Habitat Management to Support Pollinators & Other Beneficial Insects

bumble bee & hedge-nettle
(aka woundwort), *Stachys* sp.
Blue Ridge Parkway, July 2015

Nancy Lee Adamson, PhD
Pollinator Conservation Specialist
Xerces Society for Invertebrate Conservation
& USDA-NRCS East National Technology
Support Center, Greensboro, NC

Photo: Nancy Adamson

Xerces Society & NRCS partnering for conservation

Xerces-NRCS partner biologists support pollinator habitat creation and management, which benefits other beneficial insects and wildlife

Since 1971, the Xerces Society has worked to protect wildlife through the conservation of invertebrates and their habitat.

Xerces blue butterfly (*Glaucopsyche xerces*), the first U.S. butterfly to go extinct due to human activities.

www.xerces.org

meadow near Carthage, NC

Photo: Nancy Adamson

2008 & 2014 Farm Bill Pollinator Habitat Provisions

- **Pollinators a priority for all USDA land managers & conservationists**
- **Encouraging inclusion of pollinators in all USDA conservation programs--** *adding diversity to plant mixes & promoting IPM at NRCS*

sweat bee, *Agapostemon* sp.
on annual sunflower,
Helianthus annuus

http://plants.usda.gov/pollinators/nrcsdocuments.html

Photo: Nancy Adamson

Talk Outline

- Pollinators matter!
  - Health update
  - Multiple benefits of pollinator habitat
- Your plantings matter!
  - Basic bee & other insect biology, e.g. habitat needs
  - Video of pollinators on native plants through the growing season
  - Native plants for pollinators (highlights)
- Farm Bill programs
- Additional resources

bumble bee on blazing star, *Liatris spicata*

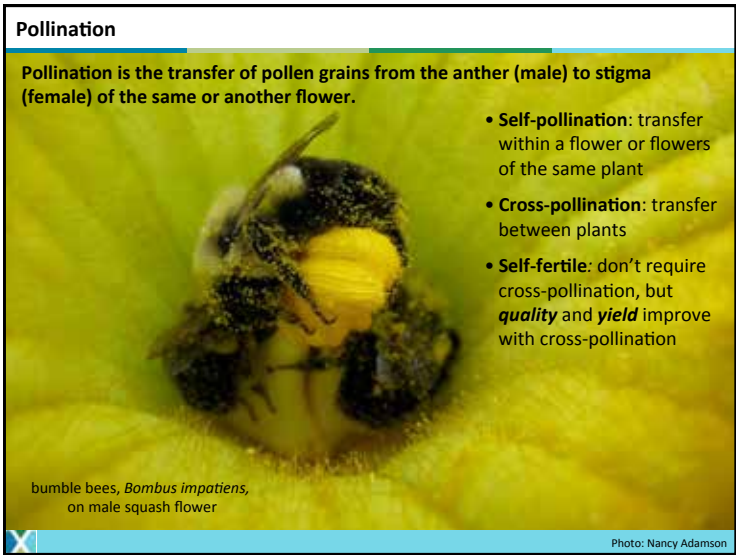
Photo: Nancy Adamson

green sweat bee
on blueberry

Photo: Nancy Adamson

Pollination

Pollination is the transfer of pollen grains from the anther (male) to stigma (female) of the same or another flower.



- **Self-pollination**: transfer within a flower or flowers of the same plant
- **Cross-pollination**: transfer between plants
- **Self-fertile**: don't require cross-pollination, but ***quality*** and ***yield*** improve with cross-pollination

bumble bees, *Bombus impatiens*,
on male squash flower

Photo: Nancy Adamson

Pollination and Human Nutrition

Food that depends on insect pollination

- 35% of crop production, worldwide
- Over $18 to $27 billion value of crops in U.S. ($217 billion worldwide)
- One in three mouthfuls of food and drink we consume

Morse RA, Calderone NW. 2000. The value of honey bees as pollinators of U.S. crops in 2000. Bee Culture 128: 1–15.
Klein et al. 2007. Importance of pollinators in changing landscapes for world crops. Proc. R. Soc. B 274: 303-313.

Photo: USDA-ARS/Peggy Greb

Importance of Pollinators: VA Agriculture*

High value crops in VA pollinated by bees

- Apples $33 mill. (2010 VDACS) Industry value $235 mill. (2010 VA Apple Board)
- Cucurbits $8 mill.—cucurbits include squash, cucumbers, cantaloupe, pumpkin (2006 VDACS)

longhorned bee, *Melissodes bimaculata*, on cucurbit

*VA Dept. of Agriculture & Consumer Services (VDACS)

Photo: Nancy Adamson

Importance of Pollinators: VA Agriculture*

Improved yield with cross-pollination**

- Soybeans $165 mill.
- Tomatoes $52 mill.
- Cotton $46 mill.
- Cotton seed $ 6 mill.

bumble bee on pinkeyed purple husk pea

*2010 VA Department of Agriculture
**10-15% increased yield for soybeans and cotton

Photo: Nancy Adamson

Importance of Pollinators: VA Agriculture

Depend on alfalfa & clover seeds

- Cattle $373 mill.
- Hay ~1/3 of $72 mill.

Berries & other specialty crops important, too!

- Blueberries
- Caneberries (raspberry & blackberry)
- Strawberries
- Muscadine grapes (scuppernongs)

mining bee, *Andrena* sp. on blueberry

Photo: Nancy Adamson

bumble bee on wingstem, *Verbesina alternifolia*

Photo: Nancy Adamson

Honey bee* decline in 2006** brought bee health to national agenda

Winter losses

- Pre-CCD (1995-2006): 15%-22%
- Post-CCD (2006-today): 22%-36%

Annual losses (2012-2015): 34% - 45%

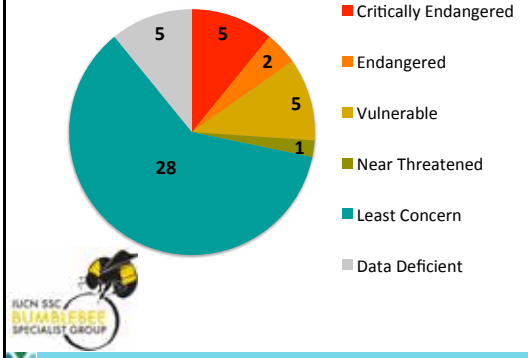
*Non-natives, European honey bees arrived in North America in the 1600s.
** Colony Collapse Disorder (CCD) and diseases associated with varroa mite

Photo: Nancy Adamson

Bumble bees also in decline

North America's Bumble Bees

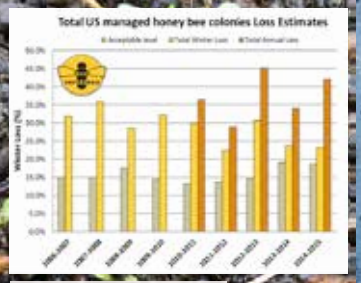
- 1-in-4 at risk of extinction today
- 2014 IUCN & Xerces Society Status Review



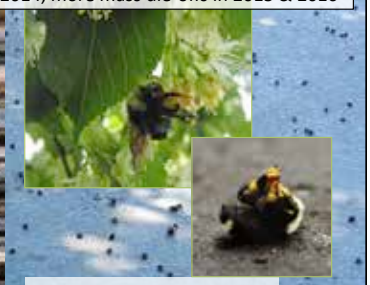
Photos: © Leif Richardson (yellowbanded) , © Jen Knutson (rusty patched)

Despite increased awareness since 2006, continued losses

Some of the highest losses *ever* in 2013 & 2014, more mass die-offs in 2015 & 2016



Graph: Steinhauer et al 2015.
http://beeinformed.org/



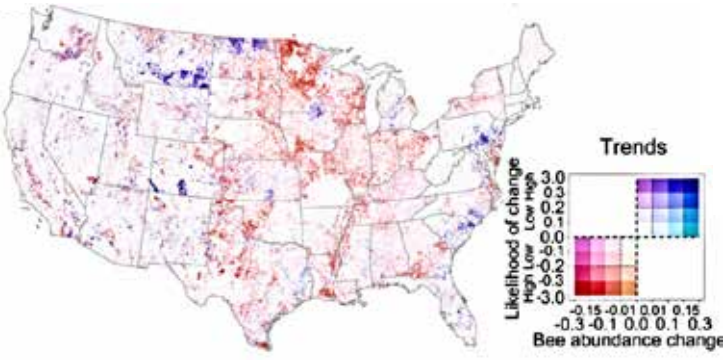
Mass bee kills continue to be reported around the globe:

- Bumble bees in photos above killed in Oregon 2014--others reported subsequently
- Honey bees in Canada and CA almond orchards

Honey bees photo: Dan Gunderson, MN Public Radio. Bumble bee photos: Rich Hatfield (Xerces Society); The Oregonian

Estimated wild bee declines

Between 2008 and 2013, wild bee abundance declined **23%** across the US.



Koh *et al*. 2016. Modeling the status, trends, and impacts of wild bee abundance in the United States. Proceedings of the National Academy of Sciences. Online December 21, 2015. doi: 10.1073/pnas.1517685113.

Monarch Butterfly Decline & National Framework for Conservation

In the 1990s, **100s of millions** of monarchs made the epic flight each fall from the northern plains of the U.S. and Canada to sites in the oyamel fir forests north of Mexico City.

In 2013, only 33 million made that trip.

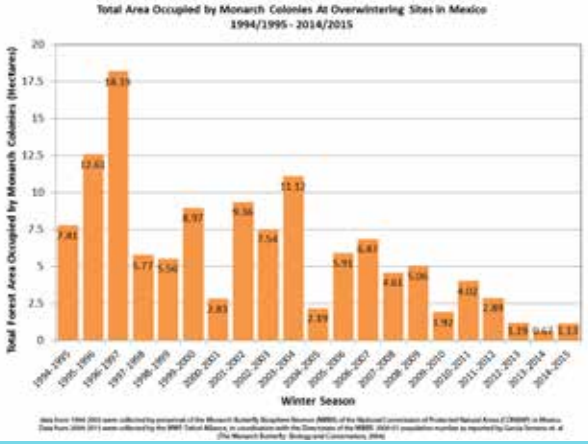
U.S. Fish and Wildlife Service "High Level Monarch Working Group"

- *Partners:* Agency heads, Forest Service, National Park Service, Bureau of Land Management, Federal Highway Administration, Natural Resources Conservation Service and others.
- Working with the U.S. Geological Survey Powell Center to develop models and tools to aid in conservation.

Photo: World Wildlife Fund

Monarch Butterfly Decline

North American monarchs are at an all time low.



Area of forest occupied by colonies of hibernating monarchs in Mexico. (Graph courtesy of the Monarch Joint Venture).

National Strategy to Promote Pollinator Health, May 2015

From White House: **National Strategy to Promote the Health of Honey Bees & Other Pollinators**

1. Reduce honey bee colony losses to economically sustainable levels;
2. Increase monarch butterfly numbers to protect the annual migration; an

At the State level, EPA requesting Pollinator Stewardship Plans. These are not legally binding in any way. Some states are only focusing on managed pollinators, but valuable tool for raising awareness--important to highlight all pollinators, especially agriculturally important native wild bees. See VDACS info⬇

http://www.vdacs.virginia.gov/plant-industry-services-pollinator-protection-plan.shtml

Federal BMPs for Pollinator-Friendly Lands

Also in May 2015, USDA & Department of Interior released ***Pollinator-Friendly Best Management Practices for Federal Lands***

monarch on ironweed, *Vernonia noveboracensis*

http://www.fs.fed.us/wildflowers/pollinators/BMPs/

Photo: Judy Stierand, NC Native Plant Society

(2008 &) 2014 USDA Farm Bill Pollinator Habitat Provisions

- Pollinators are a priority for every USDA land manager and conservationist
- Encourages inclusion of pollinators in all conservation programs
- Identifies pollinator habitat as a priority for EQIP
- Requires that pollinators are considered in the review of Practice Standards

Contact your local NRCS District Conservationist to learn more, www.va.nrcs.usda.gov

bumble bee on blueberry

http://plants.usda.gov/pollinators/nrcsdocuments.html

Photo: Nancy Adamson

Meet the Pollinators: Butterflies and Moths

About 700 species of butterflies & 13,000 species of moths in US

long-tailed skipper *Epargyreus clarus*

Photo: Nancy Adamson

Meet the Pollinators: Butterflies and Moths

hummingbird moth on ironweed, *Vernonia noveboracens*

Photo: Nancy Adamson

Meet the Pollinators: Flies

syrphid fly on spiderwort, *Tradescantia* sp.

Photo: Nancy Adamson

Meet the Pollinators: Beetles

delta flower scarab and other tiny beetle on mountain mint, *Pycnanthemum* sp.

Photo: Nancy Adamson

Meet the Pollinators: Wasps

great golden digger wasp on wingstem, *Verbesina alternifolia*

Photo: Nancy Adamson

Meet the Pollinators: Bees (the great pollen movers)

Bee diet (pollen & nectar) & hairiness make them especially effective pollinators

bumble bee on squash

Photo: Nancy Adamson

Bees: The Most Important Pollinators

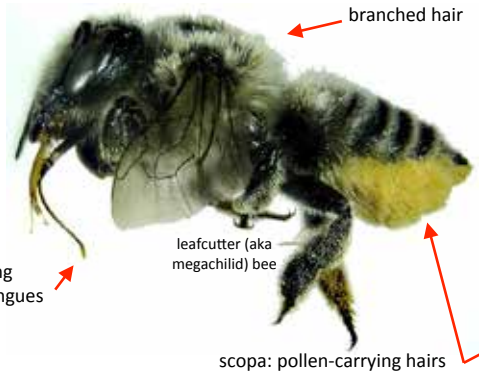
Bees are the most agriculturally important pollinators

- Bees actively collect and transport pollen
- Bees exhibit flower constancy
- Bees regularly forage in area around nest

Photo: Nancy Adamson

Bees evolved to better collect pollen & nectar!

Bees evolved from wasps into vegetarians



branched hair

leafcutter (aka megachilid) bee

long tongues

scopa: pollen-carrying hairs

(on abdomen of megachilid bees; on hind legs of most species; bumble bees & honey bees have pollen baskets, corbicula)

bumble bee

Photos: Ralph Hozenthal, Mace Vaughan, Steve Buchmann

Solitary (vs colonial) bees very efficient, collecting pollen & nectar every trip

Example: Blue orchard bee

- 250 to 750 females/acre compared to 1 to 2.5 hives (25-50k) of honey bees
- Make contact with anther and stigma on almost every visit
- Active at low light levels and low temperatures
  - 33+ hours foraging in 5 days
  - 15+ hours by honey bees

Bosch, J. and W. Kemp. 2001. How to Manage the Blue Orchard Bee as an Orchard Pollinator. Sustainable Agriculture Network. Beltsville, MD. 88 pp.

Photos: Eric Mader, Mace Vaughan

Native bee specialists include squash, blueberry, and okra bees

Squash Bees

- Ground-nesting directly at the base of squash plants
- Active in early morning hours (before sunrise)
- Pollinate flowers before honey bees begin foraging[1]
- 67% of 87 sites studied across the U.S. had all pollination needs met by squash bees[2]

1.Tepedino, V. J. 1981. The pollination efficiency of the squash bee (*Peponapis pruinosa*) and the honey bee (*Apis mellifera*) on summer squash (*Cucurbita pepo*). *Journal of the Kansas Entomological Society* 54:359-377.

2.Jim Cane (USDA ARS Logan Bee Lab). 2011. Personal communication

Photo: Nancy Adamson

Buzz pollination by native bees

Example: Cherry tomatoes
When native bees were present, Sungold cherry tomato production almost tripled.
Video online highlights buzz pollination:
https://www.youtube.com/watch?v=l_etyEdu9fQ

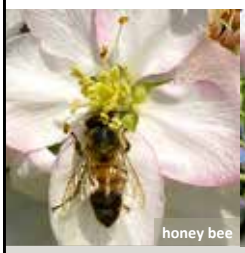
Greenleaf, S. S.,and C. Kremen. 2006. Wild bee species increase tomato production and respond differently to surrounding land use in Northern California. Biological Conservation 133:81-87.

Sungold tomatos photo: Anne Berblinger. Bee photos: Nancy Adamson

Wild pollinators: Better quality pollination

2013 research highlights importance of native bees: Wild bees improved fruit set ***twice*** as much as honey bees.

Better quality pollination relates to cross-pollination, the ability to buzz pollinate, and other ways bees interact with flowers.



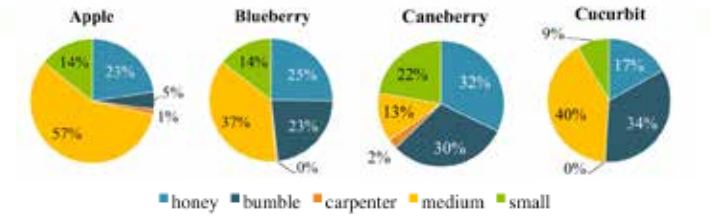
We need honey bees since we can manage them and move them to crops when needed--better protecting native bees benefits all bees…

Garibaldi, L. A. et al.. 2013. Wild pollinators enhance fruit set of crops regardless of honey bee abundance. Science 339 (6127) : 1608-1611.

Photos: Nancy Adamson

Native (wild) bee abundance in Virginia crops

SW VA Study 2008–9: **Three quarters of flower visitors were native bees**



Adamson, N.L., T. H. Roulston, R. D. Fell, D. E. Mullins. 2012. From April to August—wild bees pollinating crops through the growing season in Virginia, USA. Environmental Entomology 41 (4):813–821.

Photos: Nancy Adamson

Insect pollinators are ecological keystones

More than 85% of flowering plants require an animal, mostly insects, to move pollen.

Ollerton, J., R. Winfree, and S. Tarrant. 2011. How many flowering plants are pollinated by animals? Oikos 120: 321-326. doi: 10.1111/j. 1600-0706.2010.18644.x.
Potts, S.G., J.C. Biesmeijer, C. Kremen, P. Neumann, O. Schweiger, and W. E. Kunin. 2010. Global pollinator delines: trends, impacts and drivers. Trends in Ecology and Evolution. 25(6): 345-353.

Photo: Eric Mader

Bugs drive the system

Benefits to Other Wildlife:

- Pollinator-produced fruits and seeds comprise 25% of the global bird and mammal diets
- Pollinators are food for other wildlife
- Pollinator habitat is directly compatible with the needs of other wildlife, such as songbirds

Bear photo: © Sierra Vision Stock. Other photos: Nancy Adamson

Multiple benefits of pollinator habitat

Fruits and seeds are a major part of the diet of many insects, about 25% of birds, and many mammals

Photos: Marie Reed, USDA ARS

Multiple benefits of pollinator habitat

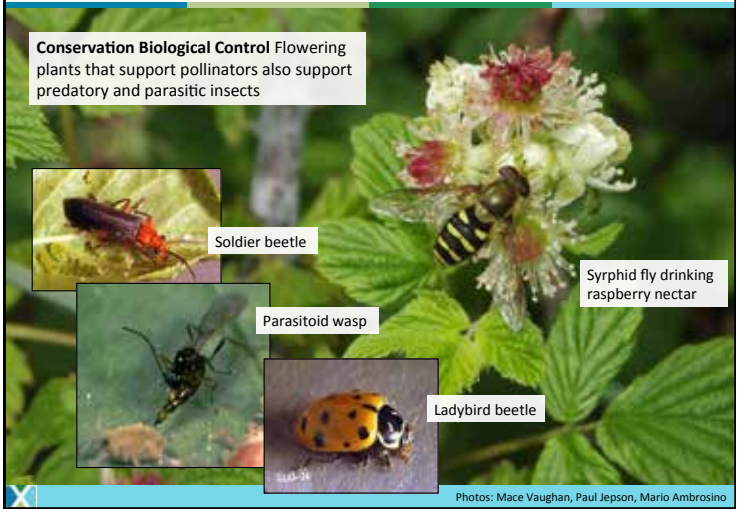
Pollinators and other insects are food for wildlife, including 89% of birds

Photo: Terry Spivey, USFS

Photo: Jeff Vanuga, NRCS

Multiple benefits of pollinator habitat

Conservation Biological Control Flowering plants that support pollinators also support predatory and parasitic insects



Soldier beetle

Syrphid fly drinking raspberry nectar

Parasitoid wasp

Ladybird beetle

Photos: Mace Vaughan, Paul Jepson, Mario Ambrosino

Many larvae are important predators, but as adults depend on floral resources

Some fly and beetle larvae are important pest predators or parasitoids
They overwinter in leaf litter or under soil layer

syrphid fly larva (aka hover fly or flower fly) eating an aphid

Photo: Alex Wild

Beneficial insect habitat (G. Tillman Study, GA)

Adding milkweed as a nectar source for a parasitoid fly led to 5X greater parasitization of southern green stink bug

Treatment	% Parasitization of SGSB adults by *T. pennipes*	Density of SGSB adults
Cotton w/ milkweed habitat	61.2	2.6
Cotton w/out milkweed habitat	13.3	3

common milkweed, *Asclepias syriaca*

tachinid fly, *Trichopoda pennipes*

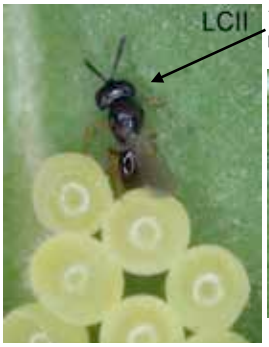
Tillman, P. G., & Carpenter, J. E. (2014). Milkweed (Gentianales: Apocynaceae): A Farmscape Resource for Increasing Parasitism of Stink Bugs (Hemiptera: Pentatomidae) and Providing Nectar to Insect Pollinators and Monarch Butterflies. Environmental entomology, 43(2), 370-376.

Photo: Nancy Adason

Tachinid fly photo: Marvin Smith (Wikimedia Commons). Milkweed photo: Nancy Adamson

Flowering cover crops support parasitoids

Nectar sources (buckwheat) in soybean supported increased (2½ times) parasitization of brown stink bugs (Glynn Tillman, USDA ARS, Crop Protection & Management Research Lab, Tifton, GA, manuscript in progress)



Telenomus podisi female parasitizing stink bug eggs

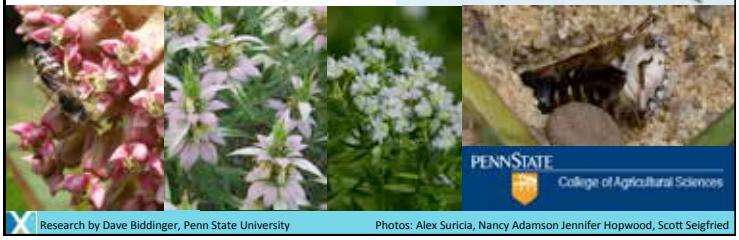
Photo: http://zoo.bio.ufpr.br/biocontrol/entomofauna.html Laboratorio de Controle Integrado de Insetos (LCII)

http://www.ars.usda.gov/research/projects/projects.htm?accn_no=420801

Natural enemies of pest stink bug need floral resources as adults

Sand wasps feed brown marmorated stink bugs to their young (research in progress at Penn. State University)

Nectar sources include milkweed (*Asclepias* spp.), mountain mint (*Pycnanthemum* spp.) & spotted bee balm (*Monarda punctata*); **solitary wasps** not defensive



PENNSTATE College of Agricultural Sciences

Research by Dave Biddinger, Penn State University

Photos: Alex Suricia, Nancy Adamson Jennifer Hopwood, Scott Seigfried

How can we better support pollinators & other insects?

Strengthen habitat and pesticide protection to support *diverse* pollinators & other wildlife—

- Plant & conserve native plants (or cover crops)
- Reduce pesticide use

Photos: Nancy Adamson

Habitat Needs

male sweat bees, *Halictus ligatus,* sheltering from the rain under wingstem flowers

Photo: Nancy Adamson

Native Bee Diversity

>3,600 native bee species in the US—most are **solitary** species, not colonial
~700 native bee species in the eastern US
~500 in Virginia

southeastern blueberry bee
Habropoda laboriosa

Specialist bees eat pollen only from one genus or family, but may collect nectar from other plants.

Photo: Sam Droege, USGS, Bee Inventory and Monitoring Lab, www.flickr.com/usgsbiml

Native Bee Nesting–3 Broad Groups

ground-nesting bees (solitary)

polyester bee,
Colletes inaequlis

orchard mason bee,
Osmia lignaria

cavity-nesting bees (solitary)

bumble bees (social)

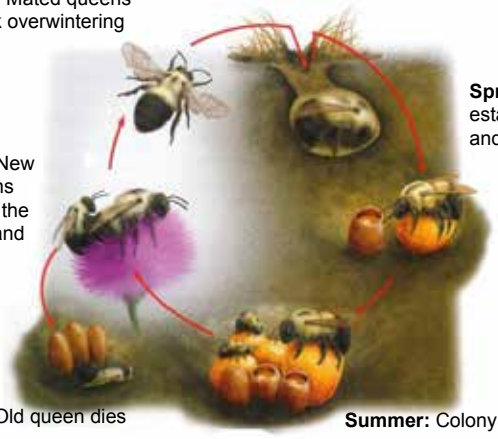
Bombus impatiens

Photos: Elaine Evans, Steve Javorek, Eric Mader

Life cycle of a bumble bee colony

Winter: Hibernating queen

Fall: Mated queens seek overwintering sites



Spring: Nest establishment and egg laying

Fall: New queens leave the nest and mate

Fall: Old queen dies

Summer: Colony peak

Illustration: David Wysotski

Bumble bees, *Bombus* spp.

- 45 species in U.S.,~26 in East, ~18 in VA
- Social colonies founded by single queen
- Annual colonies--last only one season
- Nest may contain 25-400 workers
- Nests in abandoned rodent burrows or under lodged grasses

Conserve brush piles, un-mowed areas

Bombus vagans on clover

Bumble bee nest photos: Elaine Evans. Bumble bee on clover photo: Nancy Adamson

Shelter for bumble bees

Conserve undisturbed or unmowed areas; protect possible overwintering sites for queens

- Cavities such as old rodent holes
- Under brush piles & overgrown areas
- Under bunch grasses

Excellent habitat for groundnesting birds, too!

Artificial nests ineffective (but mouse pee helps!)

little bluestem

Photos: Mace Vaughan, Matthew Shepherd, Bonnie Carruthers, Nancy Adamson

Life cycle of a solitary bee

Mining bee (*Andrena* sp.): a year in its underground nest as egg, larva, and pupa before emerging to spend a few weeks as an adult.

Photos: Dennis Briggs, Nancy Adamson

Cavity or tunnel nesting bees

Hollow stem example:

Cross-section of silk cocoons

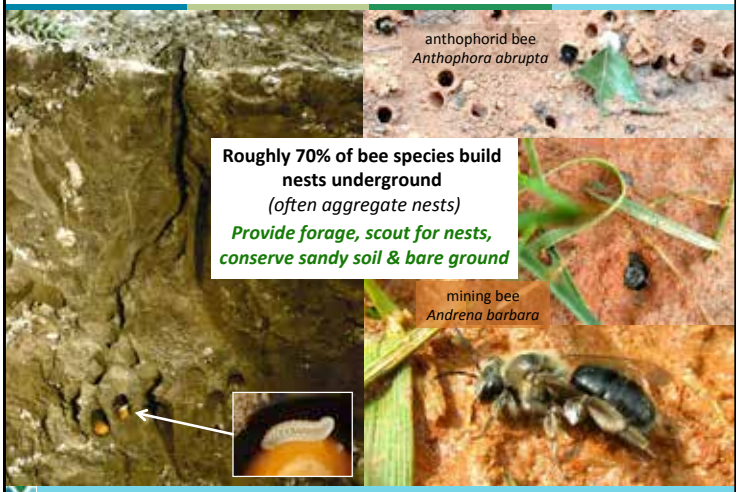
Larva Pupa Adult

Pollen mass Egg Mud wall

Silk cocoons with dormant bees inside

Mud cap closure

Ground-nesting solitary bees



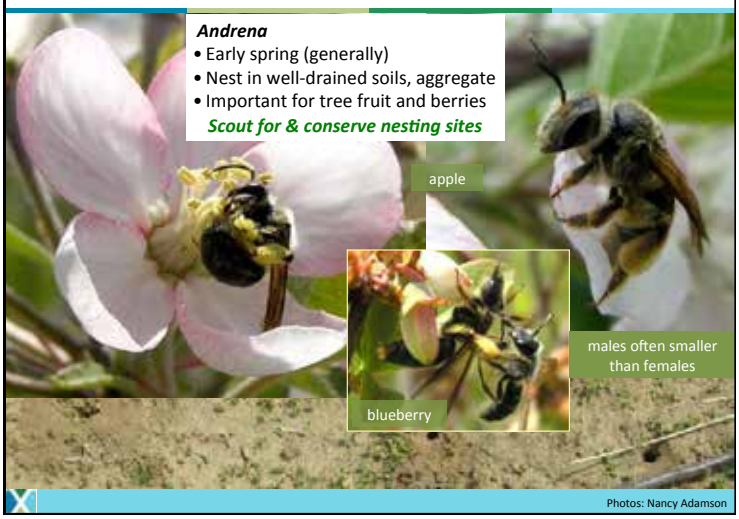
anthophorid bee
Anthophora abrupta

Roughly 70% of bee species build nests underground
(often aggregate nests)
Provide forage, scout for nests, conserve sandy soil & bare ground

mining bee
Andrena barbara

Underground nest & larva photos: Jim Cane, Dennis Briggs. Anthophorid bees photo: Florrie Funk. Mining bee photos: Nancy Adamson

Ground nesting: Mining or digger bees



Andrena

- Early spring (generally)
- Nest in well-drained soils, aggregate
- Important for tree fruit and berries

Scout for & conserve nesting sites

apple

blueberry

males often smaller than females

Photos: Nancy Adamson

Cavity or tunnel-nesting solitary bees

Roughly 30% nest in hollow plant stems, or old beetle borer holes

Provide forage, conserve snags, brush piles & pithy-stemmed plants. Leave dead plant material over winter.

small carpenter bees ↑↓

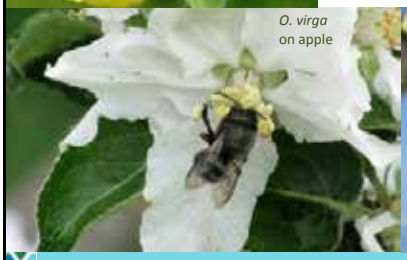
Tree snag photo: Matthew Shepherd. Larva & adult photo: © Edward Ross. Adult in blackberry: Nancy Adamson

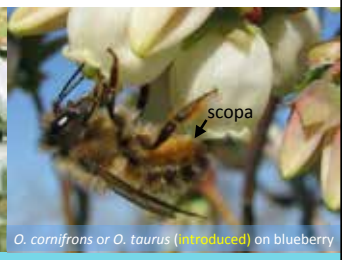
Cavity or tunnel nesting: Mason or orchard bees

Osmia

- Small to medium size, robust build
- Usually metallic blue or green
- Wide bodies and heads
- Scopa on underside of abdomen
- Active in spring and early summer

Conserve snags, brush piles & pithy-stemmed plants





Osmia collinsonia photo: T'ai Roulston, UVA. Other photos: Nancy Adamson

Tunnel nesting: Leafcutter bees

Megachile

- Small to large size
- Wide bodies and heads
- Dark, typically with pale stripes
- Scopa on underside of abdomen
- *M. rotundata* intro'd for alfalfa seed

Conserve snags, brush piles & pithy-stemmed plants

Photos: Eric Mader, Edward S. Ross, Jennifer Hopwood, Nancy Adamson

Some flowers with pollen specialist bees

- asters (various genera)
- *Cirsium,* native thistles
- *Chrysopsis,* goldenaster
- *Cucurbita,* squash
- *Helianthus,* sunflowers
- *Hibiscus,* rose mallow
- *Ipomoea*, wild potato vine
- *Oenothera,* primroses
- *Physalis*, ground cherry
- *Pityopsis*, silkgrass
- *Salix,* willows
- *Strophostyles*, fuzzy bean
- *Vaccinium*, blueberry
- *Vernonia,* ironweed
- *Viola*, violet

...many more

http://www.illinoiswildflowers.info/flower_insects/
http://jarrodfowler.com/specialist_bees.html

Photo: Nancy Adamson

Lepidoptera food needs: Host & nectar plants

Larvae eat only specific host plants

Adults sip nectar from many types

Monarch caterpillar and adult on milkweed, *Asclepias tuberosa*

Photos: Mace Vaughan, Jolie Goldenetz Dollar

Lepidoptera food needs: Caterpillars are host specific

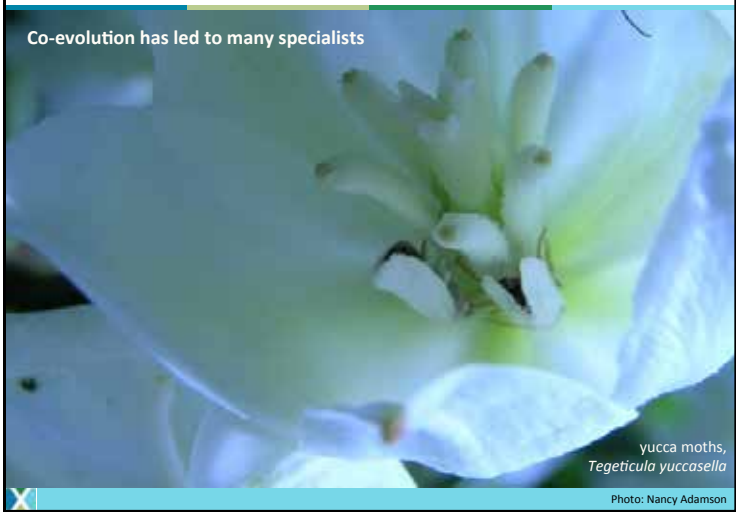


Photo: Nancy Adamson

Lepidoptera nesting—as easy to miss as bees nesting...more fire sensitive

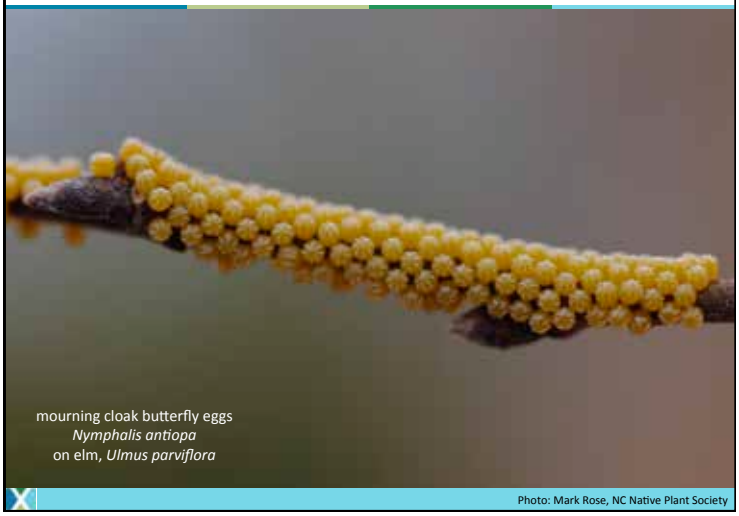


Photo: Mark Rose, NC Native Plant Society

Your Native Plantings Matter!

sunflower bee
on brown-eyed Susan,
Rudbeckia triloba

Photo: Nancy Adamson

Video:
Native plants of the mid-Atlantic support diverse pollinators
https://www.youtube.com/watch?v=HhC5iY0ijJM

Restoring Pollinator Habitat

A Spectrum of Approaches

Easy

Less Easy

- Protecting naturally diverse areas (not exactly easy…)
- Managing for early successional habitat (fallow, mowing to maintain native wildflowers/shrubs/berries, timber thinning, prescribed fire)
- Diverse flowering cover crops
- Establishing native hedgerows
- Establishing native wildflower meadows

Photo: Nancy Adamson

Insect diversity increases with plant diversity

Bee and other insect diversity improves crop production and benefits other wildlife--birds, mammals, amphibian, reptiles…

Carvell, C., W. R. Meek, R. F. Pywell, D. Goulson and M. Nowakowski. 2007. Comparing the efficacy of agri-environment schemes to enhance bumble bee abundance and diversity on arable field margins. *J of Applied Ecology* 44: 29-40.

Potts, S. G., B. Vulliamy, A. Dafni, G. Ne'eman, and P. G. Willmer. 2003. Linking bees and flowers: how do floral communities structure pollinator communities? *Ecology* 84:2628-2642.

Tscharntke, T. A., A. Gathmann, and I. Steffan-Dewenter. 1998. Bioindication using trap-nesting bees and wasps and their natural enemies and interactions. *J of Applied Ecology* 35:708-719.

Photo: Eric Mader

How much habitat is needed?

Bigger is better for pollinators, predators, and parasitoids

- Larger wildflower plantings support greater biological control without increasing herbivore density (Blaauw & Isaacs 2012)
- Farmers can enhance diversity in marginal areas and field borders, while also increasing diversity within crops

Blaauw, B. R. and R. Isaacs. 2012. Larger wildflower plantings increase natural enemy density, diversity, and biological control of sentinel prey, without increasing herbivore density. Ecological Entomology. DOI: 10.1111/j.1365-2311.2012.01376.x.

Photo: Jennifer Hopwood

Fallow patches can enhance productivity in pollinator dependent crops

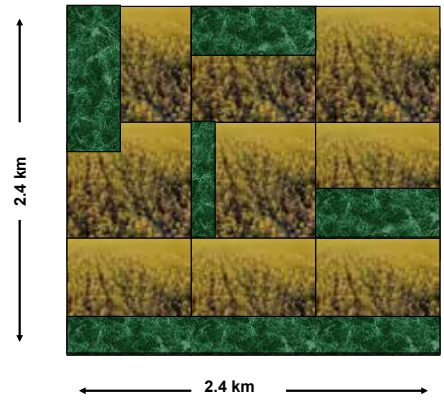
Natural Areas Case Study: Canola in Canada

In the absence of honey bees, canola growers make more money on their land if 30% is in natural habitat, rather than planting it all.

Morandin, L., and M. Winston. 2006. Pollinators provide economic incentive to preserve natural land in agroecosystems. Agriculture, Ecosystems and Environment 116:289-292.

Photo: Mace Vaughan

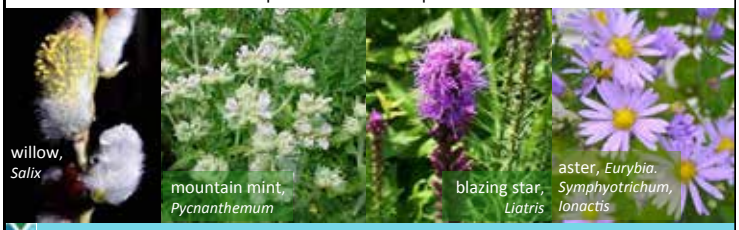
Natural Areas: Fallow Cropland Case Study



Graphic courtesy of Lora Morandin

Habitat through the growing season

Pollinators, predators, & parasitoids need **food (nectar, pollen, or prey) and refuge** when crops are harvested or pesticides used.

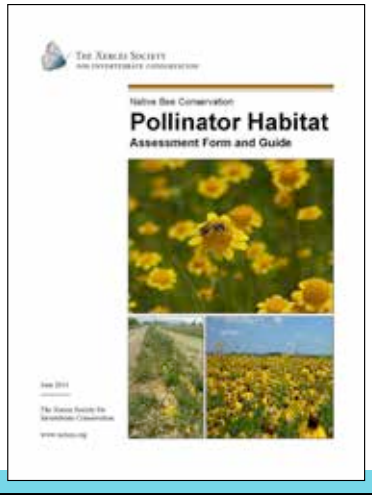


Photos: Elaine Haug NRCS, Matthew Shepherd; Mace Vaughan, Eric Mader, Jeff McMillan NRCS, Berry Botanic Garden, Nancy Adamson

The Habitat Assessment Process

Assessing Land for Pollinator Value

- A subjective process
- Quantify characteristics
  - Landscape-level
  - Site-level
- Xerces Habitat Assessment Guide



Will providing habitat increase pest pressure?

More diverse is better: Natural enemy populations are higher & pest pressure is lower in complex patchy landscapes with fallow fields, field margins, and/or wooded habitats

Bianchi, F. J. J. A., C. J. H. Booij, and T. Tscharntke. 2011. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. *Proc. R. Soc. B* 273: 1715-1727.
Forehand, L. M., D. B. Orr, and H. M. Linker. 2006. Insect communities associated with beneficial inset habitat plants in North Carolina. *Environmental Entomology* 35 (6): 1541-159.

Photo: Nikki Siebert

Wildflowers for Pollinators & Other Beneficial Insects

Beardtongue, golden Alexanders, blackeyed susan, wild bergamot, NJ tea, violet, mountain mint, wingstem, goldenrod, tick trefoil, Joe-pye weed, milkweed, blazing star, passionflower, sunflower, ironweed, gentian, aster…

Photo: Nancy Adamson

Native Milkweeds (*Asclepias* spp.)

- ~80% decline in monarch butterflies since ~2000 in corn/soybean ag regions and ~60% decline in milkweeds
- Tremendous diversity in milkweeds--great potential to expand use

Pleasants, J. M., Oberhauser, K. S. 2012.Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population. *Insect Conservation and Diversity*. doi: 10.1111/j.1752-4598.2012.00196.x.

Photos: Nancy Adamson

Native Flowering Shrubs, Trees and Diverse Hedgerows

Maple, willow, holly, redbud, blueberry, sourwood, indigobush, sumac, caneberry, wild roses, elderberry, spiraea, shrubby St. Johnswort…

bumble bee on redbud, *Cercis canadensis*

Photo: Nancy Adamson

Cover crops, herbs, & annuals also support pollinators & other wildlife

clover

Cover crops
- Red, white, crimson clover
- Buckwheat
- Austrian winter pea
- Alfalfa
- Hairy vetch
- Phacelia

Herbs
- Basil
- Borage
- Catmint
- Oregano
- Sage

Annuals
- Annual sunflower
- Zinnia
- Cosmos
- Scarlet sage

zinnia

borage

buckwheat

sunflower

clover

Photos: Nancy Adamson

Grasses are host plants, provide shelter and fuel for prescribed fire

Grasses are vital in fire adapted communities as fine fuel.
They shelter groundnesting birds, bumblebees, and other wildlife.
They are host plants for larvae of grass skippers and some true butterflies.

gemmed satyr
Enodia anthedon

Gemmed satry larvae (caterpillars) eat river oats, *Chasmanthium* spp.

Photo: Dennis Burnette, Carolina Butterfly Society

Bringing restoration seed into the trade

With growing interest in ecological restoration, particularly using local ecotypes, more regionally local seed is becoming available every day.

gulf fritillary butterflies nectaring on chaffhead, *Carphephorus bellidi*, in SC as they migrate south in fall

The Plant Conservation Alliance, consortium of public and private organizations and individuals working to conserve native plants http://www.nps.gov/plants.

Photo: Nancy Adamson

Managing Insecticides

Pesticides cause significant damage to pollinator insect populations

- Use active ingredients with least impact on bees
- Consider formulation
- Label guidelines only apply to honey bees
- Don't spray on plants in bloom
- Spray at night and when dry

http://extension.oregonstate.edu/catalog/abstract.php?seriesno=PNW+591

Biological Control ≠ Annihilation

Slow pest population growth rates

If both predator & prey are wiped out, it takes predators much longer to recover

wheel bug (assassin bug) nymph eating a Colorado potato beetle

Photo: Debbie Roos

Caution if using organic-approved pesticides

Even organic-approved pesticides aren't always safe for bees & other beneficials.

- Rotenone = Dangerous for Bees!
- Pyrethrins = Dangerous for Bees!
- Spinosad = Dangerous for Bees!
- *Beauveria bassiana* = Dangerous!

Okay when not directly applied to bees (i.e. non-blooming crops or at night):

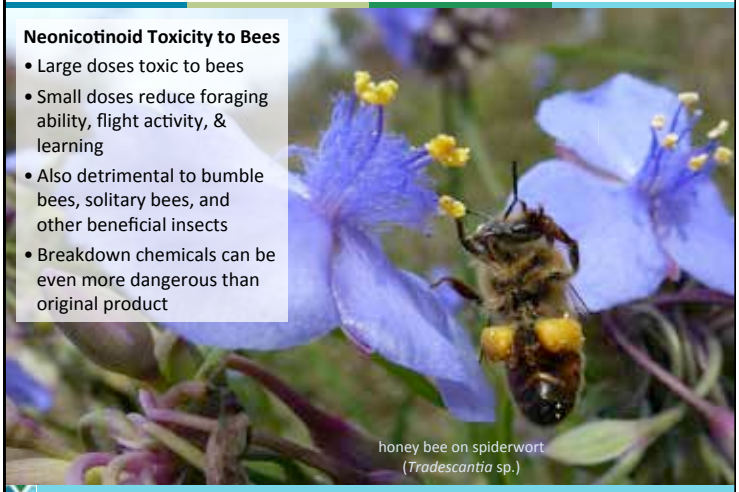
- Insecticidal soap
- Horticultural oil
- Neem

Photo: NRCS/Toby Alexander

Protection from Pesticides: Neonicotinoids

Neonicotinoid Toxicity to Bees

- Large doses toxic to bees
- Small doses reduce foraging ability, flight activity, & learning
- Also detrimental to bumble bees, solitary bees, and other beneficial insects
- Breakdown chemicals can be even more dangerous than original product



honey bee on spiderwort (*Tradescantia* sp.)

Photo: Nancy Adamson

Protection from Pesticides: Neonicotinoids

Reducing Harm from Neonicotinoids

- Avoid applying before or during bloom
- Avoid repeat annual use, esp. in perennial crops (carry over)
- NOTE: Recommended rates on household vs. ag products as much 100X rates, so lethal
- Stop "cosmetic" (vs. ag) use (http://www.beecityusa.org/)

bumble bee on blueberry

Photo: Nancy Adamson

Crops not needing pollinators may be habitat

Corn, pecans…

bumble bee loading up on corn pollen—many bees, including honey bees will gather the pollen

Photo: Nancy Adamson

Weed control: Protect ground-nesting insects

- Reduce tillage
- Plastic mulch: pros and cons

Photo: USDA-ARS

Shelter for cavity-nesting bees

Bamboo and other plants can be cut--*back end solid and front open*--to provide nests for cavity-nesting solitary bees (& solitary wasps)

mason bees, *Osmia cornifrons* (introduced from Japan)
Introduced species utilize these nests more than native species

pupae in bamboo (split open)

Providing natural nesting opportunities—snags, hedgerows with pithy-stemmed plants, wood piles, woods—is best to support native species.

Photos: Nancy Adamson

Cavity-nesters through the growing season if include varying sizes

Summer nesting leafcutter bee (*Osmia* sp.) using the smaller tubes (<3/16"). **Provide tubes ~1/8" to 3/8"**

Osmia sp., mason bee/leafcutter bee

Photos: Nancy Adamson

Other cavity-nesters include solitary wasps (& parasitoids)

Leafcutter bees and predatory wasps use the cavities later in the season. Parasitoids may seek prey in the nests.

parasitoid wasp

predatory wasp

Photo: Nancy Adamson

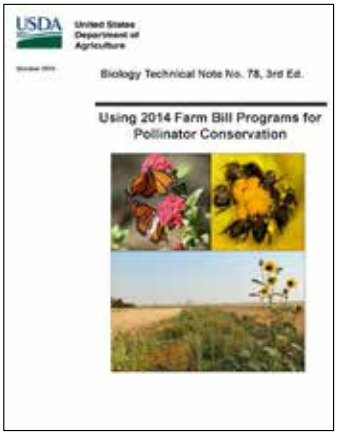
Farm Bill Implementation: Practices for Pollinators

Core Programs for Pollinators
EQIP, CRP, CSP

Agencies:
Natural Resources Conservation Service (NRCS)
Farm Service Agency (FSA)

Tech Note 78
Using Farm Bill Programs for Pollinator Conservation

Practices for Pollinators
- Tree/Shrub Establishment
- Conservation Cover
- Hedgerow Planting
- Field Border
- Restoration and Management of Rare or Declining Habitats
- Upland Wildlife Habitat Management
- Integrated Pest Management
- Early Successional Habitat Development/ Management
- *many others*



http://plants.usda.gov/pollinators/NRCSdocuments.html

2014 Farm Bill Implementation: 5% of EQIP targeted for wildlife

Environmental Quality Incentives Program (EQIP) provides financial assistance (cost-share) to farmers to improve habitat--pollinators are a "Priority Natural Resource Concern"

bumble bee
and shaggy blazing star

http://plants.usda.gov/pollinators/nrcsdocuments.html

Photo: Nancy Adamson

Is seeding appropriate?*

What is the history of the site? Was it previously cultivated?
If not, the **existing seed bank** may be the most appropriate seed source.

Donahue pine flatwood
in South Carolina

*For help determining if planting is appropriate, see Norman Melvin's "decision sequence keys" in ***Wetlands Restoration, Enhancement, and Management*** http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010838.pdf

Photo: Sudie Daves Thomas, SC NRCS

"Daylight" the seed bank

Bringing in sunlight by thinning & burning may be the best restoration strategy.

Associated NRCS practices:
- **409** Prescribed Forestry
- **338** Prescribed Burning
- **528** Prescribed Grazing
- **643** Restoration and Management of Rare and Declining Habitats
- **647** Early Successional Habitat Development or Management
- **659** Wetland Enhancement
- **657** Wetland Restoration
- **644** Wetland Wildlife Habitat Mgmt
- **381** Silvopasture Establishment

Carolina Bay in NC restored
with thinning & burning

Photo: Nancy Adamson

NRCS Conservation Practices for Pollinators

Tree & Shrub (612) or Hedgerow (422) Establishment

Plant flowering shrubs that bloom in succession. Design for multiple benefits, such as wildlife, IPM, visual screen, aesthetics, and erosion control.

Photo: Katharina Ullmann (Xerces Society)

NRCS Conservation Practices for Pollinators

Field Border Practice Standard (386): Can include a diverse mix of native and low cost non-native plants

Photo: Eric Mader

NRCS Conservation Practices for Pollinators

Cover Crop (340)
Crops for seasonal cover and other conservation purposes

PURPOSE
- Reduce erosion
- Increase soil organic matter
- Capture and recycle nutrients
- Promote nitrogen fixation
- Suppress weeds
- Manage soil moisture
- Minimize soil compaction

CONSIDERATIONS FOR POLLINATORS
- "Cocktails" may have more benefits than single species
- If possible, allow flowering before terminating
- Provide other pollen and nectar sources after terminating

Crimson clover in Rowan County, NC

Photo: Ben Knox, NC Department of Agriculture

NRCS Conservation Practices for Pollinators

No Till / Strip Till / Direct Seed (329)
Squash bee example

Example: No-Cultivation Squash
- No-cultivation squash farms in Virginia hosted three times more ground-nesting squash bees than did conventional farms

Shuler, et al. 2005. Farming Practices Influence Wild Pollinator Populations on Squash and Pumpkin. *Journal of Economic Entomology*. 98(3):790-795

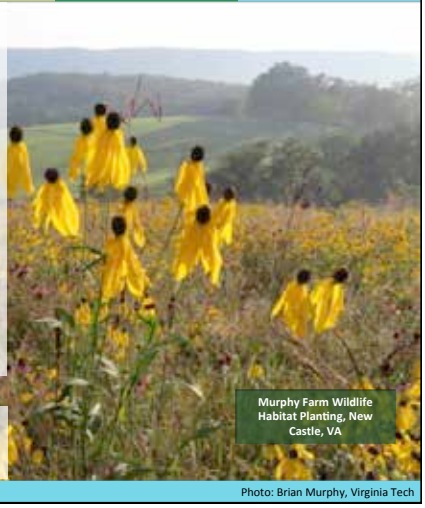
Photo: Nancy Adamson

FSA* Conservation Practices for Pollinators

Conservation Reserve Program (CRP) Practices that Support Pollinator Habitat

- CP-2 Native Grasses and Wildflowers
- CP-3A Hardwood Tree Planting
- CP-4B Permanent Wildlife Habitat
- CP-5A Field Windbreak
- CP-16 Shelterbelt
- CP-22 Riparian Buffer
- CP-23 Wetland Restoration
- CP-25 Rare and Declining Habitats
- CP-30 Marginal Pasture Wetland Buffer
- CP-31 Bottomland Timber
- CP-33 Habitat Buffer for Upland Birds
- **CP-42 Pollinator Habitat**

*The NRCS provides technical support for the Farm Service Agency Conservation Reserve Program (CRP)



Murphy Farm Wildlife Habitat Planting, New Castle, VA

Photo: Brian Murphy, Virginia Tech

Farm Bill Implementation: Watershed Protection

- **Protect watersheds**
- **Provide wildlife habitat**--*especially species needing open, early-successional habitat*

Plantings around sinkholes, with technical support provided by Robin Mayberry, NRCS Area Biologist in Cookville, TN

Photo: Nancy Adamson

Natural regeneration & watershed protection

Leaving vegetation around creeks helps clean and shade waterways; mid to late summer flowers are abundant in riparian areas when other areas are dry

NC Mountain Research Station, Waynesville. Visit all 18 NC Research Stations to see conservation techniques and plantings to support pollinators.

http://www.ncagr.gov/research

Photo: Nancy Adamson

Multiple benefits of pollinator habitat—even turf benefits!

This stream corridor supports scoliid wasp adults, who lay their eggs in grubs of Japanese beetles (that eat grass roots) in the ground

Riparian area left unmown to protect waterway and support beneficial insects at Super Sod Farm, Mills River, NC

Photo: Nancy Adamson

Multiple benefits of pollinator habitat

Scoliid wasps reduce Japanese beetle populations; adults lay their eggs in grubs and the wasp larvae eat the grubs from the inside out

scoliid wasps on marestail
Super Sod Farm, Mills River, NC

Photo: Nancy Adamson

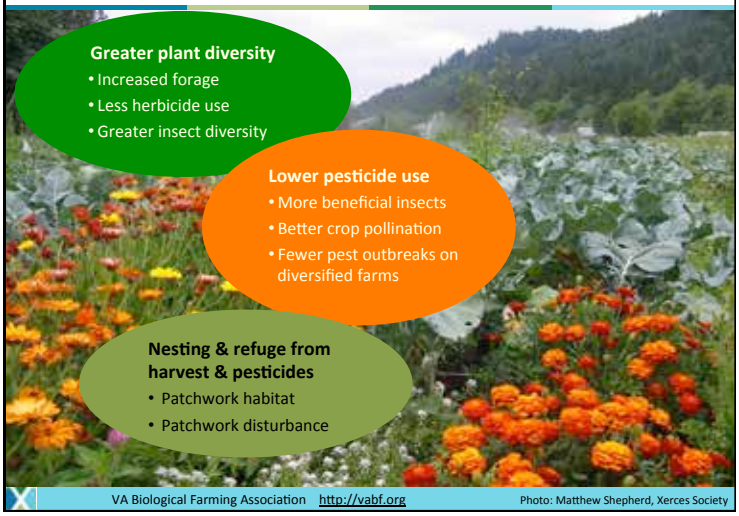
Savvy Business Management & Watershed Protection

$200/month mowing transformed into protected diverse riparian corridor;
Former barren now utilized regularly by staff and visitors

Carolina Mountain Land Conservancy
http://www.carolinamountain.org

Photo: Nancy Adamson

Biological Farming: The National Organic Program includes increasing diversity



Greater plant diversity
- Increased forage
- Less herbicide use
- Greater insect diversity

Lower pesticide use
- More beneficial insects
- Better crop pollination
- Fewer pest outbreaks on diversified farms

Nesting & refuge from harvest & pesticides
- Patchwork habitat
- Patchwork disturbance

VA Biological Farming Association http://vabf.org

Photo: Matthew Shepherd, Xerces Society

Long-term habitat management: Limit disturbance frequency and duration

Mowing, grazing, burning, disking are best at infrequent intervals
- Disturb no more than 1/3 of habitat area each year
- Time management for when most effective against target, or during dormant season
- Early successional habitat is ideal; too much disturbance favors grasses over forbs

Managed intensive rotational grazing helps restore plant roots & soil health

NCTREX team burning a longleaf pine savanna, February 2015

Photos: USDA-ARS, Nancy Adamson

Other habitat conservation & management opportunities

Often there are opportunities to better manage existing habitat

Photos: Heritage Seedlings, Inc.; NYSDOT; Anne Stine; Yamhill County Council

Remember: Wildflower-rich habitats support beneficial insects & other wildlife

Ensure
- Diverse forage & nesting sites
- Management for insect diversity

bumble bee on American germander, *Teucrium canadense*

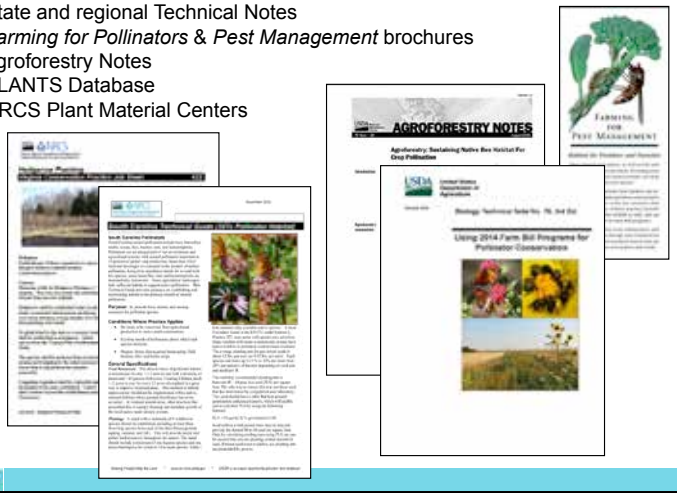
Photo: Nancy Adamson

green sweat bee, on butterfly milkweed

Photo: Nancy Adamson

USDA-NRCS Resources—Talk with your District Conservationist!

State and regional Technical Notes
Farming for Pollinators & *Pest Management* brochures
Agroforestry Notes
PLANTS Database
NRCS Plant Material Centers



In Virginia, Partner Biologists Support Farm Bill Implementation

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

VA NRCS, VA DGIF, & Virginia Tech Partner Biologists Robert Glennon & Andrew Rosenberger teaching about meadow establishment on a southwest Virginia farm

Photos: Nancy Lee Adamson

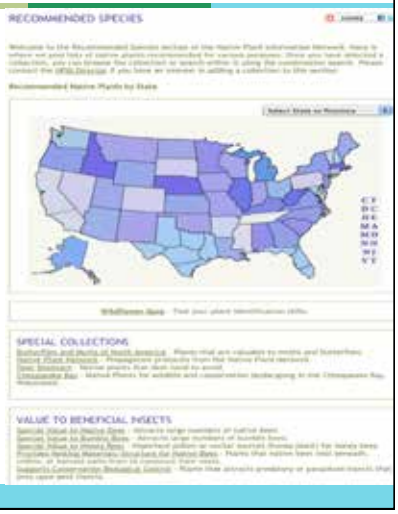
Further Information: Native Plant Database

Lady Bird Johnson Wildflower Center Recommended Species:
http://wildflower.org/collections/

Special Collections
- Butterflies and Moths

Value to Beneficial Insects
- Special Value to Native Bees
- Special Value to Bumble Bees
- Special Value to Honey Bees
- Provide Nesting Materials/Structure for Native Bees

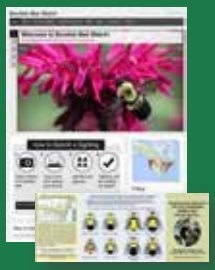
Click on a "Special Value" category, then narrow to state, habit, light & soil conditions, etc.



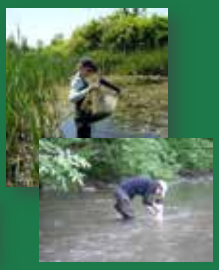
Further Information: the Xerces Society www.xerces.org

The Xerces Society: Citizen Science

Bumble Bees

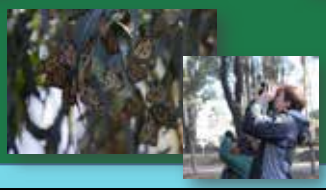


Aquatic Invertebrates



Migratory Dragonflies

Overwintering Monarchs



Thank You, Virginians & Friends!

Thank You All!

…and many excellent scientists, conservationists, and farmers

Financial support from

- Xerces Society Members
- NRCS East National Tech Center
- Turner Foundation
- Disney Worldwide Conservation Fund
- C.S. Fund
- Whole Foods Market & their vendors
- Organic Valley FAFO
- Organic Farming Research Foundation
- Nat'l Institute of Food & Agric., USDA
- Cinco
- Clif Bar Family Foundation
- Alice C. Tyler Perpetual Trust
- Sarah K. de Coizart Article TENTH Perpetual Charitable Trust
- The Edward Gorey Charitable Trust
- EarthShare (CFC #18360)
- Endangered Species Chocolate
- The Metabolic Studio
- The Ceres Foundation
- & many others…