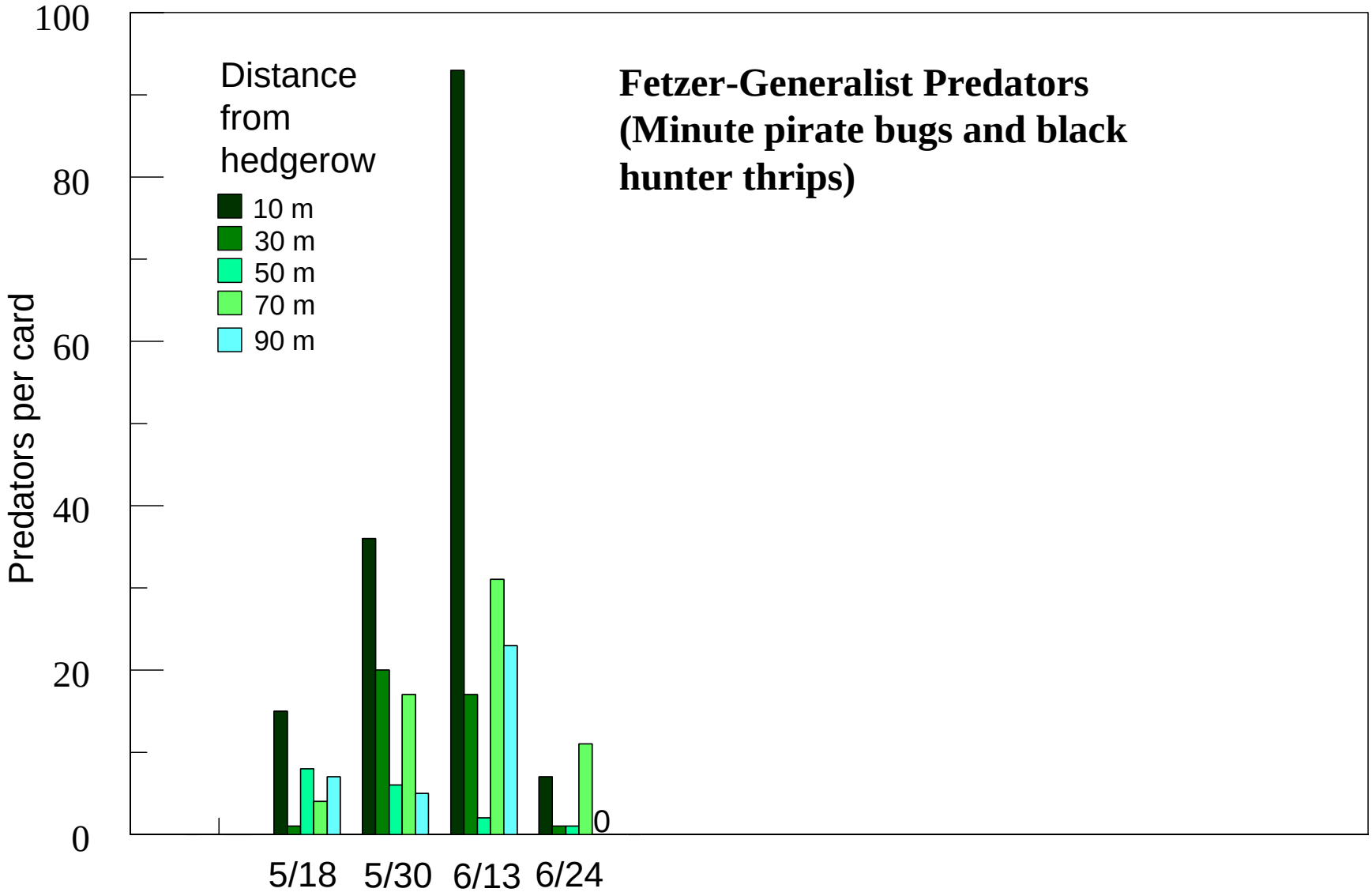
Basic information on the Vineyard & management practices used at the Fetzer Site

- **Sundial ranch - Chardonnay,** Hopland, CA; in flood plain zone of Russian River
- **Cover crops**: 97% clover (including crimson closer and rose clover) and 3% Queen Anne's Lace, seeded in the fall. (Previously used bell beans, vetch, and mustards)
- **Soil amendments**: Compost at 1 to 2 tons per acre
- **Disease and Pest management**: 3 applications of stylet oil - 1% solution in 75 gallons of water per acre, and 5 applications of sulfur dust 10-12 pounds per acre No treatments for insects.
- **Weed management**: Tillage under the vines; mowed and tilled between vines (alternate rows)
- **Certified organic**

Findings from Fetzer site

- Overall leafhopper density was low
- Leafhopper density was consistently lower in the plot next to the riparian corridor for the first generation
- *Anagrus spp*. Density was also low and showed little relationship to the corridor
- Nevertheless, there was high density of generalist predators during the six week period from May 3-June 15 in the plot nearest the corridor (10m)
  - This included high densities of minute pirate bug and black hunter thrips
  - This appears to be a clear association with the riparian habitat


Fetzer
Distance from hedgerow
10 m
30 m
50 m
70 m
90 m
Leafhopper nymphs per leaf
2.0
1.5
1.0
0.5
0.0
5/18
5/30
6/13
6/24
7/6
7/20
8/3
8/17
8/31
9/14
9/28
Date


Fetzer-Generalist Predators
(Minute pirate bugs and black hunter thrips)
Distance from hedgerow
10 m
30 m
50 m
70 m
90 m
Predators per card
100
80
60
40
20
0
0
5/18
5/30
6/13
6/24

Case 2: Bonterra Vineyard – McNab Ranch - Habitat Corridor - 104 plant species originally planted

Basic information on the Vineyard & management practices used at Bonterra Site

- **McNab Ranch –**Merlot block - in Knight's valley, a "box canyon" on McNab creek, north of Hopland
- **Cover crops:** Mix of Bell beans, vetch, clover, planted in the fall; mowed in Spring and summer, cultivated every other row for three seasons.
- **Soil amendments:** Compost at 1-2 tons/acre
- **Pest/Disease management**: 2 applications of wettable sulfur (Kumulus), plus 5 sulfur dustings. No treatments for insects.
- **Soil amendments**: Compost (2-3 tons per acre) and fish emulsion (by drip),and biodynamic preparations.
- **Weed control**: mechanical methods, under vines.
- **Certified organic** and biodynamic

Current Species in Bonterra Habitat Corridor

(plants up to 4 feet in height)

- Asters (*Aster frikartii*)
- Butterfly bush (*Buddleia davidii*)
- Lavender (*Lavendula angustifolia, L. dentata*)
- Rosemary *(Rosmarinus officinalis*)
- Willow (*Salix exigua*)
- Cat mint (*Nepeta x fassenii*)
- Scarlet gaura (*Gaura lindheimeri*)
- Hybrid rose (*Rosa* sp.)
- Coreopsis (*Coreopsis verticillata*)
- Fever few (*Chrysanthemum parthenium*)
- Blanket flower (*Gallardia X grandiflora)*
- Fig (*Ficus carica*)
- Oregano (*Origanum vulgare*)
- Climbing rose (*Rosa* spp)
- Pomegranate (Punica)
- Artemesia (*A*. X 'Powis Castle')
- Fennel (*Foeniculum vulgare*)
- Yarrow (*Achillea millefolium*)
- Feather Grass (*Stipa arundinacea*)
- Euphorbia (*Euphorbia lathyris*)
- Cone flower (*Echinacea purpurea*)
- Verbena (*Verbena peruviana*)
- Crabgrass (*Digitaria sanguinalis*)
- Flax (*Linum perenne*)

Current Species in Bonterra Habitat Corridor

(plants up 5 – 15 feet in height

- Rosemary (*R. officinalis* 'Tuscan Blue')
- Butterfly Bush (*Buddleia davidii*)
- Medlar (*Mespilus germanica*)
- Pampas grass (*Cortaderia selloana*)
- Red Willow (*Salix exigua*)
- Rose hybrids *(Rosa sp.)*
- Pomegranate (*Punica granatum*)
- Fig (*Ficus carica*)
- Peach (*Prunus persica*)
- Pineapple guava *(Feijoa sellowiana*)

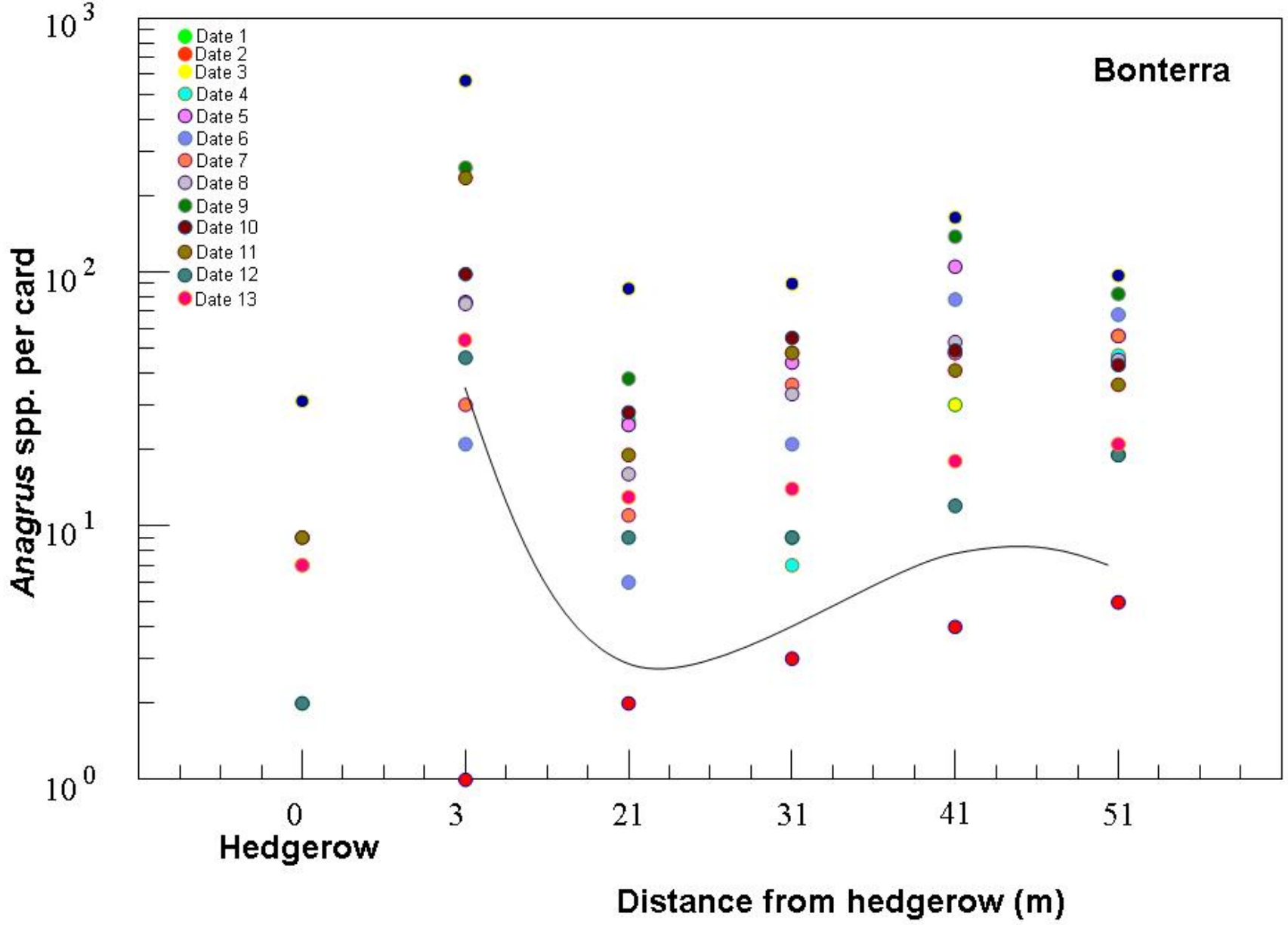
Examples of plants in habitat corridor:

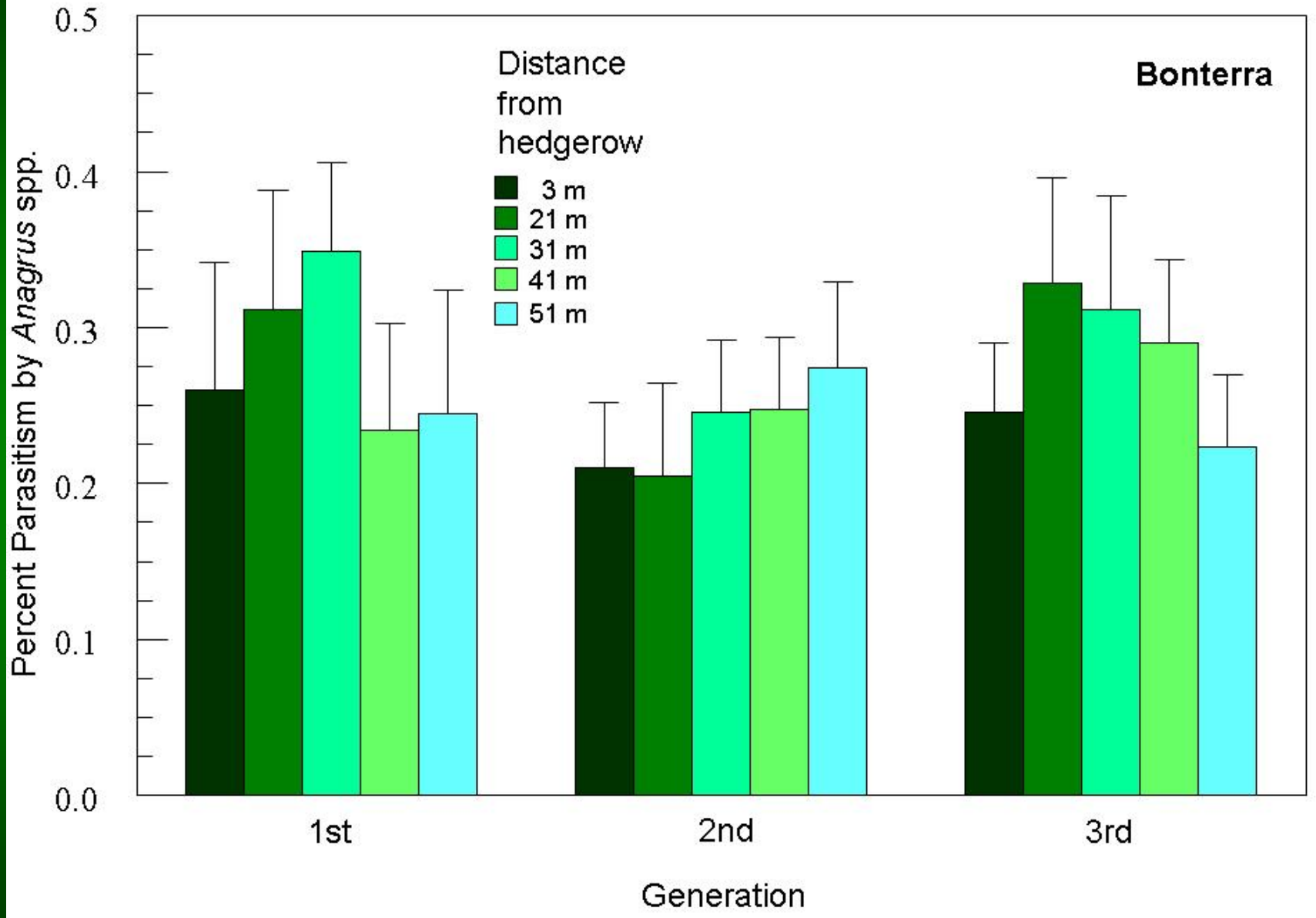
- butterfly bush
- ornamental oregano
- tansy
- Santa Barbara Daisy
- echinacea
- penstamon
- Indian blanket
- coreopsis
- yarrow
- salvia (sage)
- lavender

Additional Plants & trees: Pineapple guava tree, peach tree, plum tree, pomegranate tree, and a variety of sunflowers

Findings from Bonterra site

- The highest *Anagrus spp*. density was nearest the hedgerow (3m), and tapers off in subsequent plots.
- Relatively few *Anagrus spp*. were actually found in the hedgerow, until late June-early July.
- When first generation leafhopper nymphal density peaked (June 4), the lowest numbers were found in the two plots nearest the hedgerow.
- Overall leafhopper density was 3-4 times lower in the second generation than the first .
- The pattern of leafhopper density did not appear to be related to *Anagrus* spp. activity, as percent parasitism did not differ for first, second or the third generations


Bonterra
Date 1
Date 2
Date 3
Date 4
Date 5
Date 6
Date 7
Date 8
Date 9
Date 10
Date 11
Date 12
Date 13
Anagrus spp. per card
10 3
10 2
10 1
10 0
0
3
21
31
41
51
Hedgerow
Distance from hedgerow (m)


Bonterra
Distance from hedgerow
3 m
21 m
31 m
41 m
51 m
Percent Parasitism by Anagrus spp.
0.5
0.4
0.3
0.2
0.1
0.0
1st
2nd
3rd
Generation

Case 3: Preston Vineyards
Hedgerow and alyssum corridors

Preston-Dry Creek

Basic information on the Vineyard & management practices used at Preston Site

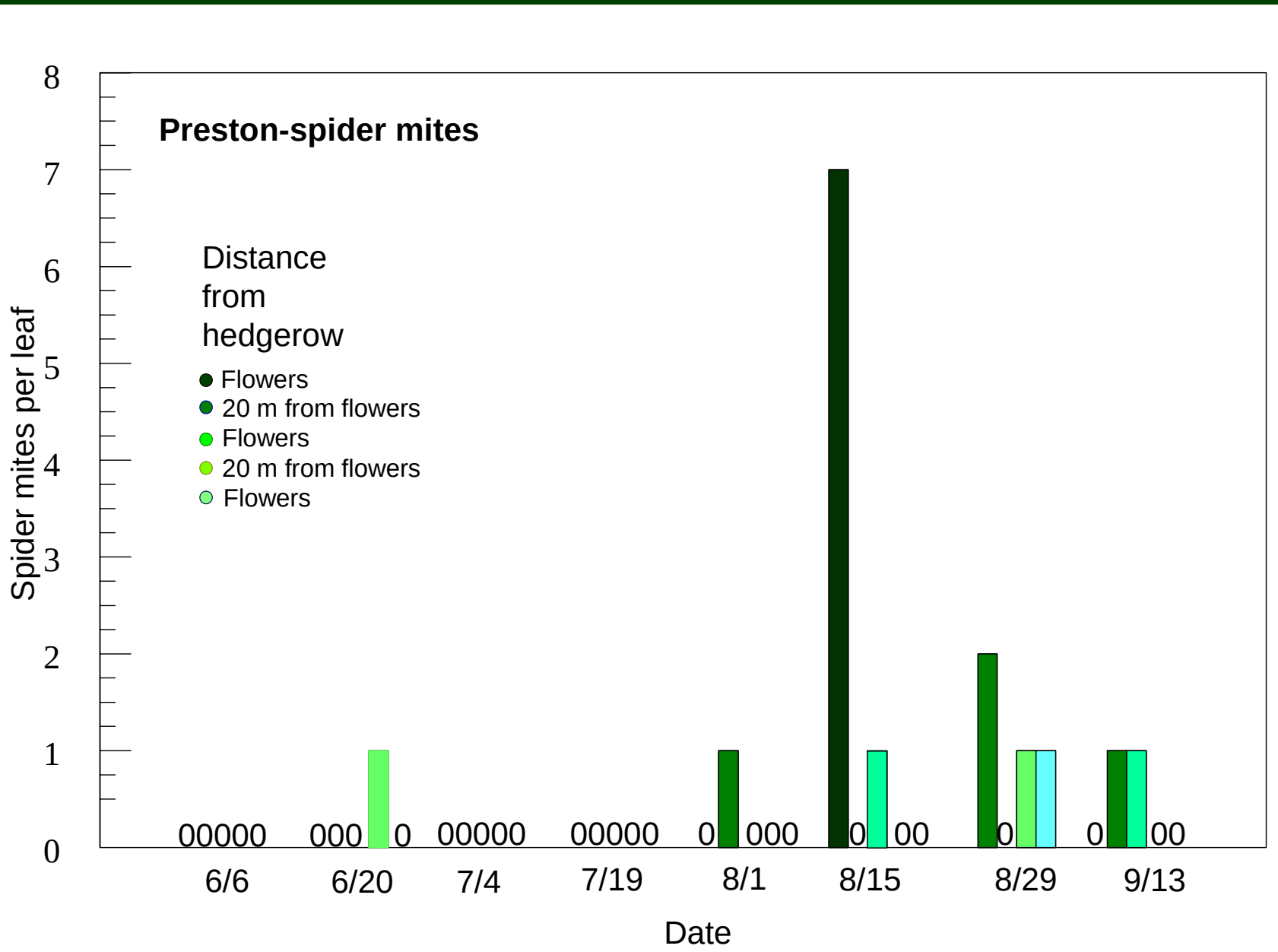
- **Dry Creek** alluvial fan, Zinfandel, California Sprawl.
- **Cover crops**: Bell Beans, peas, vetch, oats, and mustard as a passive nematicide; tilled in March-April.
- **Pest/Disease management**: Sulfur dust, started 3 weeks later than is the norm. During the first 3 - 4 weeks of growth, used compost tea and milk whey from a local goat dairy. a total of 6 applications of CT and whey, every 10 days.
- **Soil amendments**: Compost after harvest and before seeding cover crop, 500 lbs/acre. + broad spectrum minerals from Summa Minerals (Utah mined ancient sea bed); 400 lbs/acre
- **Certified Organic**

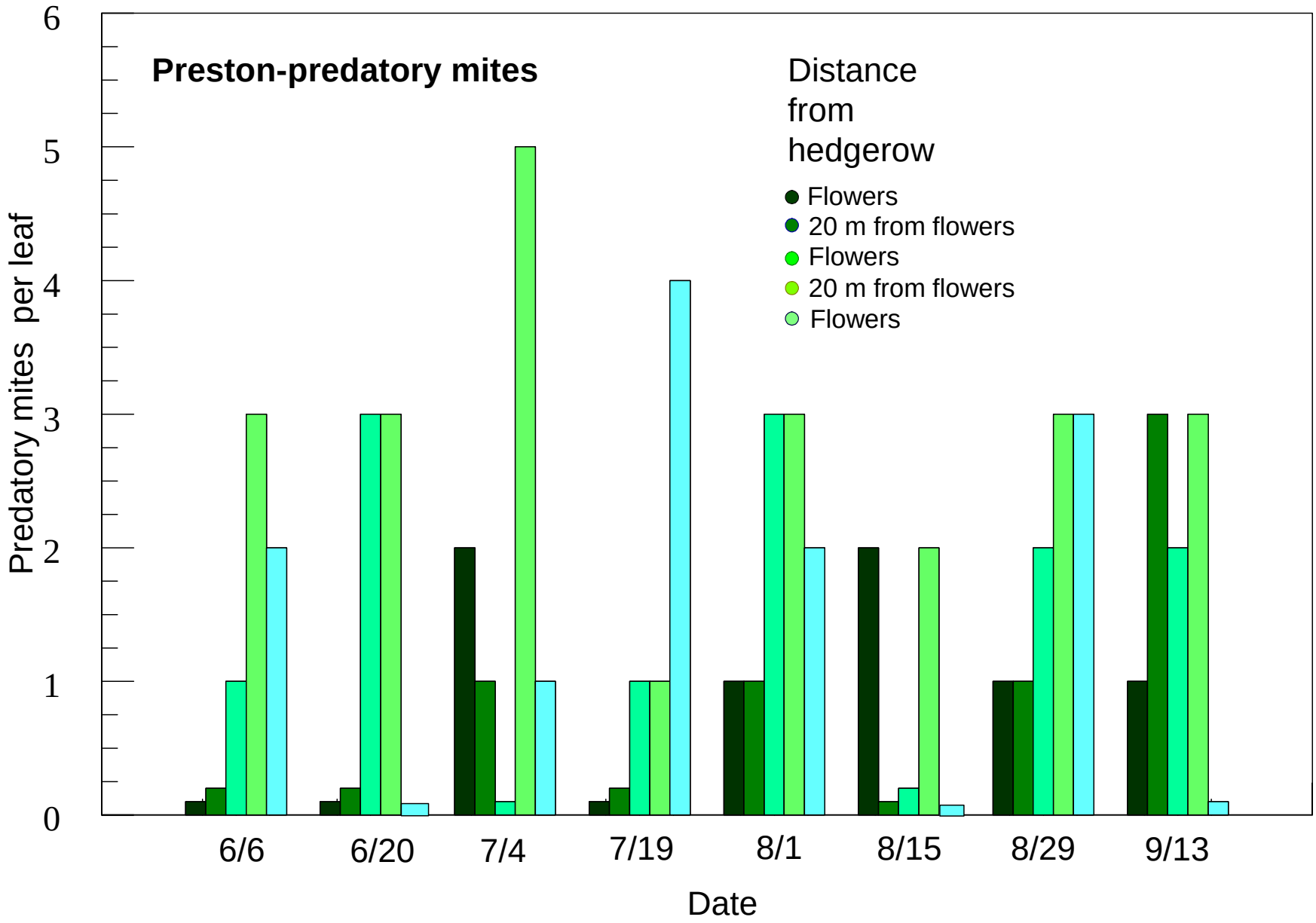
Preston Vineyards - species in hedgerow

- **Asters (*Aster frikartii*)**
- **Penstemon (*Penstemon gloxinoides, P. heterophylla*)**
- **Butterfly bush (*Buddleia davidii*)**
- **California Buckwheat (*Eriogonum fasciculatum*)**
- **Coffee berry (*Rhamnus californica*)**
- **Purple sage (*Salvia leucophylla*)**
- **Toyon (*Heteromeles arbutifolia*)**
- **White thorn (*Ceanothus leucodermis)***
- **Lavender (*Lavendula angustifolia, L. dentata*)**
- **Scarlet sage (*Salvia splendins)***
- **Sage (*Salvia greggii*)**
- **Coyote bush (*Baccharis pilularis*)**
- **Sticky monkey flower (*Mimulus aurantiacus*)**

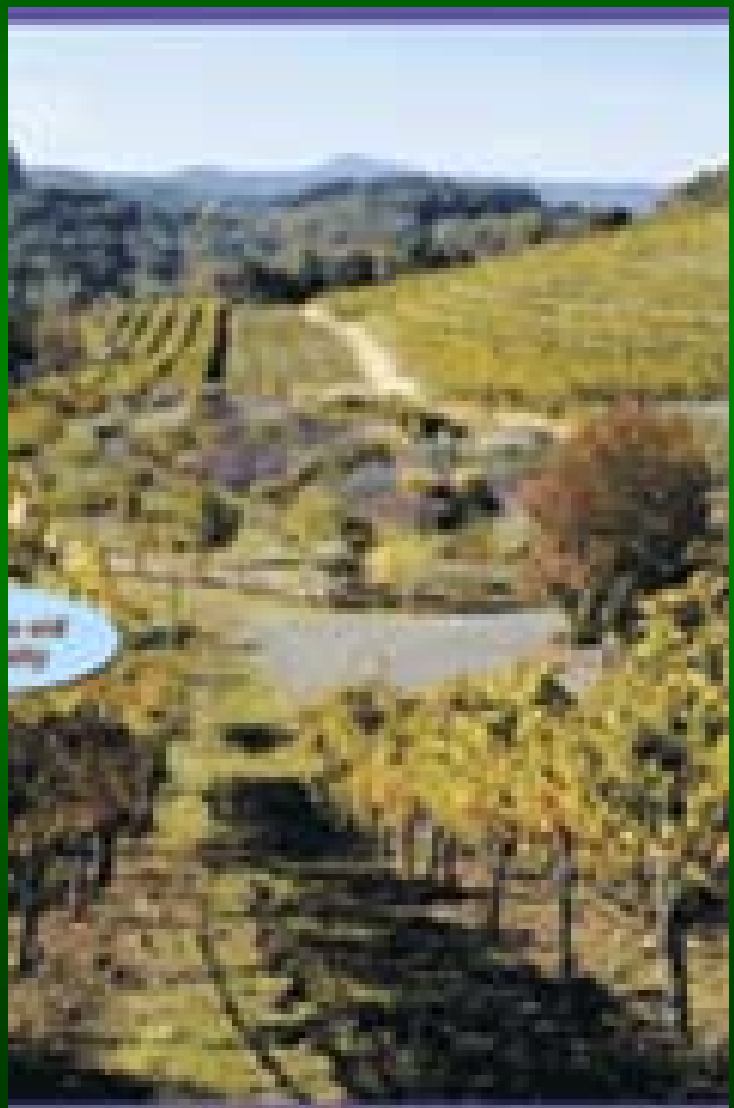
Findings from Preston Site

- **Leafhopper density and Anagrus spp. density were generally low at this site.**
- **There was no linear pattern between Anagrus spp. and the perennial hedgerow,**
- **Spider mite density at Preston was extremely low; predatory mite density was very high.**
  - **It is not certain that this is related to the hedgerow or alyssum corridor, but it is unusual (Grower attributes to less use of sulfur)**


Preston-spider mites
Distance from hedgerow
Flowers
20 m from flowers
Flowers
20 m from flowers
Flowers
Spider mites per leaf
0
1
2
3
4
5
6
7
8
00000
000 0
00000
00000
0 000
0 00
0
0 00
6/6
6/20
7/4
7/19
8/1
8/15
8/29
9/13
Date


Preston-predatory mites
Distance from hedgerow
Flowers
20 m from flowers
Flowers
20 m from flowers
Flowers
Predatory mites per leaf
0
1
2
3
4
5
6
6/6
6/20
7/4
7/19
8/1
8/15
8/29
9/13
Date

Case 4: Benziger - Glen Ellen insectary “island” planting



Basic information on the Vineyard & management practices at Benziger Site

- **Glen Ellen, Sonoma county -** Sauvignon Blanc & Cabernet Franc block next to insectory
- **Cover Crop**: Mix of 30% Peas, 20% common vetch, 10%barley, and 10% oats.
- **Soil amendments**: Compost applied at 2-3 pounds per acre, and biodynamic preparations (including 2 sprays of horn manure.)
- **Disease/pest management**: 2 sulfur dustings and one wettable sulfur application, and 6 applications of Serenade. No applications for insects.
- **Weed control**: Mechanical, under the vines.
- **Certified Organic**

Plants in Benziger Insectory

Hummingbird Plants

- Orange Carpet
- Sunset Hyssop
- Autumn Sage
- Texas Red Yucca
- Malibu Yellow Red Hot Popper
- Firecracker Penstemon
- Pineleaf Penstemon
- Desert Beard Tongue
- Mexican Sage

Butterfly Plants

- Wine Cups
- Whirling Butterflies
- Yellow Gem Kangaroo Paws
- Arctic Summer

Insectory Plants

- Moonshine Yarrow
- Blue Catmint
- Prairie Coneflower
- Russian Sage
- Blackeyed Susan
- Purple Coneflower
- Monch

Findings at Benziger

- Numbers of all key arthropods were quite low at the Benziger site.
- Saw same pattern of Anagrus spp. density in relation to insectory is the same as we saw at Bonterra (even though populations overall were higher at Bonterra)
- Again, this pattern appears to be an influence of the habitat.

Case 5: Milovina Vineyard – Hopland

low density native trees along Crawford creek

Valley Oaks *(Quercus lobata)*

Basic information on the Vineyard & management practices at Milovina Site

- **Crawford creek watershed, north of Hopland,** Chardonnay block.
- **Cover crops**: only natural vegetation between vines; no seeded cover crop; mowed in spring.
- **Disease/pest management**: 4 wettable sulfur applications, 2 sulfur dustings, one application of Rally (sterol inhibitor); No applications for insects
- **Soil amendments**: potassium 3 times in season, Nitrogen one time in drip
- **Weed control**: Glysophate application one time. Vineyard floor vegetation is kept to a very low level during the growing season.

Findings at Milovina Site

- The Milovina site had high densities of Anagrus spp., which seemed to decrease 50 meters from the tree line, increase at 70 meters, and decrease again at 90 meters
- Leafhopper nymphal density did not exhibit a clear distinction among generations, and no clear pattern with respect to the tree-line.
- The Anagrus spp. pattern also did not correlate with leafhopper density.
- The Milovina site also had one of the highest densities of the two most important generalist predator groups, minute pirate bugs and black hunter thrips

Raptors and other beneficial wildlife

at all case study sites

Wildlife species observed
(common in these case studies)

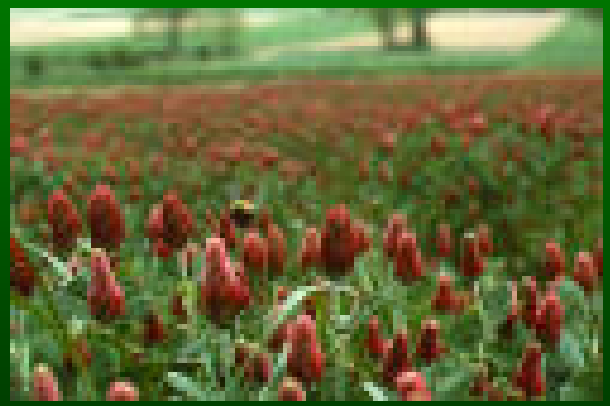
- **Fox**
- **Coyote**
- **Bobcat**
- **Skunk**
- **possum**
- **raccoon**
- **Deer**
- **Wild Pig**
- **Rabbit**
- **Squirrel**
- **Vole**
- **Gopher**
- **black bear (in one vineyard)**
- **mountain lion (in one vineyard)**
- **Snakes**
- **Lizards**
- **Frogs**
- **Owl**
- **Hawks (several species)**
- **Bats**
- **Vulture**
- **Eagle**
- **Ducks**
- **geese,**
- **Heron**
- **Egret**
- **Woodpecker**
- **Jay**
- **Mockingbird**
- **Starlings**
- **Robins**
- **(Several other song birds Tbd)**

Conclusions – implications

- No simple results about the effects of habitat biodiversity from these cases. All of the sites have slightly different features..
- Need additional time & research; need more time & data from these sites and other sites.
- However, general insights were revealed on the insect populations in these cases…

Conclusions – implications

- In all of the sites, there were no major problems from insect damage. (No perceived need for insect control applications.)
- The presence of habitat clearly increased density of natural enemies in the sites.
- Typically the greatest effect is close to the habitat
- The addition of cover crops can increase the effectiveness of diverse plants on beneficial insects



Challenges

Perceived challenges to adoption of habitat conservation and enhancement (by many farmers):

- **Land/space limitations - focus on vines only**
- **Lack of funding to plant/protect habitat (although NRCS does provide cost share funding)**
- **Water or labor limitations for establishing hedgerows**
- **May attract vertebrate pests (eg, gophers)**
- **Concern about invasive species (plants & insects)**
- **Lack understanding of measurable benefits**
- **(In other crops, food safety concerns as well)**

Research Challenges

- **Systems research – design challenges, especially in on-farm situations**
- **Difficult to identify most important variables & causal interactions (eg, effects of cover crops vs. natural habitat vs. planted habitat , etc.)**
- **Animal Species diversity – difficulty to track/monitor – need more research**
- **Need much more research on ecosystem services, including economic valuation**

Thank you - Questions?

Study report on CSWA website:
http://www.sustainablewinegrowing.org

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