



Role of Agroforestry in Supporting Pollinators



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The Buzz about Pollinators?

- 30% of food production relies on insect pollination *Klein et al. 2007*
- Over \$18 to \$27 billion value of crops in U.S
- Most of our vitamins and minerals are from insect-pollinated plants



FRUIT CROPS:

- * Apple
- * Apricot
- * Avocado
- * Berry (blackberry, blueberry, cranberry, gooseberry, huckleberry, raspberry, strawberry)
- * Cherry
- * Citrus (grapefruit, lemon, mandarin)
- * Currants
- * Kiwi
- * Litchi
- * Mango
- * Melons (cantaloupe, honeydew, watermelon)
- * Peach
- * Pears
- * Plum

VEGETABLE CROPS:

- * Artichoke
- * Chinese cabbage
- * Asparagus
- * Dill
- * Pumpkin
- * Broccoli
- * Eggplant
- * Radish
- * Brussel sprouts
- * Garlic
- * Rutabaga
- * Cabbage
- * Kale
- * Carrots
- * Kohlrabi
- * Squash
- * Cauliflower
- * Leek
- * Turnip
- * Mustard
- * Celery
- * Onion
- * Parsley
- * Pepper
- * Lima beans
- * Collards
- * Cucumber

HERBS/SPICES:

- * Anise
- * Allspice
- * Chives
- * Cinnamon
- * Coriander
- * Fennel
- * Lavender
- * Mint
- * Mustard
- * Nutmeg
- * Oregano

NUT CROPS:

- * Almond
- * Coconut
- * Cacao
- * Coffee
- * Cashew
- * Chestnut
- * Macademia

OILSEED CROPS:

- * Cotton
- * Rape
- * Safflower
- * Soybeans
- * Sunflower

Insect Pollination Of Cultivated Crop Plants

S. E. McGregor USDA 1976

Beyond Food

Over 75% of flowering plants in temperate regions require animal pollination. *Ollerton et al. 2011*



Beyond Food

Pollinators and wildlife

- Fruits and seeds are a major part of the diet of many birds and mammals
- Pollinators and insects are critical food source for 89% of birds, and many other wildlife.



Photos: NRCS/Jeff Vanuga; NPS/Karen Ward; Xerces Society/Matthew Shepherd

Pollinator Species



Bees & Wasps



Flies



Butterflies & Moths



Beetles



Bats



Hummingbirds

Threats

- Habitat loss, degradation, & fragmentation
- Pesticide exposure
- Non-native species & diseases
- Climate change



Agroforestry Practices



Hedgerows / Windbreaks



Riparian Forest Buffers



Alley Cropping



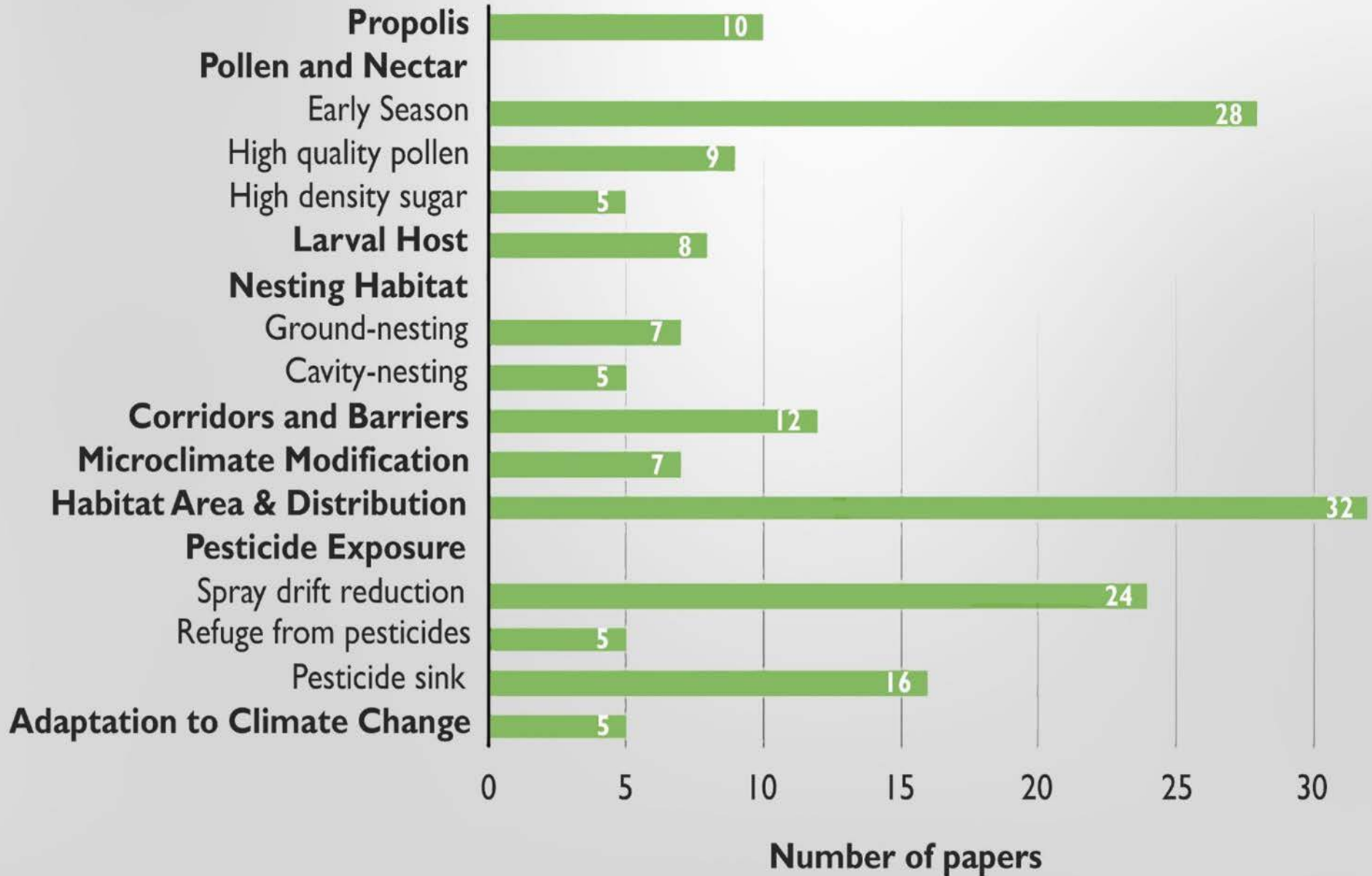
Silvopasture



Forest Farming



Additional Applications



1. Providing foraging resources & nesting or egg-laying sites
2. Enhancing site & landscape connectivity
3. Reducing pesticide exposure



Foraging Habitat

- Quality pollen/nectar
- Hi-density of resources
- Diversity of resources
- Range of bloom times
- Larval resources



Quality Pollen & Nectar

Species	Common Name	Nectar	Pollen
<i>Acer</i> spp.	Maples	0.600	0.600
<i>Amelanchier</i> spp.	Serviceberry	0.500	0.400
<i>Prunus</i> spp.	Cherry	0.750	0.750
<i>Quercus</i> spp.	Oak	0.000	0.700
<i>Rubus</i> spp.	Rubus	0.700	0.600
<i>Salix</i> spp.	Willow	0.800	0.900
<i>Sambucus</i> spp.	Elderberry	0.300	0.600
<i>Baptisia</i> spp.	Wild Indigo	1.000	0.500
<i>Solidago</i> spp.	Goldenrod	0.900	0.800
<i>Trifolium</i> spp.	Clover	0.750	0.750

0=no pollen/nectar source
 1=major pollen/nectar source

Adapted from Loose et al. 2005
 *Based on honeybee data

Hi-Density of Resources

Baude et al. 2016

Species	Flowers/m ²	Nectar productivity kg/ha cover/year
<i>Salix cinerea</i>	334,178	3612
<i>Crataegus monogyna</i>	19,003	584
<i>Aster tripodium</i>	9,565	169
<i>Epilobium montanum</i>	560	51





Bottlebrush Buckeye



Maple



Willows



Buttonbush



Range of Bloom Times

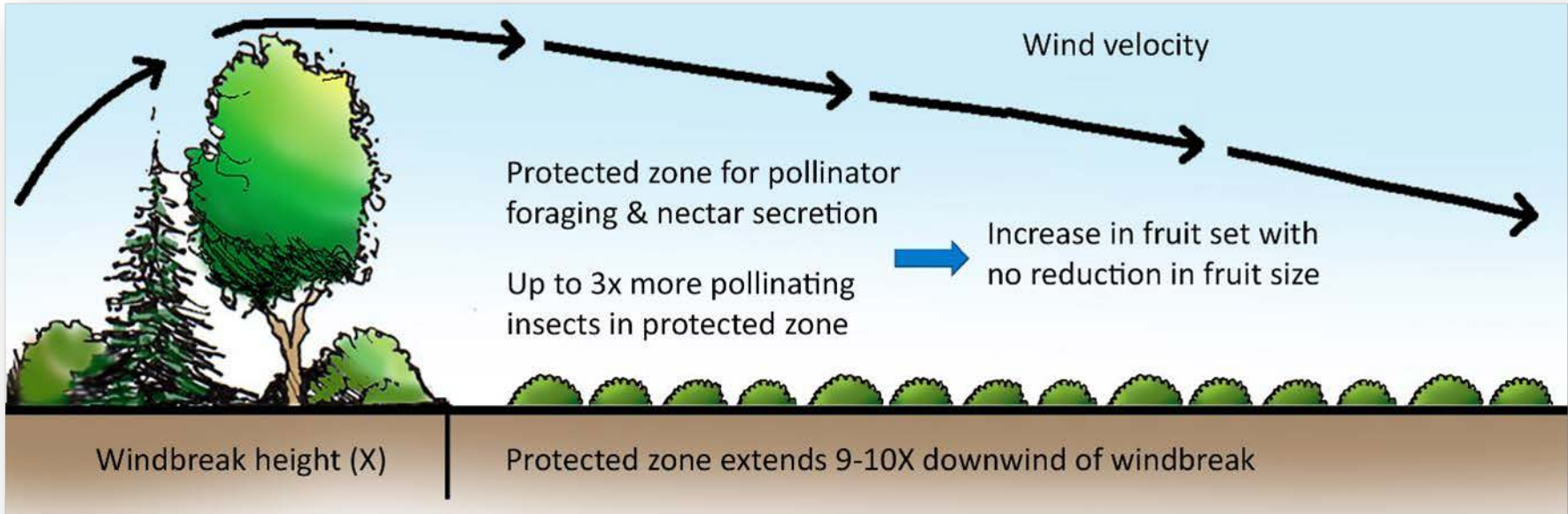
Common Name	Scientific Name	March	April	May	June	July	August	Sept
Maples	<i>Acer</i> spp.	Orange	Orange					
Willows	<i>Salix</i> spp.	Yellow	Yellow	Yellow	Yellow			
Serviceberry	<i>Amelanchier</i> spp.							
Sassafras	<i>Sassafras albidum</i>	Yellow	Yellow	Yellow				
Black cherry	<i>Prunus serotina</i>							
Blueberry	<i>Vaccinium</i> spp.		Pink	Pink				
Eastern redbud	<i>Cercis canadensis</i>		Purple	Purple				
Sumac	<i>Rhus</i> spp.		Yellow	Yellow	Yellow	Yellow	Yellow	
Chokecherry	<i>Prunus</i> spp.							
Black chokeberry	<i>Aronia melanocarpa</i>							
Cockspur hawthorn	<i>Crataegus crus-galli</i>							
Elderberry	<i>Sambucus</i> spp.							
Basswood	<i>Tilia americana</i>			Yellow	Yellow	Yellow		
Wild rose	<i>Rosa setigera</i>			Pink	Pink	Pink	Pink	

Larval Resources

Common Name	Plant Genus	# of butterflies & moths supported
Oaks	<i>Quercus</i>	543
Cherry, plum	<i>Prunus</i>	456
Willow	<i>Salix</i>	455
Birch	<i>Betula</i>	411
Poplar	<i>Populus</i>	367
Crabapple	<i>Malus</i>	305
Maple	<i>Acer</i>	297
Blueberry	<i>Vaccinium</i>	294
Hickory	<i>Carya</i>	235



Microclimate Modification



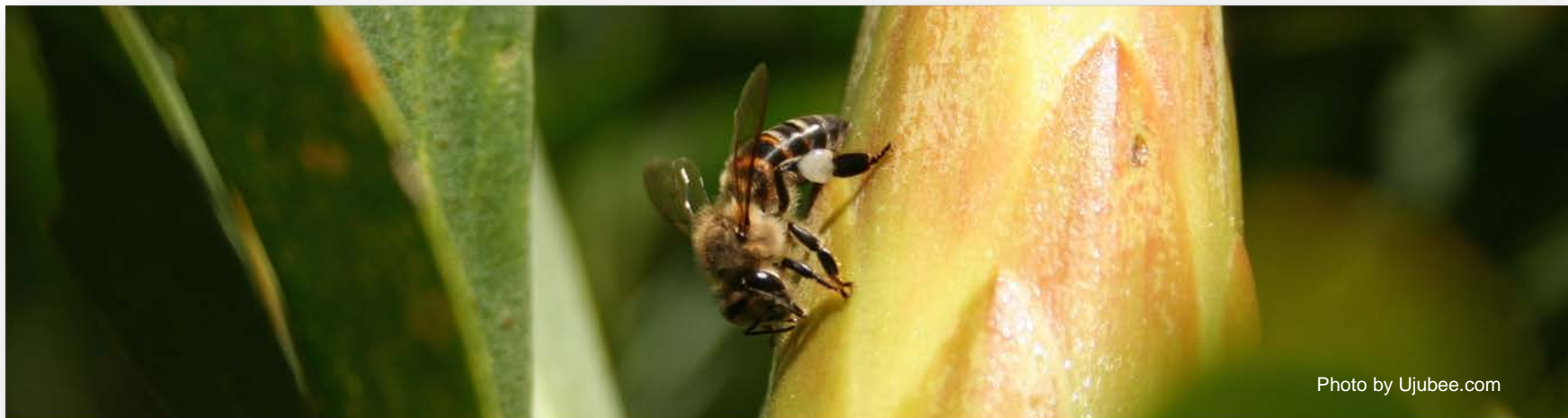
Smith and Lewis 1972, Pinzauti 1986, Pasek 1988

Populations in overwintered hives up to 52% higher when protected by windbreaks. *Merrill 1923*



Other Foraged Resources

- Bees also collect resins and oils from trees and other plants.
- Honey bees use resins to make propolis which has antimicrobial properties
- Poplar trees (*Populus* spp.) are a common source for these resins.
- Other tree species include pine (*Pinus* spp.), birch (*Betula* spp.), elm (*Ulmus* spp.), alder (*Alnus* spp.), beech (*Fagus* spp.), and horse-chestnut (*Aesculus* spp.)



Tunnel-nesting

- 30% of native bee species build their nests inside hollow tunnels.
- Use plants with soft pithy centers:
 - Elderberry
 - Boxelder
 - Rubus spp.
 - Dogwood
 - Sumac
- Use pruning to expose the pithy interior of the stems
- Retain dead or dying trees and branches whenever practical.



Ground-nesting

- 70% solitary ground nesting bees.
- Undisturbed area necessary for ground nesting species.
- May be found in turf, more often on bare, exposed ground and south-facing slopes
- Sandy to loam soils preferred



Photo by Cornell University



Photo: Issac Barnes/Honeyrun Farm



Photo by Hillary Sardiñas

Bumble bees

- About 50 social bumble bee species in the U.S.
- Nest in small cavities, such as abandoned rodent burrows.
- Bumble bee nest densities twice as high in linear woody habitats.

Osborne et al. 2008



Photo: Issac Barnes/Honeyrun Farm



Photo by Elaine Evans,
University of Minnesota

Marketable Products



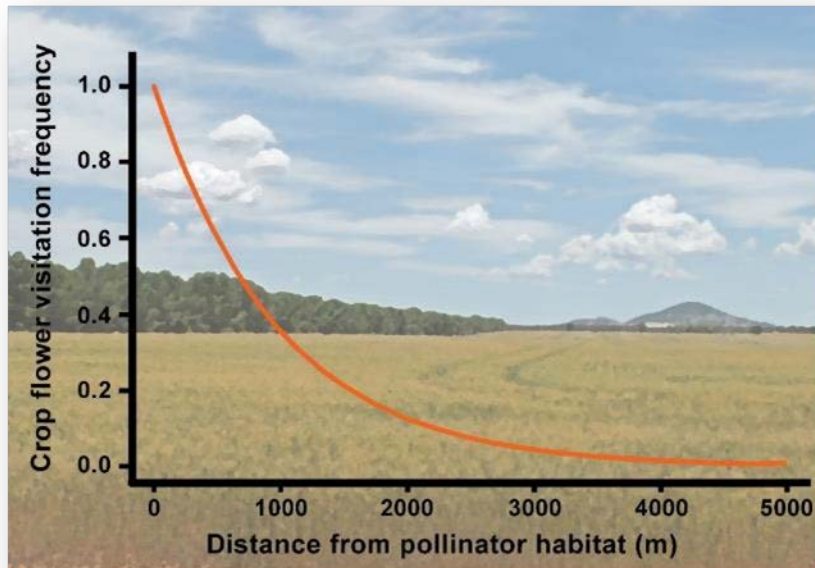
USDA National Agroforestry Center

Common Name	Wood	Fruit	Botanical	Biomass	Decorative Floral	Handicraft
Maples	•					•
Willows				•	•	•
Serviceberry		•				
Sassafras			•			
Black cherry	•					•
Blueberry		•				
Chokecherry		•	•			
Black chokeberry		•	•			
Elderberry		•	•			
Basswood	•					•

Connectivity - Foraging Distances

Bee Size	Foraging Distance (m)	Bee Group	Example of Crops Pollinated
	50-300	Dark sweat bees, blue-green sweat bees	Melon, tomato, pepper
	130-700	Mason, sweat, squash bees	Tomato, pepper, squash, peach, pear
	500 -1100	Plasterer, mining, alkali bees	Blueberry, apple, strawberry, alfalfa
	1500-2500	Bumble bees	Cranberry, squash, watermelon, sunflower, cucumber, tomatoes, clover

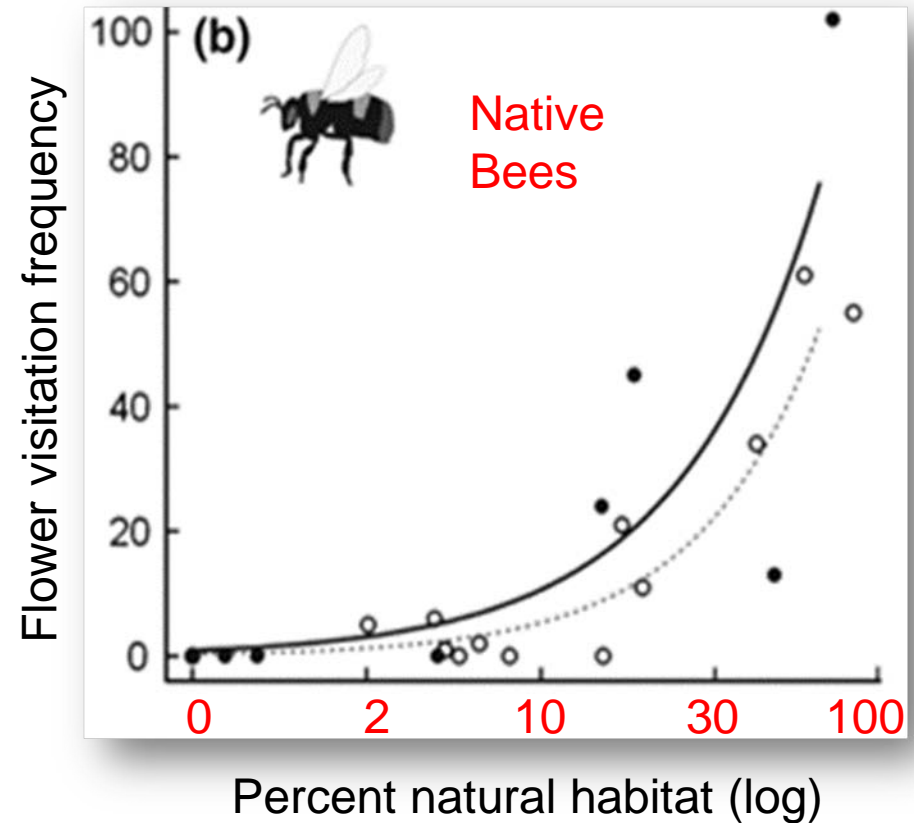
Site & Landscape Connectivity



Pollinator visits to crops declines to 50% of its maximum at ~600 m (2000 ft) from semi-natural habitat. *Ricketts et al. 2008*



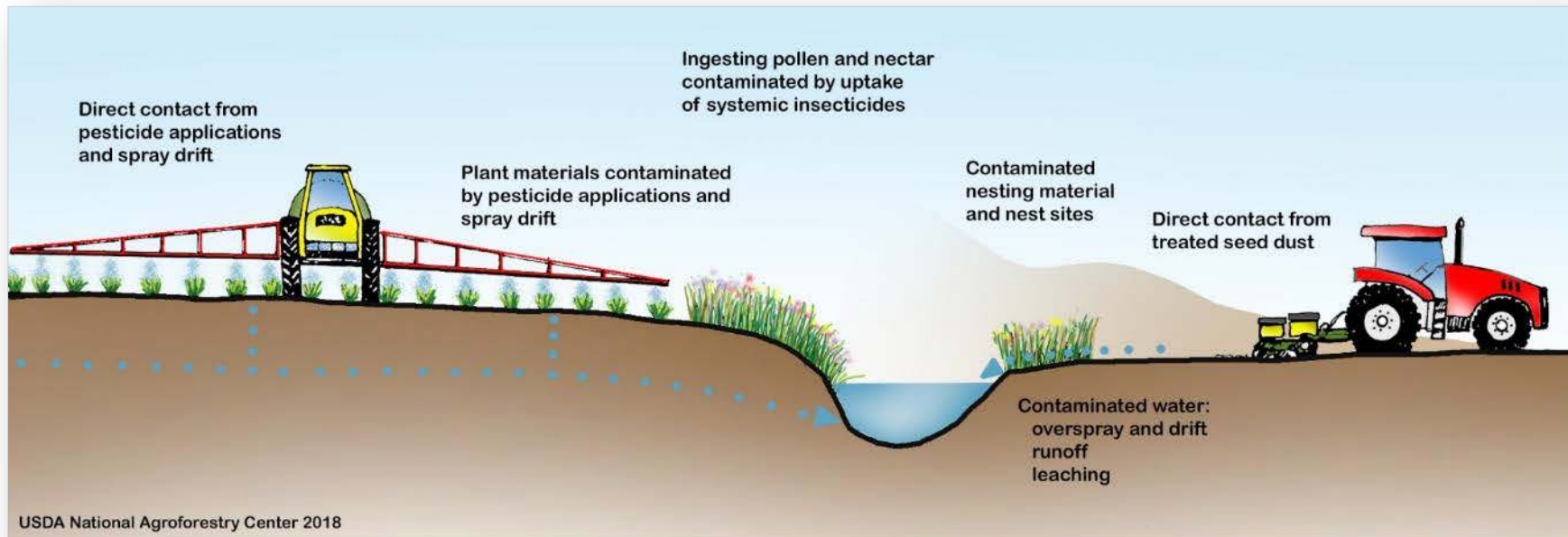
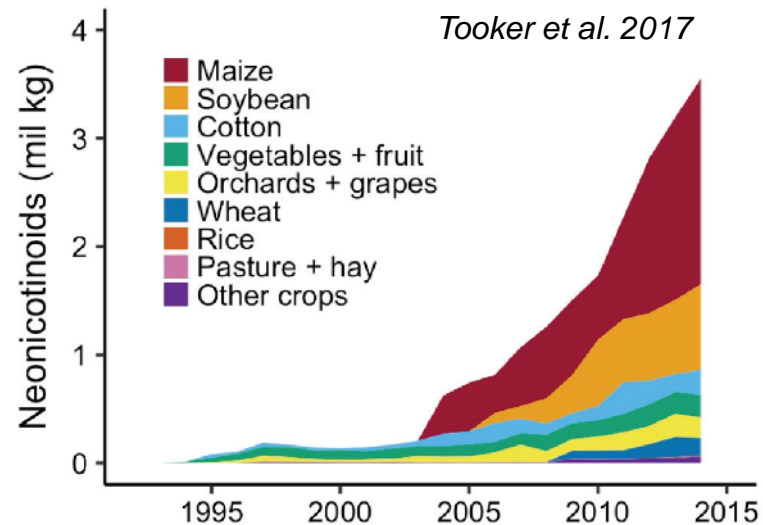
Spatial Extent & Area



Full pollination for watermelon when 30% of the land within 1.2 km of a field is in pollinator habitat. *Kremen et al. 2004*

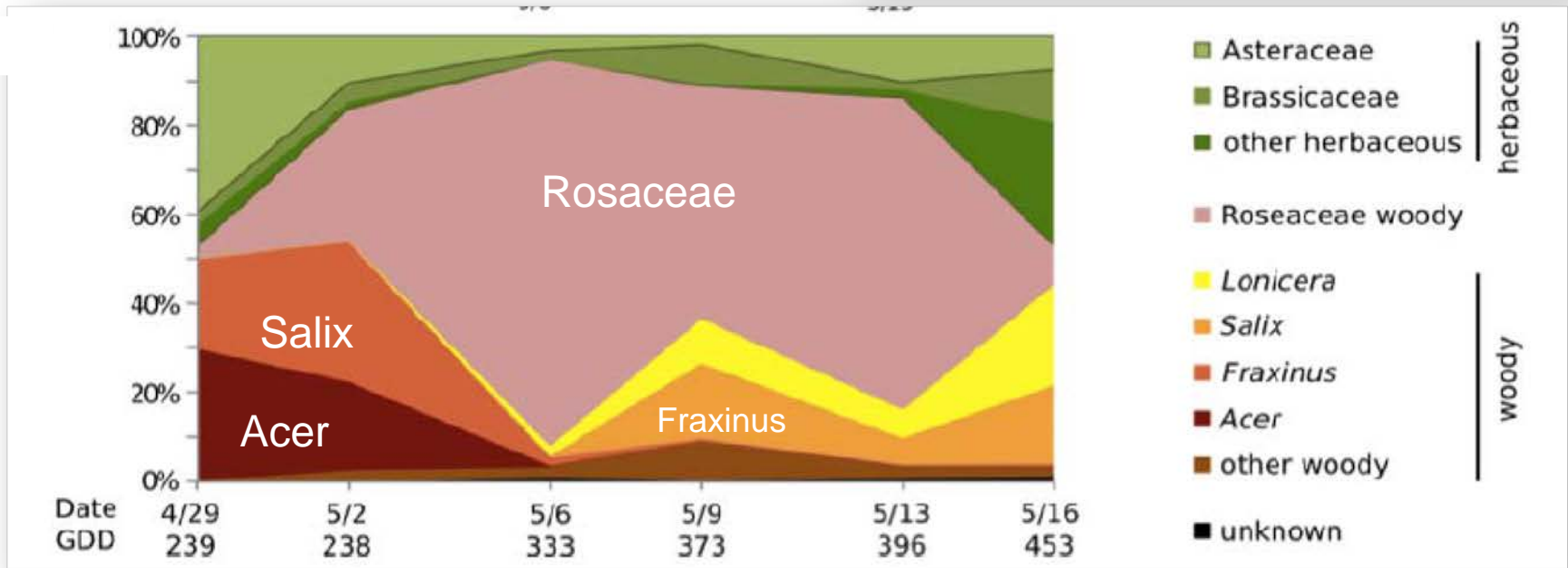
Pesticide Exposure

- Woody plantings can reduce spray drift by up to 80-90%. *Ucar and Hall 2001*
- 40 to 100% reduction of pesticides in run-off using agroforestry systems. *Pavlidis and Tsihrintzis 2017*

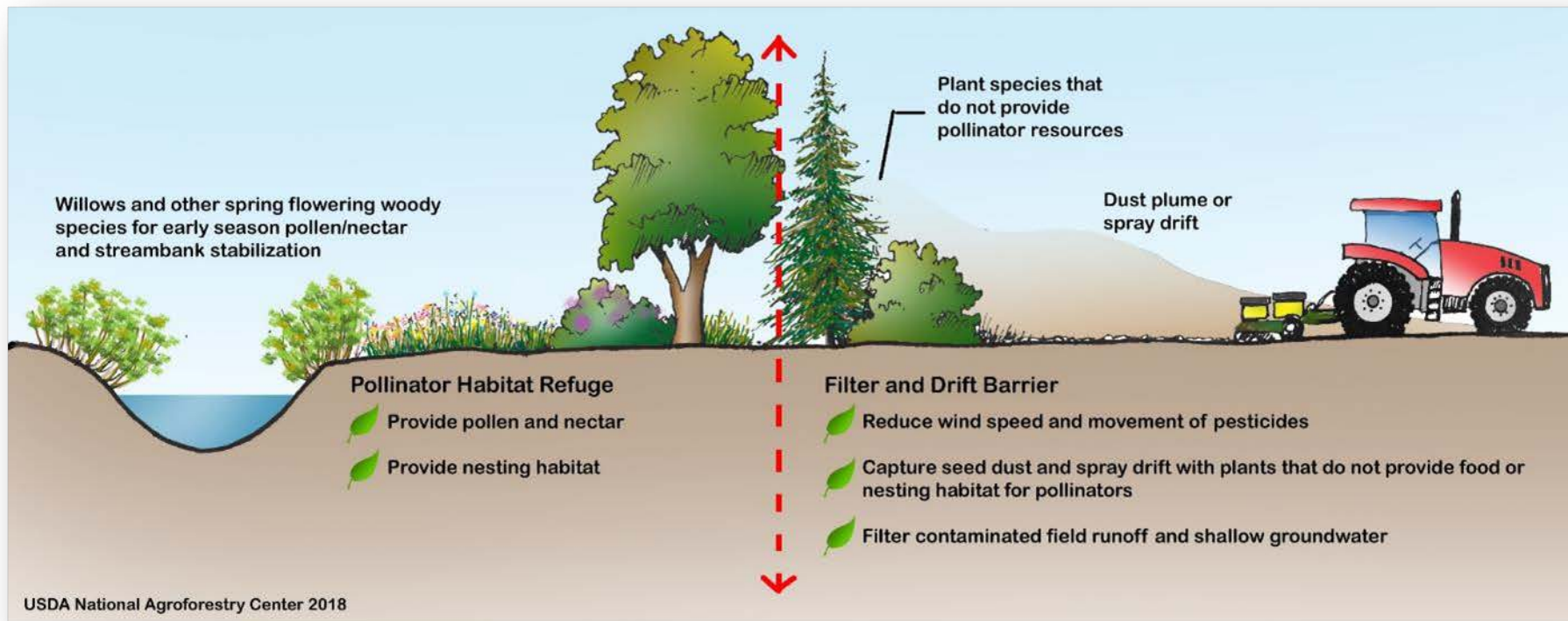


Pesticide Sink?

High concentrations of neonicotinoids in early-flowering tree and shrub pollen.



Reducing Pesticide Exposure



Hedgerows:

Poll benefits: Can be designed to include species that provide forage and nest sites for pollinators

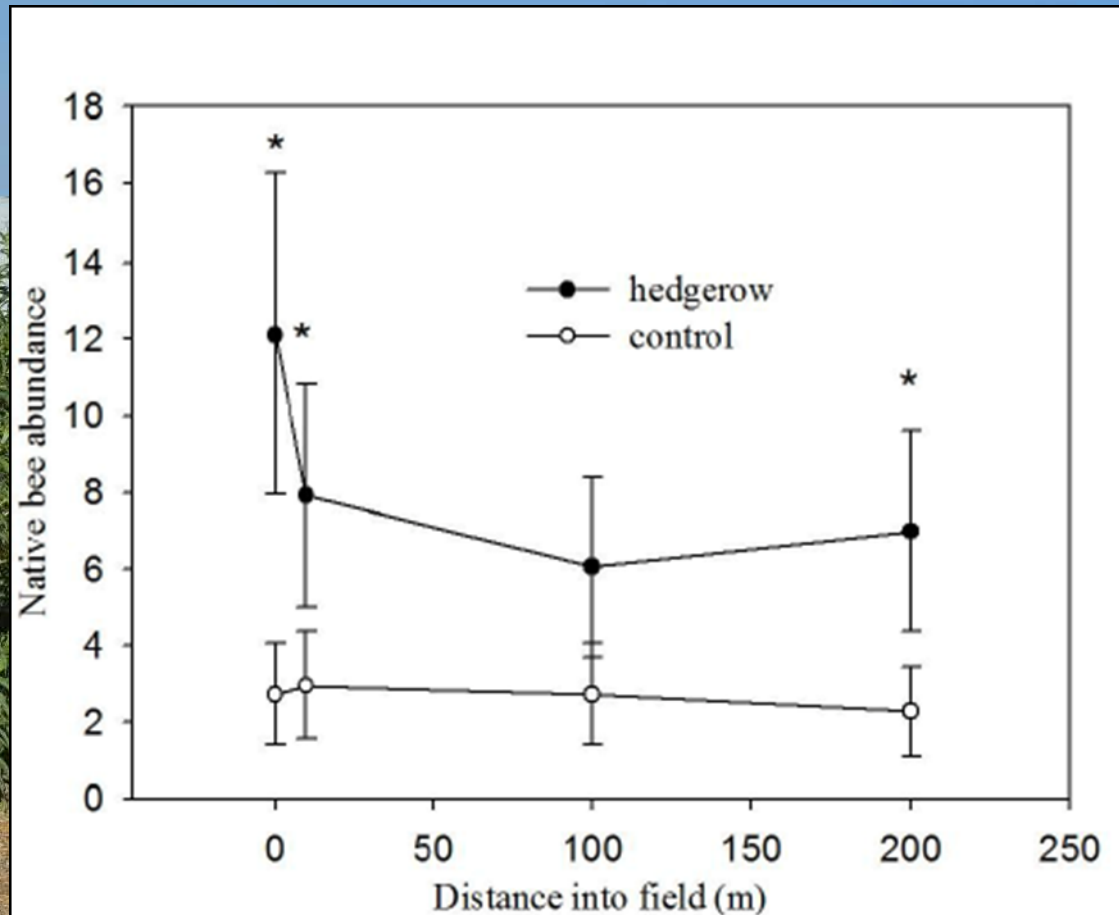
Other benefits:

- Improve crop microclimate
- Help retain moisture
- Reduce abrasion from blown soil
- Support other beneficial insects that fight pests



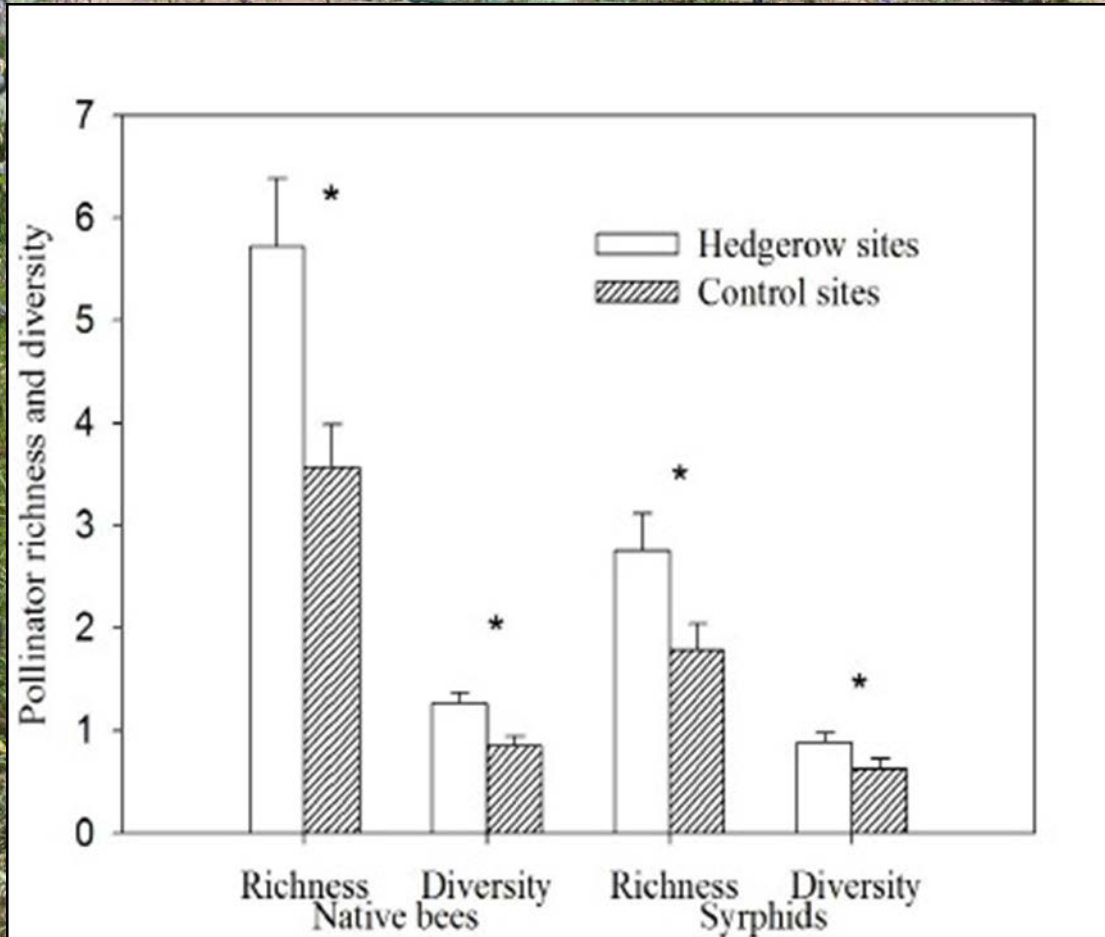
Agroforestry Practices: Hedgerows

More Bees travel into crops adjacent to hedgerows



Agroforestry Practices: Hedgerows

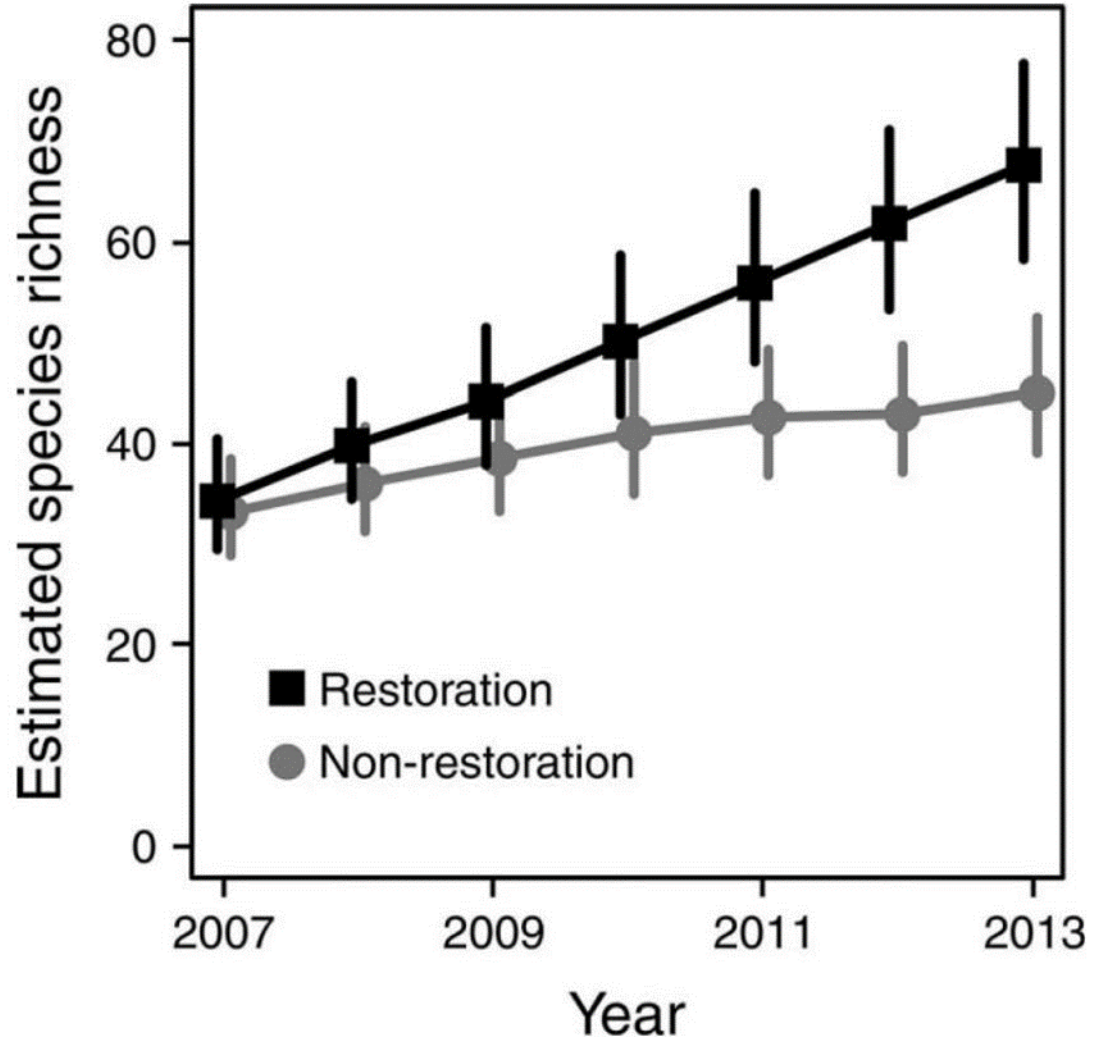
Greater pollinator abundance and diversity on farms with hedgerows



Agroforestry Practices: Hedgerows

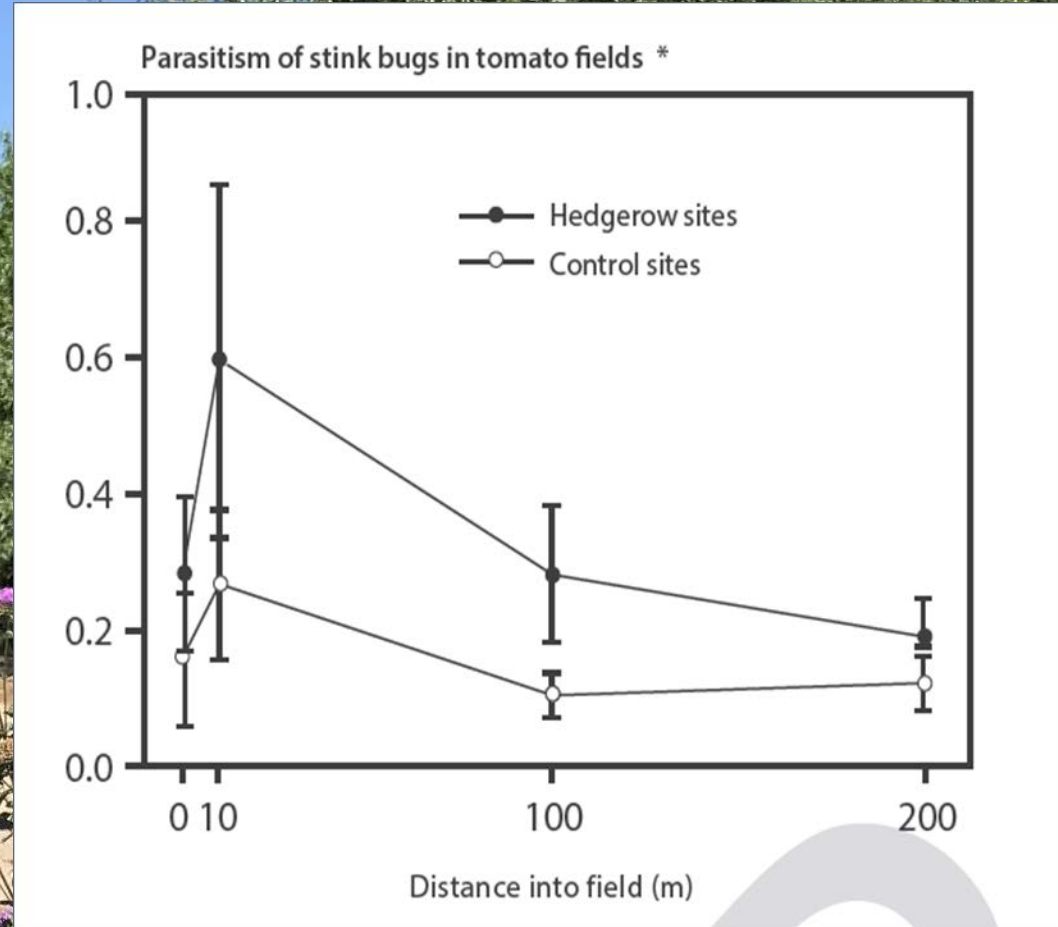


Hedgerow plantings along crop fields increased stability of native bee populations over time



Native Plant Hedgerows Enhance Pest Control

More stink bug eggs parasitized by wasps in fields with nearby native plant hedgerows



Hedgerows:

Other design considerations:

- Tree height and number of rows
- Proximity to crops: balance protection from pesticide drift and foraging distance of bees
- Can choose edible species or species that help feed wildlife
- Addition of perennial wildflowers adds pollinator benefits before trees and shrubs mature

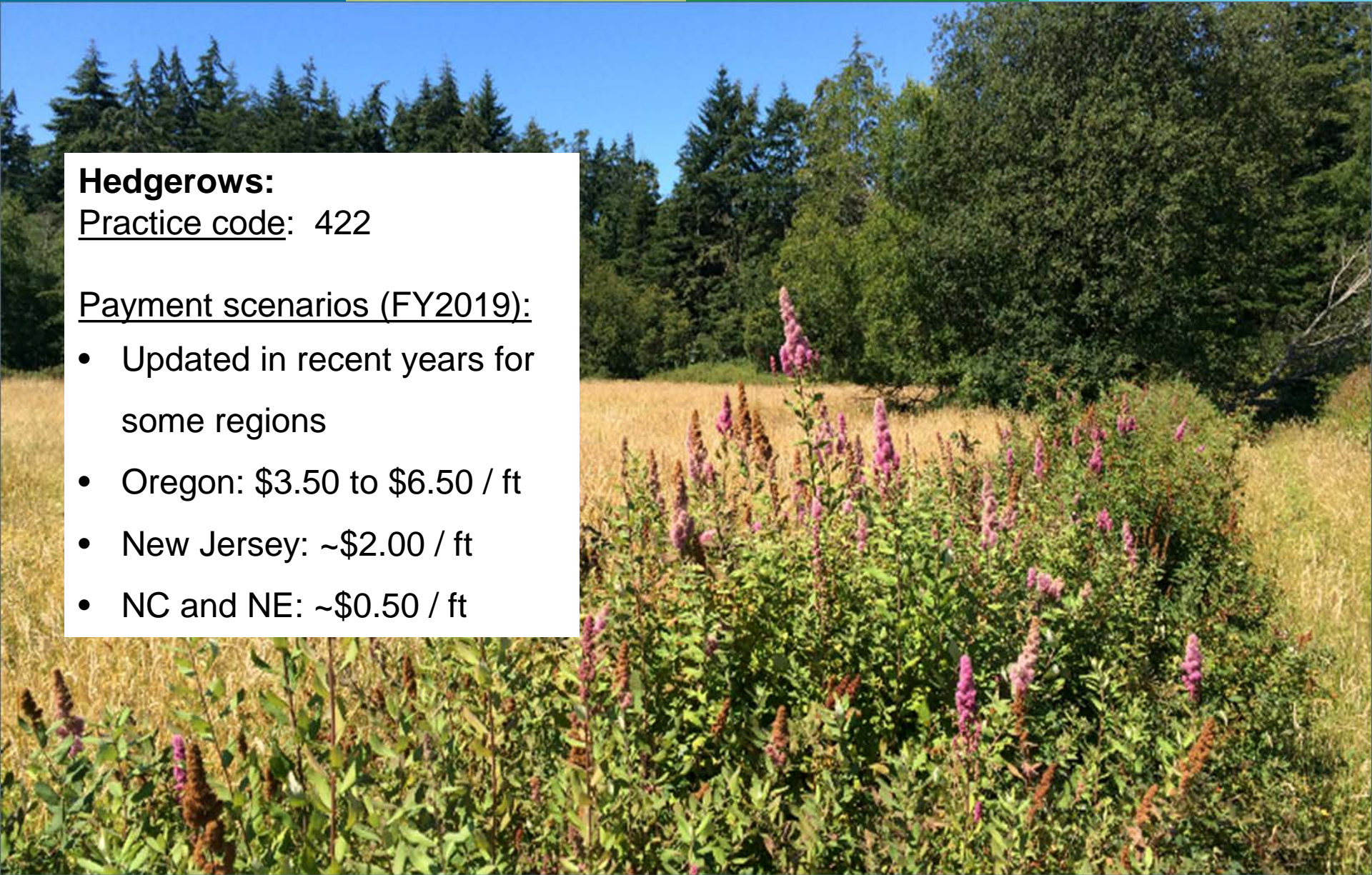


Hedgerows:

Practice code: 422

Payment scenarios (FY2019):

- Updated in recent years for some regions
- Oregon: \$3.50 to \$6.50 / ft
- New Jersey: ~\$2.00 / ft
- NC and NE: ~\$0.50 / ft



Windbreaks:

Can be designed to include species that provide forage and nest sites for pollinators



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Can be designed to include species that provide forage and nest sites for pollinators

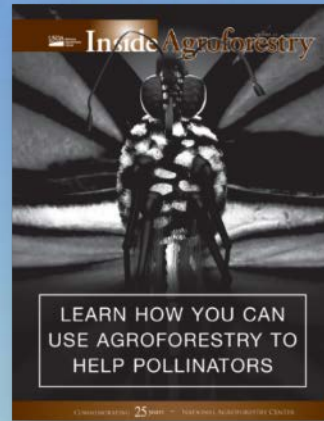


Windbreaks:

Can be designed to help prevent or capture drifting pesticides

Key design considerations:

- Small needled conifers that don't drop lower branches (e.g. spruce, juniper, arborvitae, fir, etc.)
- ~ 60% density, in at least two rows



Windbreaks:

Practice code: 380

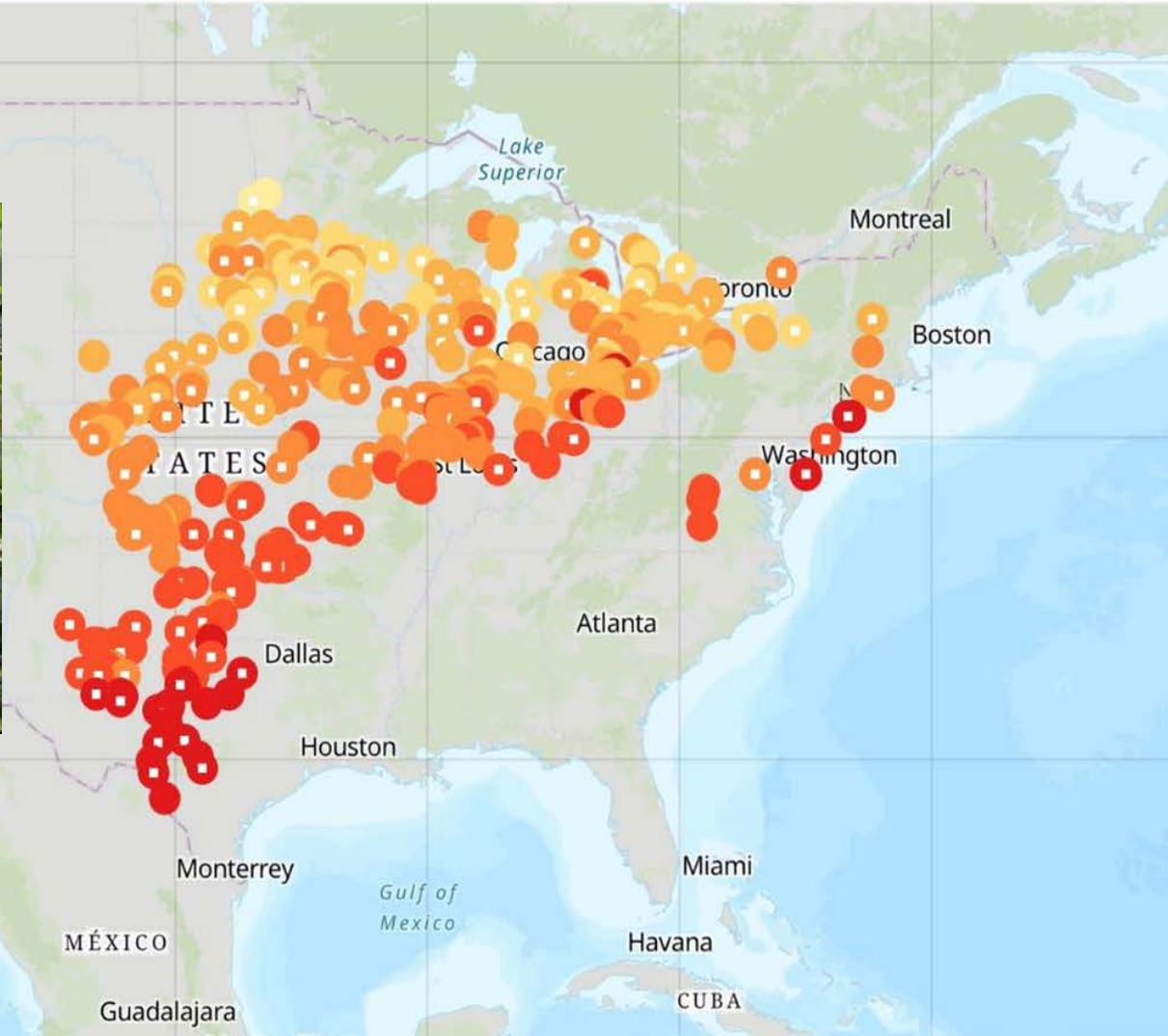
Payment scenarios (FY2019):

- Oregon: \$0.50 to \$3.50 / ft
- Nebraska: \$0.50 to \$6.50 / ft
- New Jersey: \$0.50 to \$10.00 / ft
- North Carolina: \$0.50 to \$2.50 / ft

Agroforestry Practices: Windbreaks



Windbreaks: Monarch butterfly roosts



Map: Journey North. Photo: Leah (Journey North)

Forest farming:
High value medicinal plants, such as
ginseng, black cohosh, and goldenseal,
benefit pollinators.



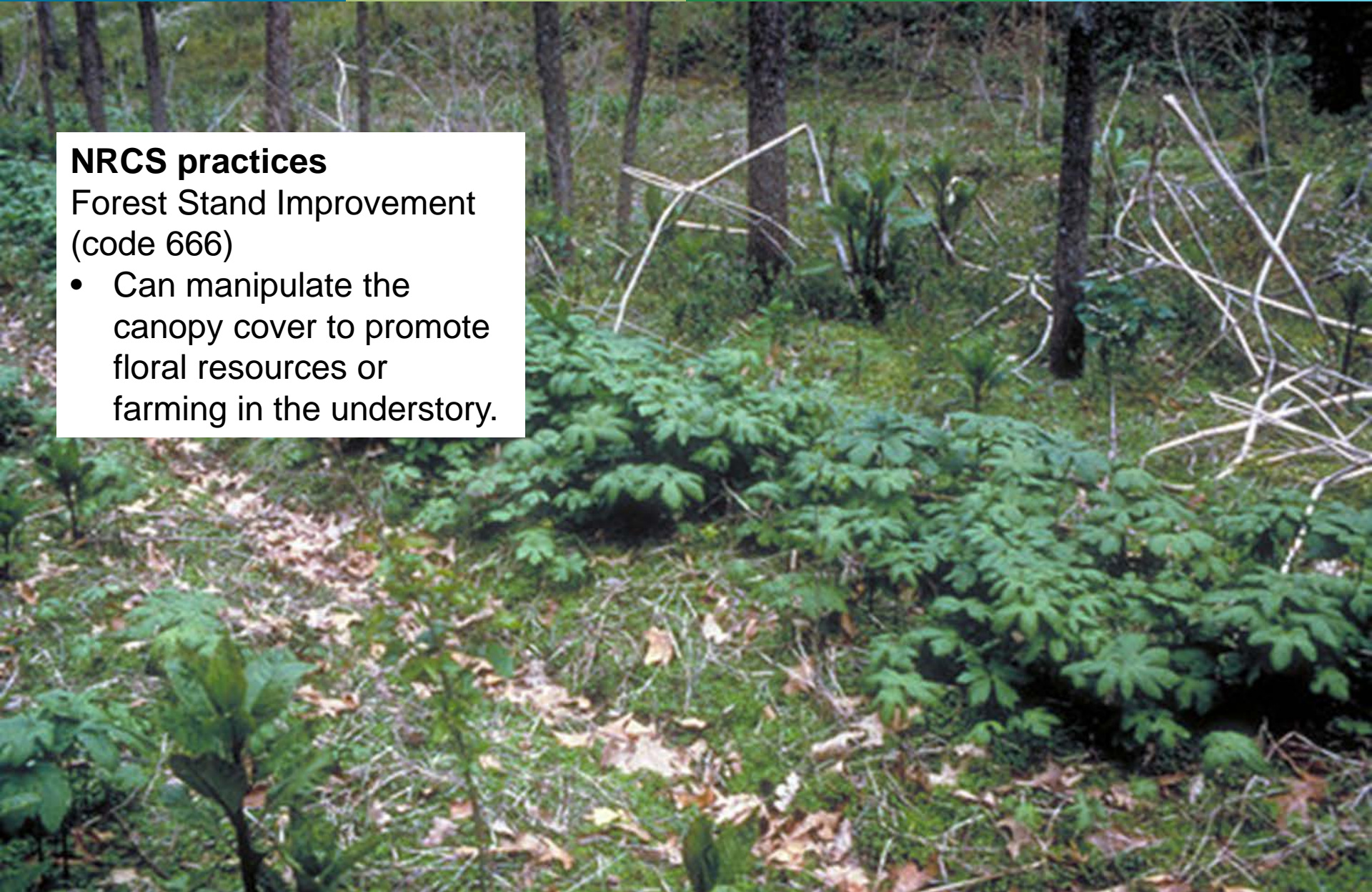
Forest farming:
Many valuable overstory crop trees:
yellow (tulip) poplar, maple,
basswood, and black cherry
provide excellent pollinator habitat.



NRCS practices

Forest Stand Improvement
(code 666)

- Can manipulate the canopy cover to promote floral resources or farming in the understory.



Riparian forest buffers:
Can easily be designed to include trees,
shrubs, and wildflowers for pollinators.



Makes me want to plant willow!

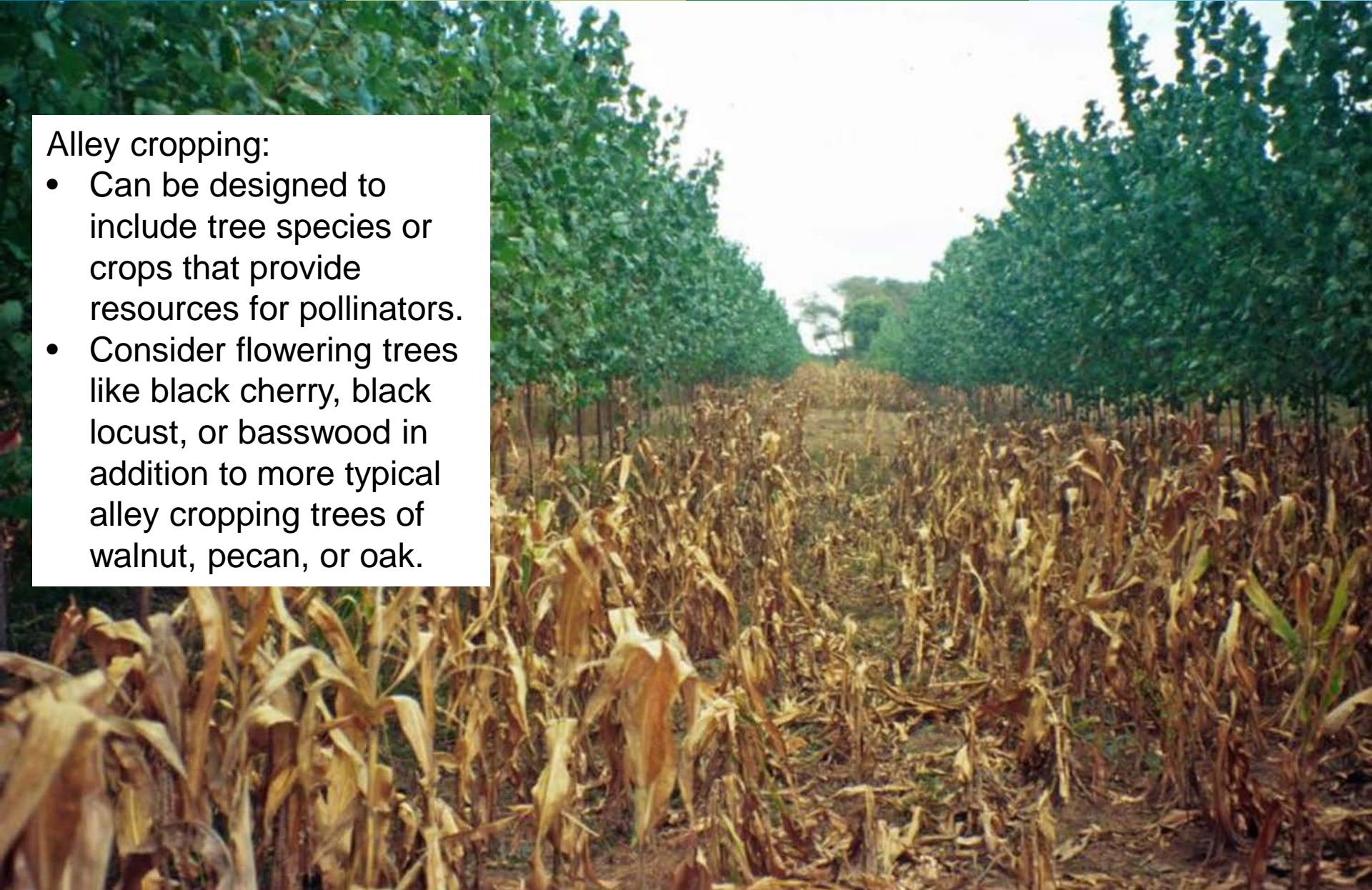
Work with nurseries to encourage production of male willow plants.



Mining bee (*Andrena* sp.) on willow (*Salix* sp.)
Blue Ridge Parkway, NC, April

Alley cropping:

- Can be designed to include tree species or crops that provide resources for pollinators.
- Consider flowering trees like black cherry, black locust, or basswood in addition to more typical alley cropping trees of walnut, pecan, or oak.



Alley cropping:

- Diverse forbs and shrubs may be planted in rows for cut flowers, berry production, or the nursery market.
- A legume forage crop between rows will fix N and provide nectar and pollen.



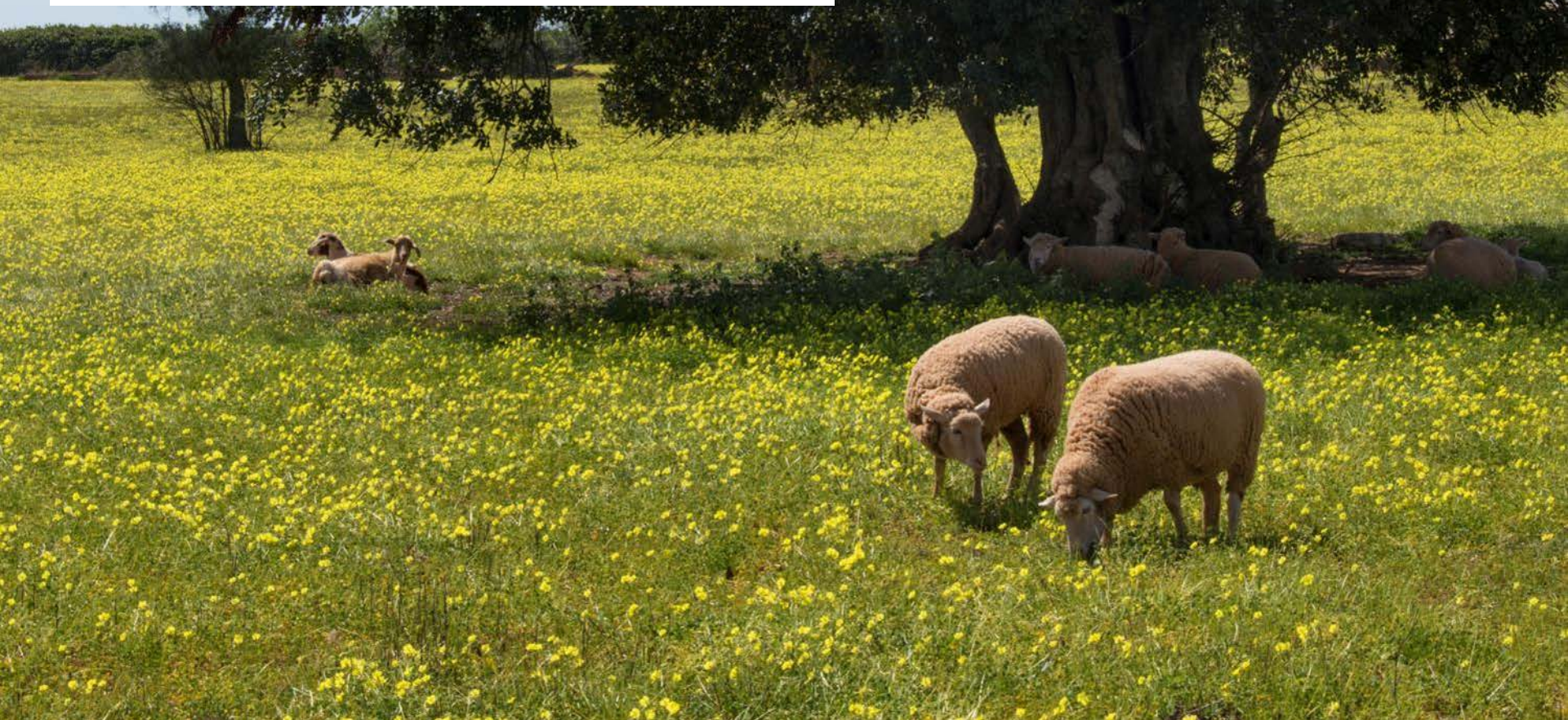
Agroforestry Practices: Silvopasture

Silvopasture:

- Trees used in silvopasture systems can be chosen to support pollinators.
- Forage for livestock can include a variety of legumes, or a diversity of native plants that benefit pollinators.
- Rotational grazing can be managed to sustain understory diversity.



Silvopasture:
Using thinning and prescribed fire to
daylight seedbanks and promote flowering
plants that benefit pollinators.



The USDA Natural Resources Conservation Service

- Technical Assistance
- Financial Support for Conservation

Find out more at: www.nrcs.usda.gov

[http://plants.usda.gov/pollinators/
NRCSdocuments.html](http://plants.usda.gov/pollinators/NRCSdocuments.html)



Core Programs for Pollinators

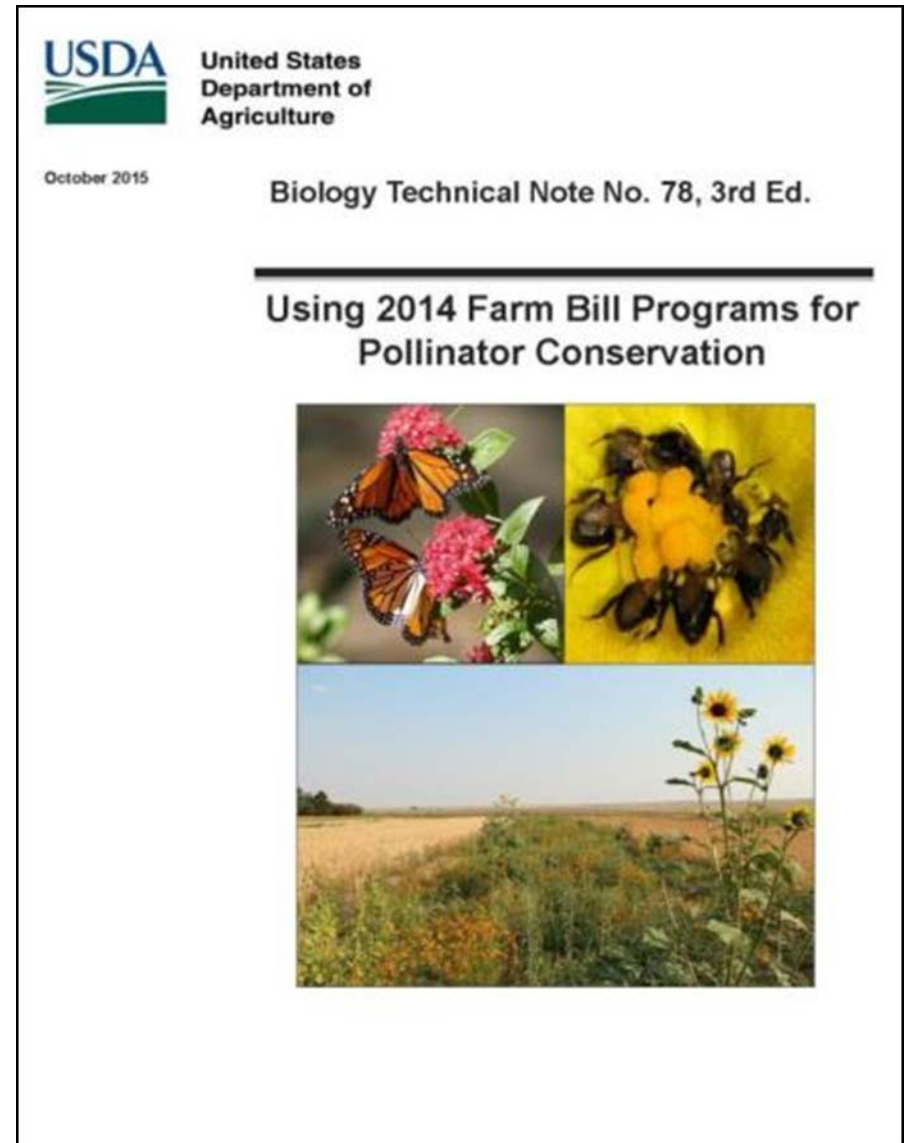
EQIP, CRP, CSP

Tech Note 78

Using Farm Bill Programs for Pollinator Conservation

Core Agroforestry Practices

- Hedgerow Planting (422)
- Windbreak/Shelterbel (380)
- Riparian forest buffer
- Alley cropping (311)
- Silvopasture (381)
- Multi-story Cropping (379)



Core Programs for Pollinators

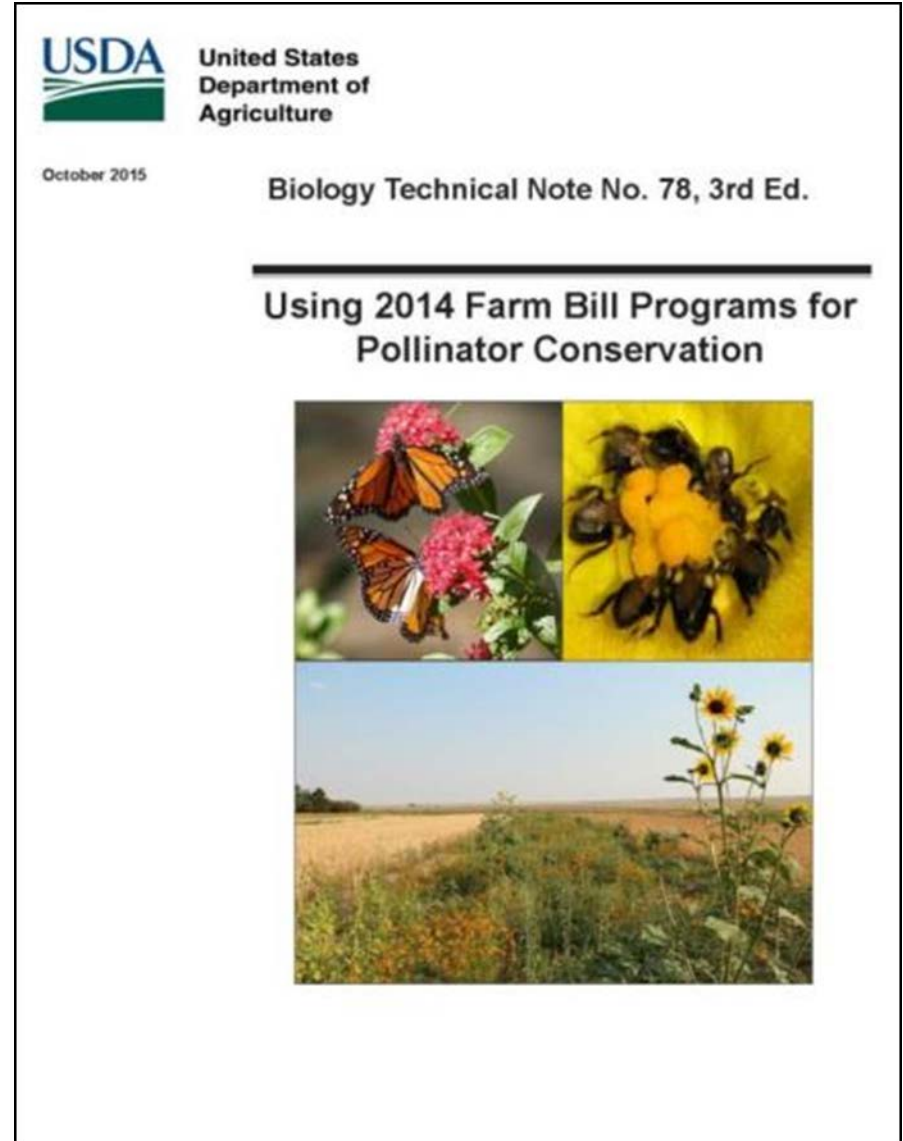
EQIP, CRP, CSP

Tech Note 78

Using Farm Bill Programs for Pollinator Conservation

Supporting Agroforestry Practices

- Forest stand improvement (666)
- Prescribed burning (338)
- Prescribed grazing (528)
- Tree/Shrub Establishment (612)
- Conservation Cover (327)
- Early Successional Habitat Development/Management (643)
- Herbaceous weed control (315)
- Mulching (484)



Core Programs for Pollinators

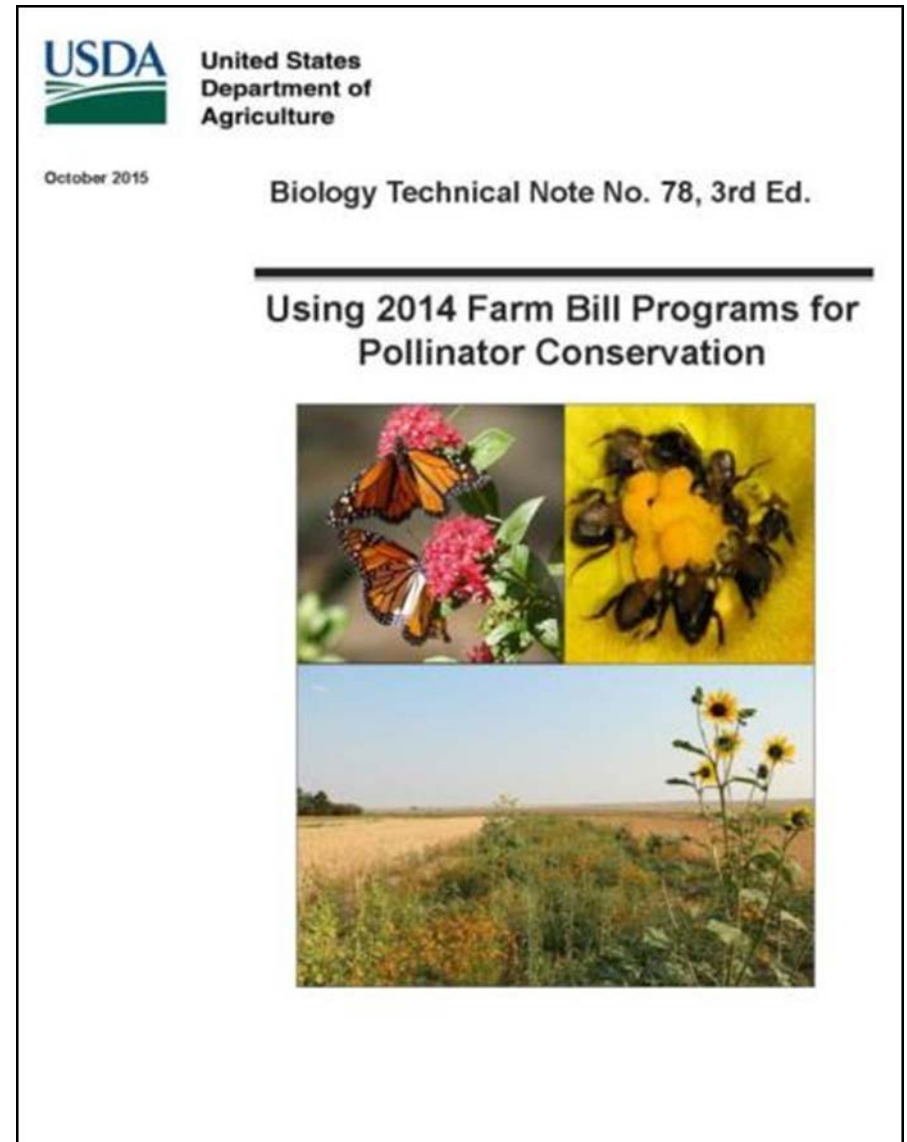
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Tech Note 78

Using Farm Bill Programs for Pollinator Conservation

Forest Farming:

- Forest stand improvement (666)
- Herbaceous weed control (315)
- Prescribed burning (338)
- Prescribed grazing (528)
- Tree/Shrub Establishment (612)






<https://xerces.org>
<http://xerces.org/pollinator-resource-center/>

422A Hedgerow Planting, Pollinators: Central Valley, Central Coast, Southern California

Conservation Practice Specification




Specifications

These standards provide on-site assistance in how to install hedgerows for pollinators. To take a practice plan, these specifications will use the Agroforestry Department form. These standards are intended to be used in addition to how to do the Hedgerow (422) specification on all projects.

Definition and Purpose
Installation of cover vegetation in a linear design to reduce erosion, retain soil, and create habitat for pollinators.

Client Conservation Objectives
Depending on landscape objectives, owners design pollinator hedgerows that may provide food, cover, and nesting for other wildlife. Provide habitat for pollinators and beneficial insects as a component of an integrated pest management plan, provide food cover or shade for nearby operations and/or provide structure, shelter, and nesting sites for pollinators, cover or water for birds, or as an ornamental design.



Tom Katten | 422 Hedgerow Practice

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Hedgerow Planting (422) for Pollinators Florida Installation Guide




February 2013

The Xerces Society for Invertebrate Conservation
www.xsccs.org

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Tree/ Shrub Establishment (612) & Hedgerow Planting (422) for Pollinators Oklahoma Installation Guide



March 2013

The Xerces Society for Invertebrate Conservation
www.xsccs.org

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Hedgerow Planting (422) for Pollinators New Jersey Installation Guide and Job Sheet





September 2013

The Xerces Society for Invertebrate Conservation
www.xsccs.org

THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Habitat Planting for Pollinators Pacific Islands Area





November 2014

The Xerces Society for Invertebrate Conservation
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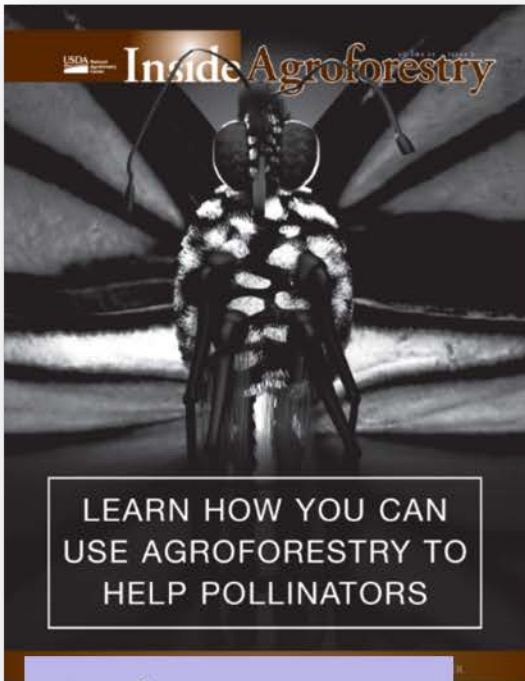
THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

Hedgerow Planting (422) for Pollinators: Western Oregon & Washington Specifications and Implementation Requirements



June 2013

The Xerces Society for Invertebrate Conservation
www.xsccs.org



LEARN HOW YOU CAN
USE AGROFORESTRY TO
HELP POLLINATORS



Working Trees for Pollinators

Over 100 agricultural crop species in North America need a pollinator to be most productive. Agroforestry practices can be designed to support these pollinators.

In the past, native bees and other honey bees used to visit the polliniferous trees and shrubs, and prairie fields, and produce the honey products because the farms were typically adjacent to areas of forests, pastures, and riparian corridors. Today, farms in the U.S. are larger and have less adjacent habitat to support bees. The world's pollinators in agricultural landscapes has never been greater. Without the help, the success of the trees of honey bees, each and flowering plants that provide food for pollinators. Agroforestry, the production of trees, shrubs, and grasses, and perennial crops, pollinates and food trees span the landscape as well. Some 25 percent of honey bees are being managed by beekeepers, and the abundance of flowering plants and shrubs in agroforestry systems is being developed. Ongoing research demonstrates, however, that these native bees play a role in the production of food.

Info

How does agroforestry help crop pollination?

Agroforestry practices can support native bees, honey bees, and other pollinators. Providing protective and nesting habitats can improve crop production.

Visually, it's similar to crop rotation, which is done over several years. All rotations include crop rotation, which is done over several years. Agroforestry practices can support pollinators while keeping the soil productive. Agroforestry is usually better for pollination than the other two, but it's not perfect. Agroforestry can help in some ways, but it's not perfect. Agroforestry can help in some ways, but it's not perfect. Agroforestry can help in some ways, but it's not perfect.

Some crops that benefit from insect pollination are:

Almond	Apple	Avocado	Raspberry
Cherry	Elderberry	Peas	Peach
Raspberry	Squash	Strawberry	Tomato

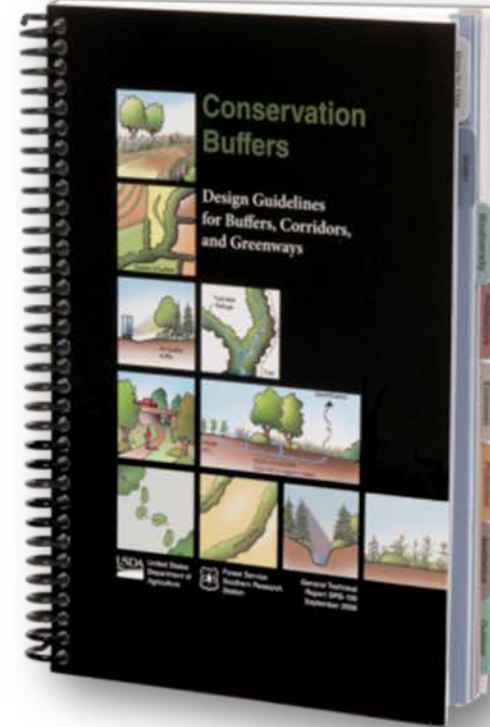
AGROFORESTRY NOTES

Using Agroforestry Practices to Reduce Pesticide Risks to Pollinators & Other Agriculturally Beneficial Insects

35 Years of Progress

Introduction

Pesticides are tools commonly used to manage weeds, diseases, and crop pests. Pesticide use should be balanced against the importance of maintaining healthy populations of crop pollinators and natural enemies of crop pests that can be harmed by pesticide applications. Over 100 crops in North America depend on insect pollinators, and only a few all crop production benefits from pest control provided by predators and parasitoids. Small, diverse farms often host adequate populations of native bees and other beneficial insects in field borders and other habitats adjacent to crops or orchards. Today's larger farms, with less nearby habitat, often rely on honey bees for crop pollination and pesticides to control weeds and crop pests. Native bees, however, are important crop pollinators where habitat is available and where they are protected from pesticides, providing the majority of pollination for some crops and insurance for crops pollinated primarily by honey bees. Likewise, when allowed to thrive, natural enemies of crop pests help prevent pest outbreaks and reduce the need for pesticides.



Thanks and Questions



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