USDA National Agroforestry Center

Inside Agroforestry

VOLUME 23 ISSUE 2

LEARN HOW YOU CAN USE AGROFORESTRY TO HELP POLLINATORS

COMMEMORATING 25 *years* – NATIONAL AGROFORESTRY CENTER

NAC Director's Corner

A commentary on the status of agroforestry by Susan Stein, NAC Director

In the 25 years since the inception of the National Agroforestry Center (NAC), our focus has broadened from soil conservation and water quality to a myriad of other agroforestry benefits, critical to the production of many crops. This issue of *Inside Agroforestry* highlights ways that agroforestry has supported pollinator conservation and management as well as efforts that have also served to educate the public.

In light of critical concerns over pollinator declines, a Memorandum was released by President Obama on June 20, 2014, creating a Federal Strategy to Promote the Health of Pollinators. Since the release of this Memorandum, USDA agencies have been taking steps to respond, some of which I will review here.

A Pollinator Health Task Force was formed and is co-chaired by USDA and the EPA; a report on their actions is planned for this spring. USDA agencies have been cataloguing their work related to pollinators and implementing new projects in response to the Memorandum. The US Forest Service Research & Development Deputy Area, for example, has conducted a wide variety of research related to pollinators, including pollinators' relationships with restoration, native plant reproduction, climate change, and invasive species. The Agricultural Research Service has been exploring ways to breed bees that naturally resist varroa mites (*Varroa destructor*), considered the most serious pest of honey bee colonies worldwide.

In 2014, USDA provided $7 million in technical and financial assistance to encourage farmers in Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin to improve pollinator habitat on working lands through EQIP and CRP. In August of 2014, USDA's National Institute for Food and Agriculture awarded $6.9 million to Michigan State University to develop sustainable pollination strategies for specialty crops grown in the United States.

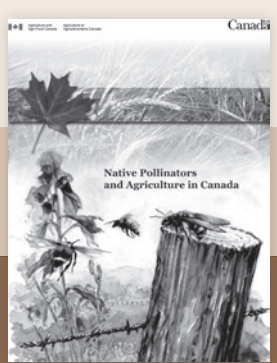
These efforts all complement the important work that private forest and agricultural landowners have undertaken to support pollinators. Throughout this issue of *Inside Agroforestry*, we hope that you will be inspired to consider pollinator conservation efforts – such as provision of food and habitat – as you continue your work to increase agroforestry practices across the landscape. In future issues, stay tuned for more highlights of agroforestry over the last 25 years.

NAC Resources on Pollinators

NAC has four technical publications related to pollinators. These were developed in cooperation with the Xerces Society and the Agricultural Research Service (ARS). These publications (found in the Agroforestry Notes series) are for those who are thinking about the pollinators in their landscapes:

- Agroforestry: Sustaining Native Bee Habitat For Crop Pollination (AF Note #32)
- Improving Forage For Native Bee Crop Pollinators (AF Note #33)
- Enhancing Nest Sites For Native Bee Crop Pollinators (AF Note #34)
- Pesticide Considerations For Native Bees In Agroforestry (AF Note #35)

These resources give more detailed information on species considerations, habitat needs, and landscape design and are available to download from the NAC website: http://nac.unl.edu/publications/agroforestrynotes.htm.



Native Pollinators and Agriculture in Canada

Agriculture and Agri-Food Canada recently published a report on Native Pollinators and Agriculture in Canada. Along with describing important pollinators such as bees, wasps, flies, butterflies, moths, and beetles, the report also outlines how to protect native pollinators. The report promotes saving existing habitat and creating new habitat through a variety of practices, including managing and installing shelterbelts and buffers. The publication is available here: http://publications.gc.ca/collections/collection_2014/aac-aafc/A59-12-2014-eng.pdf

The Value of Insect Habitat in Agroforests

Adam Kranz, Graduate Student,
Woody Perennial Polyculture Research Site,
University of Illinois at Urbana-Champaign

The Woody Perennial Polyculture (WPP) research site in Urbana, Illinois, is an experimental plot created to study the ecology and economy of highly diverse fruit, nut, and hay polycultures. Polycultures are multiple crops grown in the same space, often designed to resemble the diversity of natural ecosystems. The site is designed to mimic the structure and composition of the oak savanna community historically widespread in the western Midwest. Like oak savannas, WPP is comprised largely of grasses and forbs, but also contains many woody shrubs, small trees, and vines, and in its mature state it will be partially shaded by large nut-bearing trees. The woody crops included are all near-relatives of major savanna species—chestnuts share a family with oaks, while currants, grapes, apples, raspberries, and hazelnuts all have native cousins within their genera. This generalized mimicry of a native ecosystem is intended to improve agricultural performance in a number of ways, from increased water infiltration and reduced nitrogen runoff to carbon sequestration and improved habitat value.

Providing insect habitat can and should be a goal for agricultural systems. Insect diversity is crucial for many ecosystem services and integrally supports all other taxa of life, which makes insect conservation inextricable from biodiversity conservation as a whole. High plant diversity meets the varied needs of many different insect taxa, and that diverse insect community in turn provides services to farmers, like nutrient cycling, pest control, and pollination. These services could reduce input costs for perennial polycultures compared to monocultures, potentially increasing profits.

Effective insect pollination is necessary for many fruit crops, including apples, raspberries, and currants, to achieve their full potential yield (nut crops, as well as grapes, are wind-pollinated).

Honeybee and bumblebee hives work throughout the growing season and need pollen and nectar available at all times. WPP systems provide a succession of different floral resources throughout the year, from currants and apples in the spring to clover and raspberries through the summer and fall.

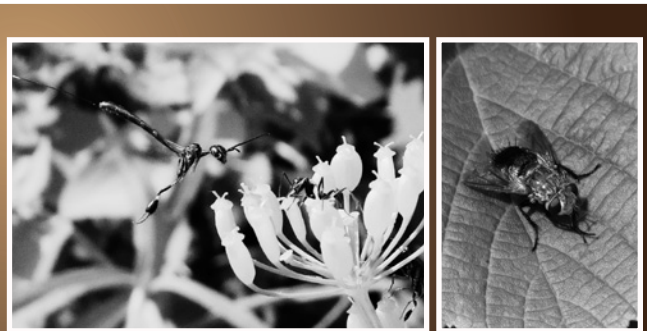
Insects have diverse needs throughout their life cycle. Bees need pollen as larvae to provide the protein they need to grow and eventually build their adult bodies, while adult bees need nectar to fuel their flight and warm their muscles in cold weather. They also need places to shelter their young. Depending on the species, solitary bees nest in holes in wood, hollow reed and bramble stems, and in bare earth. Mimicking as many aspects of the oak savanna as is feasible is a broad-brush way to meet many of those needs. For instance, hay in WPP alleys provides grass clumps and abandoned mouse nests that bumblebees use to make their nests. Below-ground nests can survive mowing and hay removal but not plowing, and plowing eliminates existing holes that below-ground nesters use.

It's important to remember that pollinators are only one aspect of the larger issue of invertebrate conservation. Fruit crop pollinators generally have long tongues and look for larger flowers with lots of nectar. Other insects have different needs that aren't provided by these crops. Many insects have shorter tongues and can only feed from shallow nectaries like those on carrot family plants. Parasitic wasps and flies, among the most important insects for pest control, depend on such small flowers as adults.

While plantings and management practices have a significant impact on the insect communities active on farms, management outcomes are limited by the possibilities offered by landscape context. Nearby flower meadows, weed fields, forests, and gardens provide source populations for hundreds of insect species, a large proportion of which colonize farms every year. If conditions are amenable to their survival, they will establish a new population that remains in genetic contact with other populations in the area. This network of habitat patches creates what is called a metapopulation, and it is at this regional scale that invertebrate conservation efforts function.

Agroforestry sites are inescapably different from the native habitats that house the great majority of our biodiversity. They often overlook

Continued on page 11



Left: A Gasteruption wasp flies in to feed on a golden alexander (*Zizia aurea*). Their larvae are predators of stem-nesting bees and wasps. **Right:** A tachinid fly, genus *Archytas*, sits on a hazelnut leaf. Their larvae are parasitoids of moth caterpillars. Photos by Adam Kranz.

Incorporating Pollinator Habitat into Silvopasture

Tom Ward, Forester, USDA NRCS East National Technology Support Center
Nancy Adamson, Pollinator Conservation Specialist, Xerces Society/NRCS ENTC

Silvopasture is the intentional combining of trees (silvo) and forages for grazing or browsing animals (pasture). In its simplest application there may be only two plant species included in a silvopasture, a pine tree species, for example, and a forage grass like tall fescue. Neither of these offers much for pollinators.

Adding Pollinator Habitat to Simple Silvopasture Designs

A typical silvopasture design includes one or more rows of trees alternating with wide "alleyways" for grazing. An alternative design that provides habitat for pollinators might include maple as the tree component (an important spring pollen source) and little bluestem (a grass that lodges and provides good bumble bee nesting habitat) for the forage component. There are many potential combinations of trees and forage plants, including lots of choices that benefit pollinators. Some pollinator-friendly forages include several species of clover and vetch, which need to be reseeded every few years. Less commonly used are some native perennial legumes that, if managed well, will persist once established such as bush clovers and tickseeds.

Adding Pollinator Habitat to More Complex Silvopasture Designs

When the silvopasture design includes two or more tree rows, pollinator plants can be added or allowed to grow within or between the tree rows. These additional small trees, shrubs, forbs and grasses can provide additional pollen, nectar, and nesting sites for pollinators. The diagram below illustrates how to incorporate a variety of native grasses, forbs, and shrubs into various tree row designs for silvopasture.

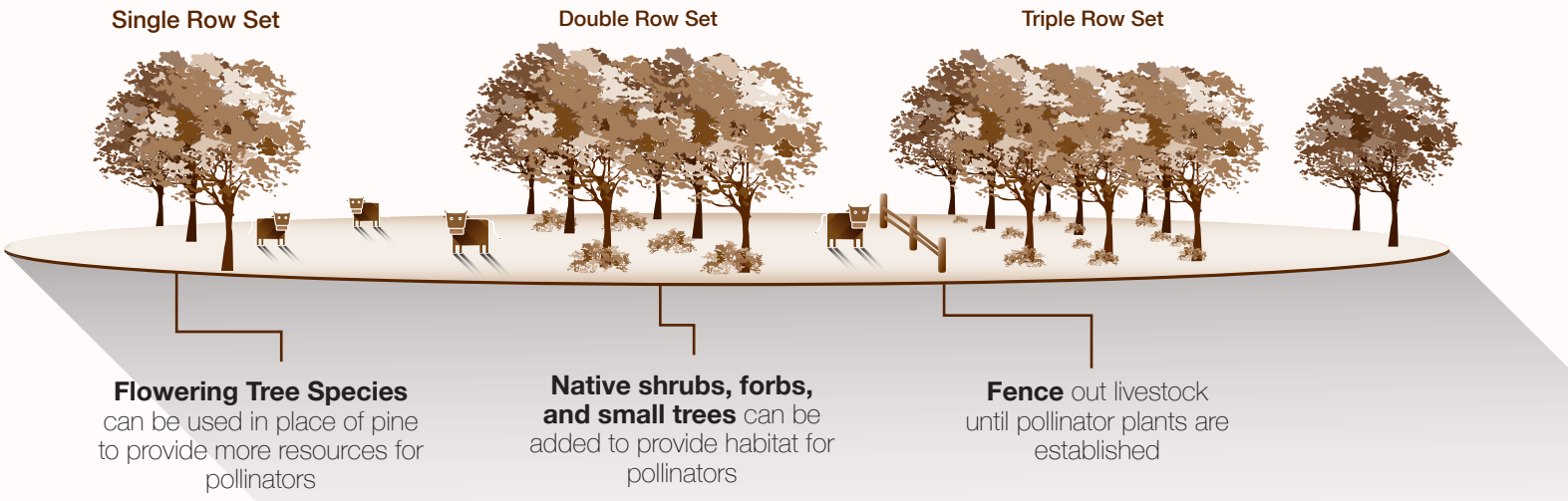
Depending on the soils and site conditions (such as annual precipitation, average temperature, growing season, etc.) a variety of forbs, shrubs and small trees can be added between tree rows without reducing the forage crop in the alleyways. Plants established in the tree rows will need to be at least somewhat shade tolerant, although considerable sunlight will reach the ground because of the open alleyways on either side of the tree rows. Pollinator plants may need protection from grazing or browsing while becoming established.

Other Management Activities that Favor Pollinators

Rotational grazing systems (those that involve limiting the grazing period and return interval of livestock) have been found to stimulate germination of seeds existing in the soil. Within a few years this results in greater natural diversity than season-long grazing systems or overgrazing. Managed rotational grazing that leaves adequate plant structure both protects pollinator species in tree rows and increases species diversity in alleyways. More information on managed rotational grazing can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ky/newsroom/factsheets/?cid=stelprdb1101721.

Native tree species are more likely than non-native species to provide habitat for a diversity of insects, including agriculturally beneficial predators and parasitoids. Tree choices that are good for pollinators in the southeast include tulip poplar, sourwood, black locust, basswood, black cherry, persimmon, sourwood, maple, basswood, and black gum. Although pine species are popular choices in silvopasture systems due to fast growth and high timber value, flowering tree species provide more resources for pollinators. Additionally, some flowering trees such as tulip poplar, may have nearly the same growth rate and timber value as pine species. Other tree species that provide a mix of pollinator and timber value include black locust, basswood, black cherry, persimmon, maple and basswood.

Silvopasture Diagram



A portion of a silvopasture alleyway has been disked to prepare the site for natural generation of native plants expected to be in the soil seed bank. Photo by Tom Ward.

Potential pollinator-friendly tall shrubs to include within and between tree rows are: serviceberry, redbud, willow, dogwood, witch-hazel, hawthorn, crab apple, plum, sand cherry, elderberry, mountain-ash, paw-paw, blueberry, sumac, and nannyberry. Potential low shrubs include: paintbrush, bedstraw, salal, huckleberry, blackberry, and raspberry. Potential forbs are too numerous to list.

Alleyways are typically reserved for forage but pollinator habitat can be increased by reserving a portion of the alleyways for pollinator plants. The design for these areas will be similar to a field border designed for pollinators. In systems that tolerate burning, prescribed fire can help rejuvenate understory plants and increase diversity.

Some may prefer a more natural appearance with silvopasture trees in groups. As with the row systems, pollinator habitat can be created with additional plantings or by managing grazing. Livestock may need to be fenced out until pollinator plants are established.

Silvopasture is a good example of an agroforestry practice that can be easily modified to incorporate key elements of pollinator habitat. A multi-functional design will integrate elements of grazing, forestry and pollinator biology. We can learn from some of our most spectacular pollinator habitats- our native prairies- how grazing can help enhance floral diversity, and support not only large grazing mammals, but the bees and other pollinators that help feed us.

Thinning for pollinators and healthier forest communities

Tom Ward, Forester
USDA NRCS East National Technology Support Center

Nancy Adamson, Pollinator Conservation Specialist
Xerces Society/NRCS ENTC

Forests provide an additional opportunity to manage for pollinators. This article explores opportunities to think about pollinators in the context of forest management. Managing existing woodlands or forest stands by thinning and leaving dead wood can be very beneficial for pollinators. While the primary aim of thinning is to grow bigger and higher quality trees, opening the canopy also allows more light to reach understory plants, stimulates flowering, and can greatly enhance forage resources for pollinators. Thinning can also be targeted to improve the growth of canopy trees or understory species that are especially good sources of pollen and nectar. In the southeastern United States, for example, maple, sourwood, basswood, black gum, black locust (where it's not invasive), tulip tree, and magnolia are important pollinator species. Understory pollinator plants that might benefit from the thinning of overstory trees include: serviceberry, redbud, blueberry, huckleberry, holly, azalea (important for spring migrating hummingbirds), black cohosh, and many others. In riparian areas, thinning can be especially important for encouraging regrowth of shrubs and herbaceous plants that improve soil stabilization. Leaving dead wood to provide nesting habitat for bees and other insects (that in turn become food for birds and other forest wildlife), also creates excellent substrate for natural forest regeneration. Rotting logs host some species of native bees and are also hot spots for new seedling growth, with seeds taking root in mosses and fungal hyphae that set the stage for succeeding forest communities. If managed for both timber and wildlife, standing snags provide homes for other cavity nesting species.

Sourwood, *Oxydendrum arboreum*, is a good example of an important nectar and pollen source for pollinators that might benefit from forest management, such as thinning and prescribed burning. Sourwood is most commonly found on dry sites and relatively poor soils, although it occurs on a wide variety of sites. Sourwood is very shade tolerant and often found in the understory or midstory of mature forests. Maximum flower and seed production, however, will be obtained if the sourwood crown is in full sun. Cutting or killing one or more trees that overtop a sourwood tree will likely result in a slow increase in the number of blossoms and seed produced. Sourwood seedlings will germinate and grow on undecomposed leaf litter on the forest floor but prescribed burning to reduce leaf litter will increase the abundance of sourwood seedlings. Thinning to increase the amount of light reaching the forest floor will accelerate the development of any sourwood seedlings that are present. It's possible to increase both the number of blossoms per tree and the number of sourwood trees per acre by carefully thinning and prescribed burning forestland with existing mature sourwood trees.

Bumble bee foraging on sourwood. Photo by Debbie Roos.

Feasting on the forest buffet...er...buffer:

Planting riparian forest buffers for diverse harvests, to support pollinators, and to protect our watersheds

Nancy Adamson, Pollinator Conservation Specialist, Xerces Society/USDA NRCS ENTSC
Katie Trozzo, Doctoral Student, Forest Resources & Environmental Conservation, Virginia Tech

Riparian forest buffers support multiple goals:

- Protection of soils and waterways
- Greater water infiltration into the ground and aquifers
- Conservation of wildlife
- Production of harvestable crops and other products harvestable

Planning a multifunctional riparian forest buffer would stimulate the appetite of even the most well-fed among us—juneberries and mulberries in the spring; black raspberries, blackberries, blueberries, wild plums, and elderberries in summer; persimmons, pawpaws, walnuts, hickories, and hazelnuts in fall. Planting these buffers adjacent to our waterways creates a corridor of food throughout the landscape that can sustain us throughout the seasons and for years to come. Processing the harvest by canning, freezing, and drying can help provide food through the winter and add value to products sold. Much of this harvest depends on or is improved by pollinators. Combining multifunctional plants in riparian buffers ensures there is food and shelter for pollinators through the growing season.

Riparian buffers, perennial vegetation between agricultural fields and waterways, also reduce wind velocity, reduce soil erosion, enhance rain water infiltration, and improve water quality. Plant diversity reduces the risk of disease or crop failure associated with monoculture plantings, and when combined with structural diversity (a mixture of trees, shrubs, and groundcovers), provides a variety of niches for wildlife, including predators and parasitoids that reduce crop pests. We promote natives for conservation plantings because they evolved with wildlife, including insects, and are adapted to local conditions. Including herbaceous perennials in the mix, such as Jerusalem artichoke (which has an edible tuber), or other flowers for cutting or for sale as herbs or medicinals, provides another layer of pollen and nectar sources for insects, and income opportunities for landowners. When adjacent to annual crops, diverse native forest buffers provide refuge for pollinators and other beneficial insects, particularly at times when crops are harvested or managed with insecticides. These diverse buffers can ensure a source of beneficial insects for recolonizing successive crops in nearby fields. Depending on the plants chosen, these buffers can also serve as focal points for hands-on education about regional culture and natural history.

Because of their location in riparian areas, these plants often provide pollen and nectar through the driest parts of the

Left: Leafcutter bee foraging on blackberry. Photo by Nancy Adamson.
Right: A flametwig dogwood within a riparian forest buffer just after establishment. Photo by Katie Trozzo.

growing season, when pollen and nectar may be scarce elsewhere. For the farmer, that available moisture can help ensure fruit, nut, and flower harvest during drought, while at the same time support the pollinators, predators, and parasitoids that improve crop yields.

Some landowners may not have considered multifunctional options, or not be aware of the availability, relatively low cost, and delicious flavor of many of these plants' fruits or nuts. One of our sweetest native fruits, persimmon, has orange and vanilla overtones. Pawpaw has a flavor that hints at banana and pineapple. Honoring its family connections, the custard apple family (*Annonaceae*), pawpaw has the texture of crème caramel (a silky French pudding). Some of these crops are most appropriate for local markets or processing as frozen, canned, or baked goods.

For those interested in promoting this type of planting (or allowing naturally occurring buffers to grow), researchers have looked at landowner perceptions of and willingness to adopt streamside buffer plantings. In a survey of landowners of nonforested streamsides, researchers found that some landowners see riparian conservation and agricultural production as competing objectives (Trozzo et al. 2014). Multifunctional buffers offer a way to bridge these objectives, potentially attracting new landowners to plant. When surveyed, landowners varied in their likelihood to adopt multifunctional buffers, reflecting differences in primary management goals (income or stewardship), current land use, and income level. Tailoring conservation outreach based on specific management goals and other differences could improve adoption.

When planting for pollinators, survey the land for existing pollen and nectar sources and nesting habitat, plant to ensure flowering throughout the growing season. To qualify for financial support through Farm Bill programs, some programs require planting nine flowering species, with three flowering per season (spring, summer, and fall). In warmer parts of the country, include winter-blooming species to support pollinators.

Whatever your management goals, adding diversity and protecting the natural bounty of your land can add to both your bottom line and your belly!

More information can be found in these publications:

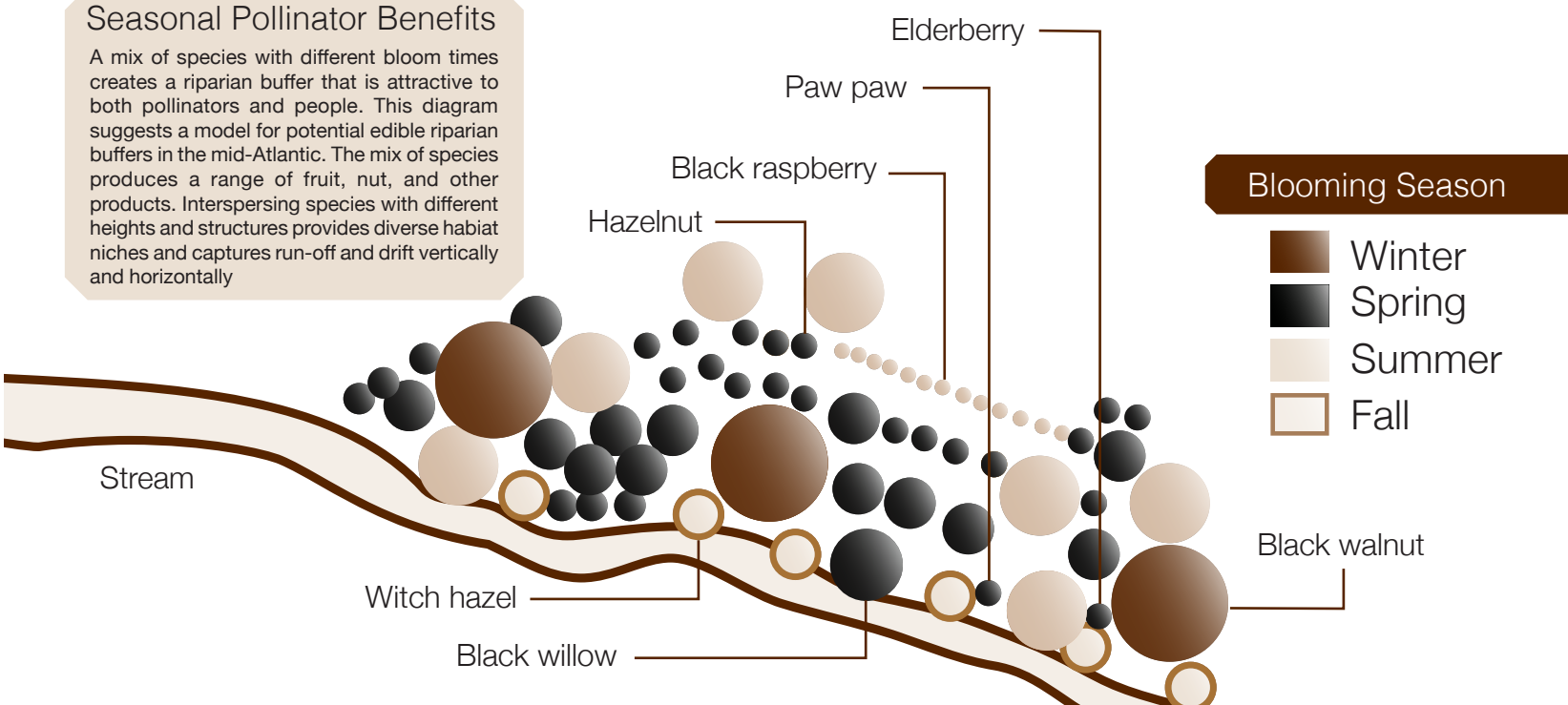
"How to plan for and plant streamside conservation buffers with native fruit and nut trees and woody floral shrubs."
http://pubs.ext.vt.edu/ANR/ANR-69/ANR-69.html

"Potential adoption of agroforestry riparian buffers based on landowner and streamside characteristics."
http://www.jswconline.org/content/69/2/140.refs

To find maps showing species distribution
PLANTS.usda.gov
BONAP.org

Seasonal Pollinator Benefits

A mix of species with different bloom times creates a riparian buffer that is attractive to both pollinators and people. This diagram suggests a model for potential edible riparian buffers in the mid-Atlantic. The mix of species produces a range of fruit, nut, and other products. Interspersing species with different heights and structures provides diverse habiat niches and captures run-off and drift vertically and horizontally



Pollination=Preservation

A Unique Ecotourism Experience in the Nebraska Sandhills

Kat Shiffler, Ecotourism Consultant, Center for Great Plains Studies, University of Nebraska-Lincoln

In recent years, a global conversation has emerged about plummeting numbers of pollinator species. Essential to our environment, the ecological services that pollinators provide are necessary for the reproduction of over 85 percent of the world's flowering plants, including more than two-thirds of the world's crop species, according to the Xerces Society for Invertebrate Conservation. Yet as wild habitat continues to disappear from the landscape, so too do wild pollinators – the native bees, bats, birds and butterflies that are dependent on this floral diversity to survive and thrive.

Fortunately, concerned citizens are doing something about it. One great effort is underway in the Nebraska Sandhills, where landowners are working together to create some "buzz" around the pollinator issue using ecotourism.

The project, Pollination=Preservation, is a joint effort of the Loup Rivers Scenic Byway, the Loup Basin Resource Conservation and Development Council (RC&D), and the Center for Rural Affairs, with the support of the Nebraska Environmental Trust. Participants include over a dozen farmers, gardeners and community groups along the Scenic Byway – Nebraska Highways 11 and 91 – who are creating a mosaic of bio-diverse, visually appealing gardens certified by the North American Butterfly Association (NABA). The Butterfly Byway, as it is also known, will be ready for visitors in the spring of 2015.

In the year leading up to its launch, the Pollination=Preservation organizers held nearly 20 workshops in small towns along the Byway. In community centers and volunteer fire departments across the Sandhills, participants learned about the plight of the pollinators, and were provided with garden design advice and area-specific plant lists and other necessary information for certifying their butterfly gardens. At a meeting this summer in the town of Ord, participants shared flower seeds and a farmer gave away butterfly houses and pollinator nest blocks that he'd made out of scrap wood.

> We know there's been a decline in bee populations, so we are doing everything possible to counter that.

To be certified by NABA, each garden must include native plants useful to pollinators: at least three plants that provide nectar to butterflies and three plants that feed caterpillars. In addition, the gardener must describe a plan to control weeds and pests without harming pollinators, i.e. involving limited and responsible use of pesticides and herbicides.

The gardens are diverse in form, located at private homes, on farms, at schools, businesses and in community spaces. In the community of Taylor, neighbors maintain a butterfly garden adjacent to the visitor information center in an old filling station. The garden in Dannebrog includes a wooded field edge. In addition to native shrubs and forbs, organizers recognize and maintain the tall wooded canopy — including cedar, hackberry, elm, cottonwood, ash, elderberry, chokecherry, and oak – as important habitat for pollinators and beneficial insects.

Kathy and Larry Mostek of Loup City manage Katalari Farms and are participants in the P=P project. In addition to growing pumpkins and Christmas trees, Katalari Farms now

A pollinator garden in Taylor, NE. Photo by Kat Shiffler.

Native carpenter bee on a leadplant in the Sandills of Nebraska. Photo by Kat Shiffler.

features a prominent pollinator garden. "We know there's been a decline in bee populations, so we are doing everything possible to counter that," says Kathy. In between the rows of squash, the Mosteks put up native bee and butterfly houses. "Because without the bees we don't have any produce."

P=P participants know that pollinators need nesting habitat and diverse forage resources to thrive. This involves planting field edges and pond margins, incorporating native plant hedgerows or windbreaks with shrubs and turning non-crop land into flowering pastures. The Mosteks are currently investigating cost-sharing options to convert several acres to wildflowers. As they've seen, pollinator habitat not only improves the yield of some crops, but also provides habitat for birds, beneficial insects and other wildlife that help control pests and reduce crop losses.

The ecotourism component seemed like a natural fit for their business that already includes a greenhouse and gift shop. "It's one more way to bring customers to our business," says Kathy. The couple has plans to incorporate sculpture and art into the garden as well as create a butterfly pavilion.

"Promotion of the pollinator gardens could spread the idea among the thousands of visitors already coming to the area, and perhaps create many more islands of safe habitat for native pollinators across the state and across the country," said Wyatt Fraas, of the Center for Rural Affairs, one of the project coordinators.

In November, the Loup Rivers Scenic Byway became a founding member of the Great Plains Ecotourism Coalition (GPEC), a group coordinated by the University of Nebraska-Lincoln's Center for Great Plains Studies. The GPEC includes both non-profit and for-profit members and works to connect members to each other and to the relevant research and expertise of the University. In addition, the Coalition works on creative regional marketing. The Pollinator=Preservation project is featured in one of the 12 posters in the Coalition's kick-off graphic arts campaign. The Butterfly Byway and other posters are aimed at drawing new attention and enthusiasm for natural attractions and ecotourism opportunities of the Great Plains.

While tourists can visit the network of pollinator gardens for free, the hope is that they will bring tourist dollars to participating rural communities and the region as a whole. This is the promise of ecotourism, a form of travel that deepens one's engagement with nature, conserves the environment, and improves the well-being of local communities.

Zaagkii

The Earth's Gifts bestowed upon Michigan's Upper Peninsula Landscape

Jan Schultz
Program Lead: Botany, Nonnative Invasive Species and Special Forest Products
Eastern Region Regional Office,
US Forest Service

People have shown appreciation for their natural resources in many ways, but not all languages succinctly express a deep spiritual connection. The Anishinaable word "zaagkii," however, seems to do just that. Translated as "the loving gifts which come from the earth," the term was suggested by Ojibwa Keweenaw Bay Indian Community elders as a helpful way to frame the collaborative efforts of the Zaagkii Wings and Seeds Project. This project encompasses a number of botanical topics and endeavors including crop wild relatives, special forest product production, long term biodiversity and genetic preservation, food security, and climate change. These efforts often tier to traditional ecological knowledge (TEK) of agroforestry and may also contribute to future work with other agroforestry practices, especially multi-story cropping.

Leaders of five of Michigan's federally recognized tribes have now passed five resolutions concerning the project. Michigan tribes formally entering into this partnership include the: Sault Ste. Marie Band of Chippewa Indians; Lac Vieux Desert Band of Lake Superior Chippewa Indians; the Keweenaw Bay Indian Community; Bay Mills Chippewa Indian Community; and Hannahville Indian Community. Combined, these Native American communities oversee a total of over 70,000 acres of tribally managed lands. The Wings and Seeds Project was coordinated over the last seven years across Michigan's Upper Peninsula by the USDA Forest Service Eastern Region in partnership with the nonprofit Cedar Tree Institute and Northern Michigan University's Center for Native American Studies. The common language of these resolutions read that the area's five tribes "desire to join in partnership the Hiawatha and Ottawa National Forests and other Native American communities in Northern Michigan to further work with the Zaagkii (Wings and Seeds) Project in recovering native plants, encouraging pollinator protection, and restoring threatened ecosystems."

The Zaagkii Project includes the following efforts:

- Habitat restoration using native plants and native pollinators. Keweenaw Bay Indian Community's (KBIC) new Native Plants Greenhouse is a central accomplishment toward the tribe's considerable restoration targets. With a geodesic dome design, the structure is used to propagate native plants for tribal plant restoration projects and beyond. The site also functions as a training site for botanical technology transfer workshops. Examples of locally native plants produced include: black-eyed Susan; coreopsis; liatris; evening primrose; oxeye; and many more. The KBIC Natural Resources Department is also monitoring for bumblebees at this site.
- Ethnobotany and the recovery and protection of traditional knowledge involving locally native plants are core components of the project. To this end, over 100 hours of ethnobotanical interviews with Northern Michigan University's Center for Native American Studies students and 24 Ojibwa elders from five tribal communities have been conducted.
- The Keweenaw Bay Indian Community of Baraga County in Michigan's Upper Peninsula hosted a first ever Zaagkii Cranberry Crop Wild Relative (CWR) Workshop for partnering efforts

2012 Zaagkii project volunteers. Photo courtesy of the Cedar Institute.

among KBIC, the Forest Service Eastern Region, the USDA Agricultural Research Service (ARS), and the Chicago Botanic Garden. CWRs are wild plants related to socio-economically important plant species and have contributed many useful genes to crop plants. Modern varieties of most major crops now contain genes from their wild relatives. The ultimate goal of the group's cranberry project is to conserve the range of genetic variation in wild cranberry, starting with populations on National Forests and potentially on tribal lands also. There are also efforts underway concerning other crop wild relatives such as blueberries and sunflowers. These collective efforts help increase "food security" as our climate continues to change.

- Workshops, trainings and technology transfer gatherings are hosted by each tribe and are scheduled several times each year. Participation is open to tribal members and non-tribal members who work for or with tribal agencies. These efforts are intended to provide and increase various botanical technology transfer opportunities and skills and have included such topics as: native plant propagation; seed collection, cleaning and storage, invasive plant identification, crop wild relative (CWR) collection protocols, plant taxonomy, special forest products and much more.

This project celebrates the loving gifts the come from the earth by focusing on the restoration, rehabilitation and cultivation opportunities through the use of native plants. Participants are very hopeful that this partnership will also increase the cultivation of valuable and useful native understory forest products such as ginseng, goldenseal, wild leeks, and the many other bulb and tuber-producing native perennials that can be produced in a multi-story cropping system. Future work will also explore the opportunities in the cultivation of native nut and berry species such as hazelnuts, blueberries, elderberries and so many more. Through this partnership, a diverse assemblage of ecological knowledge is being applied to natural resource management and the production of many native plant products. While the term agroforestry has not been specifically employed to describe Zaagkii activities, these efforts integrate forest and crop production with consideration for native foods and pollinators. These efforts provide valuable lessons about how to best restore, manage, and sustainably gather gifts bestowed by the earth.

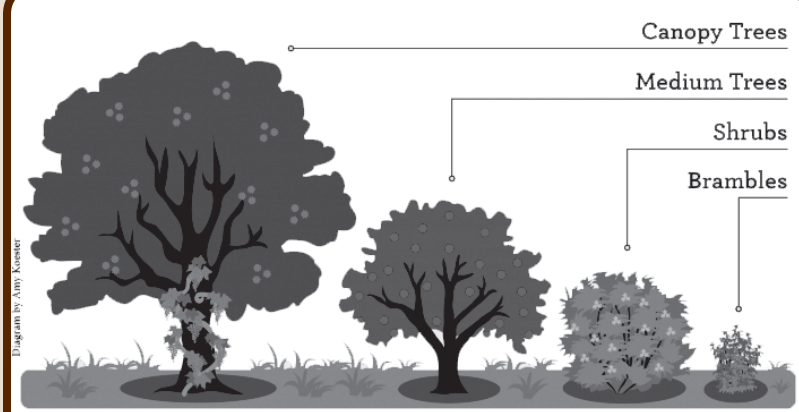
To learn more about specific activities regarding the Zaagkii Project please visit the links provided:

Celebrating Wildflowers – a number of articles on Zaagkii Projects and crop wild relatives: http://www.fs.fed.us/wildflowers/

Zaagkii Wings and Seeds Project: http://wingsandseeds.org/

Continued From Page 3

major plant functional groups, and rarely include the native plants that coevolved with rare and threatened pollinators and herbivores. Agroforest management practices differ substantially from the disturbance regimes that many of those plants and insects need (for example, oak savannas are fire-driven ecosystems). However, surrounding remnant and restored forests and savannas with medium habitat-value land-uses like WPP could mitigate edge effects, ease movement between high-quality remnants, and host some stable populations of insects not found in annual monocultures. While WPP plantings are not effective substitutes for traditional oak savanna restoration, they could become a useful element in the conservation toolbox at the regional scale.



Six Plant Layers of a Savanna-Based Woody Perennial Polyculture

Diagram by Amy Koester

Did you know?

The Woody Perennial Polyculture site is six acres, formerly managed in conventional corn-soy rotation. It is divided into eight blocks, four of which are still managed in corn-soy, and four of which include a diverse mix of perennial crops, the WPP experimental treatment. Each WPP plot consists of six tree rows separated by hay alleys (four cool-season grasses and two clover varieties). The tree rows alternate between hazelnut-raspberry rows with apple-grape pairs spaced throughout, and red currant-black currant rows with chestnut-grape pairs, and have a white clover ground cover.

Research includes biogeochemical cycling of carbon and nitrogen, assessment of economic variables like labor input and yield, and broad-spectrum sampling of insect biodiversity. The data will create a picture of how insect communities change and grow during the transition from annual crop to a diverse agroforest system.

Visit http://wppresearch.org/ *to learn more about the site, the theory behind it, and current research. Check out the Media section to see the site and the research in action.*

Pollinator Conservation in Pacific Islands Agroforestry

By Eric Lee-Mäder, Xerces Society for Invertebrate Conservation, Portland, OR, USA
Jolie Goldenetz-Dollar, Research Forester, American Samoa Community College

Pollinator conservation in the Pacific Islands Region offers a few challenges not found in the mainland United States. Among these are scarce commercial availability of native plants for habitat restoration, small land holdings that require farmers to maximize their land's crop production potential, and limited pollinator biodiversity (for example only one genus of bees is native to the Hawaiian islands).

All of these challenges can be met by integrating pollinator conservation throughout the entire farm. In particular, crop diversity, multi-level forest farming, and dual-use plants (those that produce crops and support wildlife) offer opportunities to sustain pollinators and farm profits.

Multi-Story Farming

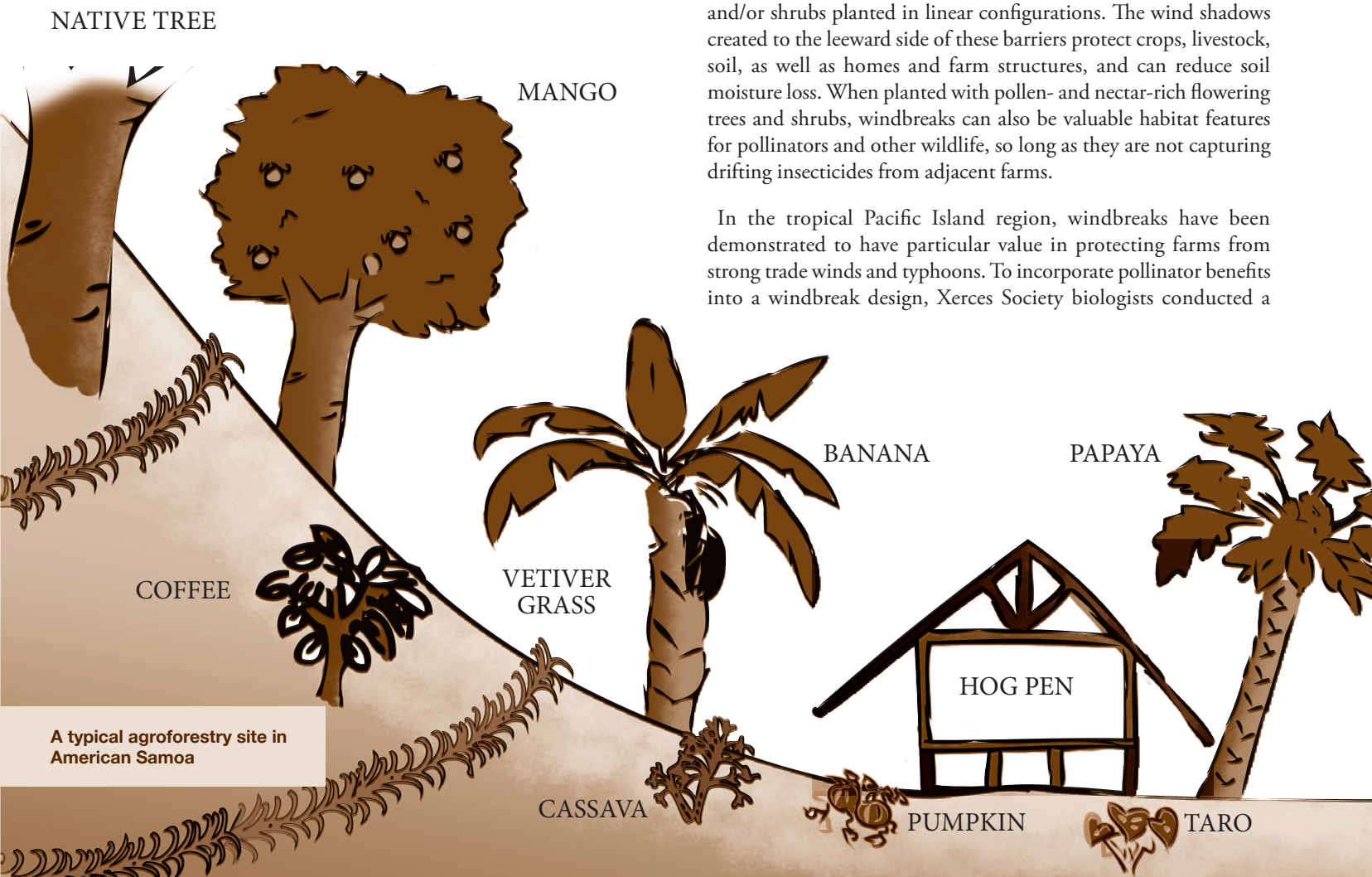
Multi-story farming is a common practice among farmers in the tropical Pacific Island region. Using this farming approach, existing or planted stands of trees and shrubs are managed as an overstory with an understory of woody and/or non-woody plants that are grown for a variety of products. Typically overstory tree-to-tree distance is wide enough to let sufficient light through to understory or groundcover plants.

A model multi-story agroforestry system designed by the Xerces Society, foresters at American Samoa Community College, and the Natural Resources Conservation Service for the Pacific Islands recommends an overstory of pollinator-attractive trees such as macadamia (*Macadamia spp.*), avocado (*Persea americana*), neem (*Azadirachta indica*), 'Ōhi'a lehua (*Metrosideros polymorpha*), or mango (*Mangifera spp.*), and an understory of shade-tolerant pollinator-dependent plants such as coffee (*Coffea spp.*), cacao (*Theobroma cacao*), vanilla (*Vanilla planifolia*), or cardamom (*Elettaria spp.* and *Amomum spp.*). In such combination plantings, the diversity of species provides extended bloom periods for pollinators, as well as more complex vegetative structure for nesting by leafcutter bees, carpenter bees, and other insects.

Insectary Windbreaks

Windbreaks consist of one or more rows of closely spaced trees and/or shrubs planted in linear configurations. The wind shadows created to the leeward side of these barriers protect crops, livestock, soil, as well as homes and farm structures, and can reduce soil moisture loss. When planted with pollen- and nectar-rich flowering trees and shrubs, windbreaks can also be valuable habitat features for pollinators and other wildlife, so long as they are not capturing drifting insecticides from adjacent farms.

In the tropical Pacific Island region, windbreaks have been demonstrated to have particular value in protecting farms from strong trade winds and typhoons. To incorporate pollinator benefits into a windbreak design, Xerces Society biologists conducted a



A typical agroforestry site in American Samoa

An agroforestry site in Vatia Village on the island of Tutu'ila in American Samoa. With assistance from NRCS EQIP, the site was cleared of invasive and undesirable plants. Desirable overstory trees such as mango, avocado, breadfruit, and citrus were left. With help from the Forestry Extension Program at American Samoa Community College, the landholder is planning to install additional overstory trees and understory plants.

review of windbreak species recommended by the NRCS Molokai Plant Materials Center to identify which trees offer potential pollinator value. This process highlighted the value of gliricidia (*Gliricidia spp.*), avocado (*Persea americana*), dwarf banana (*Musa spp.*), kou (*Cordia subcordata*), milo (*Thespesia populnea*), mango (*Mangifera spp.*), tree-like varieties of hibiscus (*Hibiscus spp.*), and coconut (*Cocos nucifera*) as recommended species. In providing design recommendations to farmers, Xerces and USDA biologists note the value of including multiple tree and shrub species to provide more continuous floral resources, as well as to enhance nesting resources for pollinators. Multi-species windbreak designs may also increase their effectiveness by improving windbreak density at multiple heights.

More Information

- Molokai NRCS Plant Materials Center presentation: Windbreaks for Agroforestry http://www.plant-materials.nrcs.usda.gov/pubs/hipmssy6712.pdf
- University of Hawaii Extension publication Trees and Shrubs for Windbreaks in Hawaii http://www.ctahr.hawaii.edu/oc/freepubs/pdf/C1-447.pdf
- Shade-Grown Coffee for Hawai'i: Results of a twelve farm study in Kona http://agroforestry.net/projects/hawaii-coffee-agroforestry-systems

Susan Schultz
Education & Stewardship Specialist
National Association of Conservation Districts

The National Association of Conservation Districts (NACD) developed the "Local Heroes – Your Hardworking Pollinators" education materials project. The NACD Stewardship & Education Foundation committee has a five-year rotation of topics that are developed into educational materials each year. These materials are geared for students in grades K-8. This is the first year for pollinator materials; and NACD is now working on the 2016 project focusing on forestry. Assisting in the pollinator project are: The Pollinator Project (pollinator.org); United States Department of Agriculture (USDA); and conservation district staff around the nation.

NACD is celebrating its 60th year of Soil and Water Stewardship This year, it's scheduled for April 26 - May 3. Outreach is continued throughout the year in various forms by local conservation districts and other educators.

Visit the NACD education pages to find materials related to pollinators including free student worksheets, an educators guide with information on additional resources, next generation science standards, literature connections and more.

Visit www.nacdnet.org/education/resources *for our complete list.*

- USDA – NRCS Pollinators & Plants www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/
- USDA Forest Service - Pollinator Resources: www.fs.fed.us/wildflowers/pollinators/
- Pollinator Partnership – Eco-Regional Planting Guides and more: http://pollinator.org
- Additional Pollinator resources are located in the NACD Local Heroes – Your Hardworking Pollinators educators guide found at: www.nacdnet.org/education/resources/local-heroes

Illustration by: Jolie Gldenetz-Dollar & Joseph Banegas

Forest Farming:
Pollinators and Native Medicinals

**Anne Stine, Pollinator Conservation Specialist, Central Region,
NRCS Partner Biologist, The Xerces Society for Invertebrate Conservation**

In most forest farming systems, crop pollinators are something of a mystery. This article explores the pollination ecology of forest farming through the examples of three high-value medicinal plants from the eastern temperate forest: American ginseng (*Panax quinquefolius*), goldenseal (*Hydrastis canadensis*), and black cohosh (*Actaea racemosa*). All three species have similar habitat requirements and can be cultivated together in a mixed system.

These three crops have the potential to provide a large supplemental income. In August of 2013, producers could sell ginseng for up to $1200 per dried pound, more than four times the price of silver. Meanwhile, goldenseal averages $30 per dried pound, while black cohosh sells for a more modest $6 per pound. 'Wild' or 'wild-simulated' products are more highly valued than intensively cultivated crops. When developing a patch of wild-simulated plants, after the initial seeding and site preparation no more maintenance is required until harvest 6 to 10 years post establishment.

There are a number of reasons beyond profits to grow these medicinal crops. Forest farming of medicinal plants can help ease pressure on threatened and declining wild populations. Goldenseal is in decline, imperiled, or endangered in all of the 27 states to which it is native, yet in 2010, 77% of collected goldenseal was wild-harvested. In the case of another valuable forest medicinal, black cohosh, 99% of the world's supply is wild-harvested.

While the biggest threat to ginseng growers is poaching, there is evidence that this high-value species is also pollen limited.

While the biggest threat to ginseng growers is poaching, there is evidence that this high-value species is also pollen limited, meaning that a ginseng plant's reproduction efforts are capped by not receiving enough pollen. Ginseng suffers because it has been harvested to the extent that it is now somewhat uncommon in the wild. This makes outcrossing less likely to occur. Inbred

plants are smaller than outcrossed individuals. Additionally, fruit production per flower increases with population size, possibly because larger patches are easier for pollinators to find. While the jury is still out on whether all forest understory perennials are pollen limited, there is evidence that outcrossing by native pollinators produces healthier plants. Outcrossing occurs when the ginseng plant receives pollen from another (not closely related) individual. The opposite of outcrossing is 'selfing'.

The primary spring pollinators in eastern temperate forests are small generalist bees and bumble bee queens. Ginseng, goldenseal, and black cohosh are all pollinated by generalist sweat bees and syrphid flies, while black cohosh has also been observed to attract bumble bees. These three plant species can self-pollinate, outcross, or reproduce vegetatively, and they tend to have a somewhat clumped distribution across a landscape. Their reproductive characteristics combined with clumped populations help these plants avoid reproductive failure.

Sweat bees, the best pollinators of these forest crops, overwinter underground. In the spring they emerge and dig nests in the soil which they then provision with pollen for their offspring. These bees are not very picky about the pollen they gather. Adults collect pollen from a variety of plants and are only limited in their selection by the shape of their mouth parts. Sweat bees have short tongues and prefer to feed on the easily reached nectar of shallow flowers.

Syrphid flies overwinter as pupae in the litter layer. Approximately 40 percent of syrphid fly species feed on aphids and other garden pests in their larval stage before metamorphosing into nectar-feeding adults. The remainder show a remarkable diversity of feeding behaviors- from snorkeling in stagnant water to consuming detritus on the forest floor. Similar to sweat bees, and for similar reasons, syrphid flies prefer shallow flowers. Syrphid fly mouthparts do not grant them access to flowers with longer tubes.

There are many ways to boost pollinator populations in your forest. Sweat bees and syrphid fly populations both increase with wildflower availability. Sweat bees also need bare soil in which to dig their nests. Because sweat bees and syrphid flies overwinter in or on the ground, tillage can damage dormant populations. Insecticide use can also be detrimental. In summary, sweat bee and syrphid fly populations can be increased by planting additional wildflowers (especially shallow flowers with readily accessible nectar), avoiding tillage and pesticide use, and allowing areas of litter and bare soil to remain undisturbed overwinter. Providing for these pollinators can help support the growth and reproduction of a variety of forest farmed crops.

Black Cohosh

Inside Agroforestry VOLUME 23, ISSUE 2

USDA National Agroforestry Center
1945 N 38th St.
Lincoln, NE 68583–0822

Official Business
Penalty for Private Use, $300

Address Service Requested

PRSRT STD
POSTAGE & FEES
PAID
USDA — FS
PERMIT NO G-40

Upcoming Events

For more upcoming events, visit our website calendar: http://nac.unl.edu/events/index.htm

April 10-13, 2015
Woody Agriculture: Theory and Hazelnut Practices
Lanesboro, MN
http://badgersett.com/news/events/2015/shortcourse.html

April 11, 2015
Agroforestry Workshop
Columbia, MO
http://www.centerforagroforestry.org/events/2015AgroforestryWorkshop.pdf

April 24 or April 25, 2015
Silvopasture Works
Andalusia, AL
https://mell-base.uce.auburn.edu/wconnect/CourseStatus.awp?&course=C150424

May 20-21, 2015
Agroforestry Workshop
Topeka, KS
Email: kfu.mary@gmail.com

May 30-June 2, 2015
North American Agroforestry Conference
Ames, IA
https://web.extension.illinois.edu/registration/?RegistrationID=11440

July 24-28, 2015
Silviculture and Agroforestry Training
Ithaca, NY
http://fingerlakespermaculture.org/?page_id=3239

USDA National Agroforestry Center

"Inside Agroforestry" is published by the USDA National Agroforestry Center. Phone: 402-437-5178; Fax: 402-437-5712.

- **Susan Stein,** NAC Director
- **Michele Schoeneberger,** FS Research Lead (ext. 4021)
- **Richard Straight,** FS Lead Agroforester (ext. 4024)
- **Vacant** - NRCS Lead Agroforester
- **Kate MacFarland,** FS Assistant Agroforester (ext. 4012)
- **Joseph Banegas,** Information Assistant/ "Inside Agroforestry" Designer (ext. 4014)

http://nac.unl.edu

Mission

The USDA National Agroforestry Center (NAC) is a partnership of the Forest Service (Research & Development and State & Private Forestry) and the Natural Resources Conservation Service. NAC's staff is located at the University of Nebraska, Lincoln, NE. NAC's purpose is to accelerate the development and application of agroforestry technologies to attain more economically, environmentally, and socially sustainable land use systems by working with a national network of partners and cooperators to conduct research, develop technologies and tools, establish demonstrations, and provide useful information to natural resource professionals.

Policy

Opinions expressed in "Inside Agroforestry" are those of the author and do not necessarily represent the policy of the USDA Forest Service and the USDA Natural Resources Conservation Service. The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD). To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free 866-632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at 800-877-8339 (TDD) or 866-377-8642 (relay voice). USDA is an equal opportunity provider and employer.