



Seeding for Monarchs, Pollinators and Living Snow Fence

Mark O'Brien
Area Manager, Nursery

March 8th 2017

Objective:

- > Seeding roadsides with plant species that benefit pollinators and provide wind resistance to effect snow placement.



Pollinators

- > Animals pollinate approximately 75 percent of the crop plants grown worldwide for food, fiber, beverages, condiments, spices, and medicines. It has been calculated that one out of every three to four mouthfuls of food we eat and beverages we drink is delivered to us by pollinators.
- > There is clear evidence of recent declines in both wild and domesticated pollinators, and parallel declines in the plants that rely upon them.
- > Researchers cited 139 counties as especially worrisome, with wild bee numbers decreasing while farmland for crops dependent on such pollinators is increasing.
- > The counties included agricultural regions of California such as the Central Valley, as well as the Pacific northwest, the upper Midwest and Great Plains, west Texas and the southern Mississippi river valley.

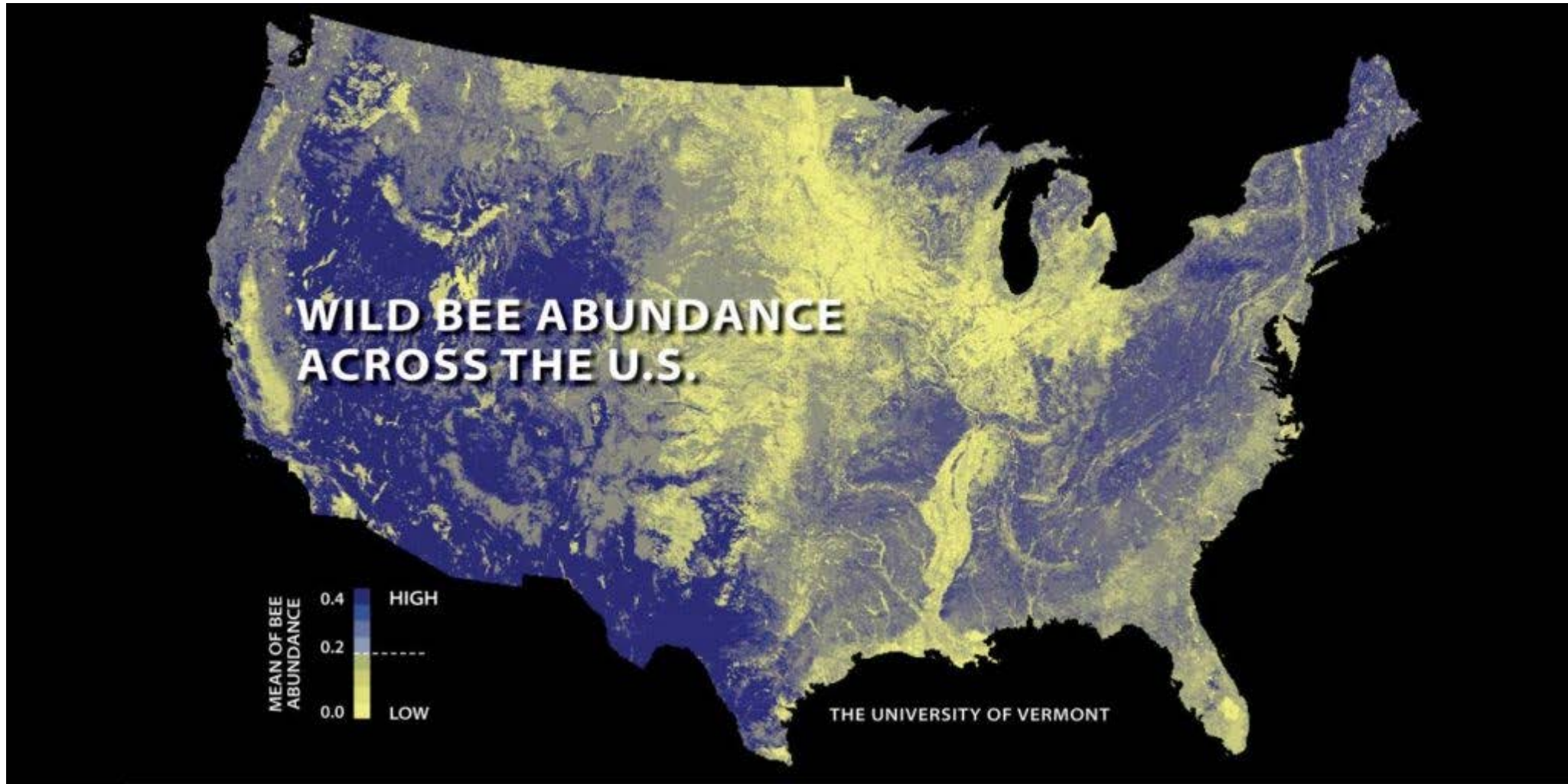


Pollination Facts

- > In 2016 California had 1.1 million acres in almond production. 890,000 in nut production and 220,000 in young trees.
- > In 2011 the almond industry in California is a \$3.5 billion business.
- > California produces an estimated 1.85 billion pounds of shelled almonds annually. That is 75% of the worlds supply.
- > Production is increasing an estimated 13% per year.
- > Pollinators (bees) account for an estimated 30% of the cost of almond production.
- > Pollinators (bees) are the biggest concern for limiting the increased production of almonds.
- > Bee hive rental prices have doubled in the past few years.
- > The almond industry has invested millions of dollars into pollinator research.
- > Native plants, habitat and native pollinators play a role in this solution.



Pollination – Wild Bee Map



Possible causes of pollinator declines

- > The loss of basic habitat requirements in our landscapes such as floral resources other than flowering crops that provide food to pollinators. The loss of other basic needs such as nesting sites and materials may also contribute to the problem.
- > The simplification of the landscape with the promotion of monoculture crops, larger fields and less traditional features such as hedgerows, set-aside land and wildflower rich grassland. This results in less of the food and nesting resources occurring in landscapes and the isolation of resource-rich semi-natural habitats.
- > The intensive use of agro-chemicals including pesticides that may have a direct affect on insect pollinators, and herbicides that remove important floral resources.
- > Pests and diseases affecting domesticated pollinators such as honey bees and which may spread to wild populations.
- > Over-reliance on domesticated honey bees for pollination which may compete with wild pollinators for scarce resources.



What we know

- > Within a certain radius, if you have more natural habitat you have more bees
- > Native bees make a big difference. A study published in the journal Science in 2016 found that wild pollinators significantly increased yield in 41 different cropping systems around the world—from coffee to cotton—whether honeybees were there or not. In contrast, honeybees enhanced yields in just one-seventh of those cropping systems. Other studies have documented that honeybees become even more effective pollinators when wild bees are present, leading to more and better fruit.
- > Amid growing recognition of this value, some farmers, especially in agriculturally dense areas, are experimenting with planting flowers along field edges and on unused land in an attempt to attract and support native bees and, in turn, honeybees. Ultimately, **“Native bee management is really habitat management.”**



The Integrated Crop Pollination Project

- > <http://icpbees.org>
- > Every spring in the United States, bees pollinate crops valued at about \$14 billion.
- > A Michigan State University professor and a team of scientists are using a five-year, \$8.6 million grant from the United States Department of Agriculture to keep this winged workforce operating efficiently.
- > Almonds, strawberries, apples, cherries, blueberries, raspberries, watermelon, cucumbers and more depend on bees to help maximize yields. But with wild honey bee populations decimated by varroa mites and other threats, farmers are dependent on beekeepers to deliver managed colonies of honey bees during peak pollination to ensure their flowers are pollinated.



Honey Bees

- > Honey Bees (*Apis mellifera*) are commonly managed or rented for blueberry pollination.
- > Honey bees are easy to manage and transport, and provide many active pollinators per hive.
- > A 6–8 frame colony will have around 15,000–20,000 pollinating bees.
- > Hives are typically placed at a rate of 2–4 hives/acre when the crop reaches 5–10% bloom, and are removed from fields at petal fall.



Bumble Bees

- > Bumble Bees (*Bombus* spp.) are highly efficient blueberry pollinators.
- > There are at least 7 species of wild bumble bees that pollinate Michigan blueberries, and one species that is commercially available.
- > A single colony of bumble bees has around 25–400 bees.
- > Because of their large body size, bumble bees can fly at lower temperatures than honey bees, making them ideal pollinators in typical early spring weather.
- > Commercial colonies can be as effective as honey bees if enough are used, but blueberry fields with high honey bee stocking will have limited gain from the additional expense of bumble bees.



Miner Bees

- > Miner Bees (*Andrena* spp.) are solitary bees that nest in the soil.
- > Several species are excellent blueberry pollinators, including one species that exclusively visits blueberry flowers.
- > These bees are generally only active in spring when blueberry and other fruit crops are blooming.



Carpenter Bees

- > Carpenter Bees (*Xylocopa* spp.) resemble large bumble bees but with shiny rather than hairy abdomens.
- > Carpenter bees excavate nesting tunnels in wood. Like bumble bees, their large size allows them to visit flowers on cool, cloudy days.
- > Carpenter bees often cut a slit in the side of blueberry flowers in order to access the nectar, allowing honey bees to do the same in later visits.
- > Nectar robbing bees still transfer some pollen between flowers, meaning that this practice can contribute to rather than take away from total pollination; however, when nectar robbing by honey bees begins to approach half of all honey bee visits, blueberry seed and fruit set are reduced.



Other Wild Bees

- > There are many other kinds of wild bees, including sweat bees, mason bees, and plasterer bees, that pollinate blueberry flowers. Some of these bees live in the soil, while others live in above ground cavities and tunnels excavated from plant stems (including old blueberry canes) and wood. For more information on the biology and conservation of wild bees of Michigan, visit <http://bit.do/wildbeesMI>.



Salix humilis – Prairie Willow

- > **Faunal Associations:** The catkins of Prairie Willow attract primarily small bees and flies, including Cuckoo bees (*Nomada spp.*), Halictid bees (*Halictus spp.*, *Lasioglossum spp.*), Andrenid bees (*Andrena spp.*), Syrphid flies, Calliphorid flies, Muscid flies, and others. Among the Andrenid bees, the following species are specialist pollinators (*oligoleges*) of willows (*Salix spp.*): *Andrena bisalicis*, *Andrena erythrogaster*, *Andrena fenningeri*, *Andrena illinoiensis*, *Andrena mariae*, and *Andrena salictaria*. These insects seek nectar and pollen from the florets of the catkins. Many other insects feed on the foliage, bore through the wood, or suck plant juices from willows. The following leaf beetles have been observed to feed on Prairie Willow: *Chrysomela knabi* (American Willow Leaf Beetle), *Chrysomela lineatopunctata*, *Chrysomela scripta* (Cottonwood Leaf Beetle), *Crepidodera decora*, *Crepidodera nana*, *Cryptocephalus leucomelas*, and *Disonycha alternata* (Striped Willow Flea Beetle). The Prairie Willow is also the preferred host plant for the leafhopper *Empoasca humilis*. Other insect feeders include the larvae of wood-boring beetles, weevils, the larvae of gall flies, plant bugs, stink bugs, aphids, the larvae of sawflies, and the caterpillars of many moths. Caterpillars of the butterflies *Satyrium acadicum* (Acadian Hairstreak) and *Limenitis archippus* (Viceroy) feed on the leaves of willows, as do the caterpillars of the skipper *Erynnis icelus* (Dreamy Duskywing). Among vertebrate animals, such birds as the Ruffed Grouse and White-Crowned Sparrow feed on the buds and catkins of willows. Other birds, such as the Northern Harrier, Wilson's Warbler, Yellow Warbler, American Goldfinch, Gray Catbird, and Willow Flycatcher, often construct their nests in willow thickets. The twigs and leaves are often browsed by White-Tailed Deer and Elk.
- > **Lythrum salicaria** (purple loosestrife) Faunal Associations: The flowers attract long-tongued bees and butterflies, including *Bombus spp.* (Bumblebees) and the butterfly *Pieris rapae* (Cabbage White). The seeds are too small to be of any interest to birds, and it is unclear to what extent mammalian herbivores feed on the foliage.

Salix species – Willow



Living Snow Fence Advantages

> Cost effective

- Seeding and planting and area is about the same cost as building a structural wooden snow fence. Seeding and planting est. \$1,500 to \$ 2,500 per acre

> More attractive

- Flowering plants and trees, fall color and winter interest.

> Provides habitat

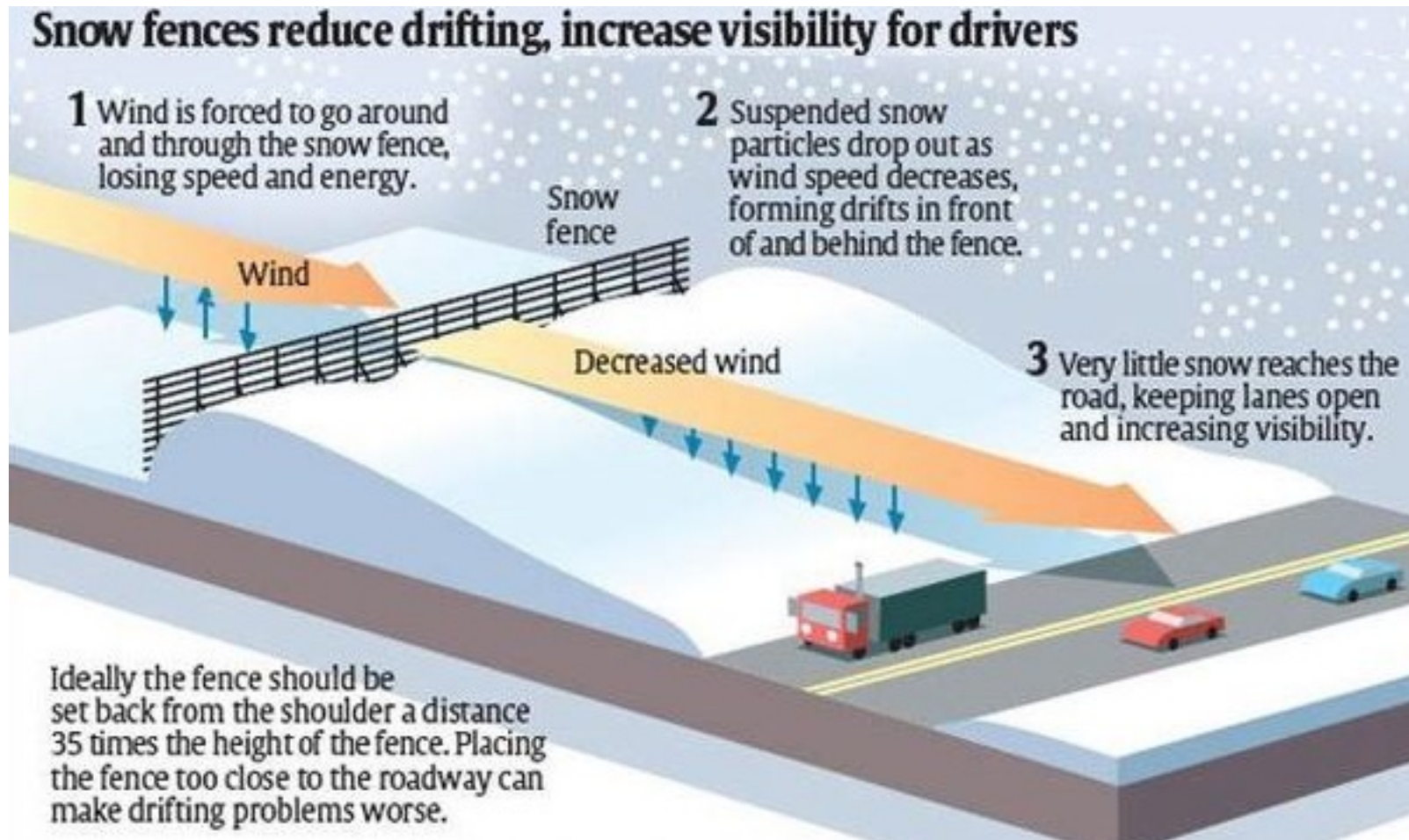
- Planting groupings of native plants can offer nesting areas and food sources for the pollinators that are critical to our food production.



Snow Fence Basics

- > The role of a snow fence is to reduce the wind speed.
- > A turbulent zone is created at a greater height than the fence, causing blowing snow to fall behind the barrier. At that point snow particles bind together to cause a drift.
- > In general snow starts to drift at 15 mph.
- > In winds less than 20 mph, 90% of the blown snow stays below 4 ft.
- > In winds of less than 45 mpg, 70% of the blowing snow remains below 4 ft.
- > Drifts will be down wind of the snow fence.
- > Know the direction of the wind. Meteorological data is available. Location signs like bent trees and fence posts can offer clues.
- > A general rule of thumb is the fetch distance should be 35 times the height of the fence.

Snow Fence



Late September and the following February



Late September and the following February



Combination of grasses and forbs stays upright longer in the winter

Late September and the following February



Diverse mixture of forbs and grasses provides food and cover

Stalks and stems needed to add support to the grasses



Stems and seed heads



Stems and seed heads provide food habitat and wind resistance

Shrub row with correct setback



Corn rows



Standing corn six to eight rows. Most effective strategy is to use two strips separated by 150 to 200 ft.

Corn rows



Corn rows tend to store the snow within the rolls

Stored snow can aid in moisture retention



Tall Rigid Native Forbs That Benefit Pollinators

Asclepias syriaca – 2-4' Jun-Aug

Echinacea pallida – 2-5' May-Aug

Eryngium yuccifolium – 3-5' Jul-Sept

Lespedeza capitata – 2-4' Jul-Sept

Oligoneuron rigidum – 2-5' Jul-Oct

Penstemon digitalis – 2-4' May-Jul

Senna hebecarpa – 3-5' Jul-Aug

Silphium laciniatum – 3-8' Jun-Sept

Silphium terebinthinaceum – 3-8' Jun-Sept

Symphoricarum laeve – 3-5' Aug-Oct

Coreopsis tripteris – 4-8' Aug-Sept

Echinacea purpurea – 3-4' Jun-Aug

Eupatorium serotinum – 2-5' Jul-Oct

Monarda fistulosa – 2-5' Jul-Sept

Parthenium integrifolium – 2-3' Jun-Sept

Rudbeckia subtomentosa – 3-5' Aug Sept

Silphium integrifolium – 2-6' Jul-Sept

Silphium perfoliatum – 3-10' Jul-Oct

Solidago speciose – 2-6' Jul-Oct

Verbesina alternifolia – 3-7' Jul-Oct

Native Shrubs That Benefit Pollinators

- > American Plum (*Prunus americana*)
- > Arrowwood (*Viburnum dentatum* & spp)
- > Buttonbush (*Cephalanthus occidentalis*)
- > Elderberry (*Sambucus canadensis*)
- > Ninebark (*Physocarpus opulifolius*)
- > Silky Dogwood (*Cornus amomum* v. *schuetzena* & spp)
- > Spicebush (*Lindera benzoin*)



Detailed Site Inspection

- > Current vegetation will give insight into the species that will work and site preparation needed
- > Soil types also determine what species to use and the rate of establishment
- > Soil pH will dictate what species will have a better chance of long term success
- > Compaction will effect germination and the rate of growth
- > Exotic species will need to be controlled
- > Surrounding vegetation will infringe on the site in time
- > Vantage points should be considered on high profile projects
- > Slopes need to be protected from erosion
- > Safety is always a concern.



Seeding Guidelines

- > What's the budget?
- > The site conditions should dictate what species to use
- > Determine a diverse mixture of natives with staggered bloom times.
- > Specify regional geno-type
- > Require pure live seed (PLS)
- > Sow at a rate of 30 to 60 seeds per square foot.
- > Proper site preparation.
- > Optimal seeding time Oct. 1st to June 15th.
- > Maintenance is critical
- > Cover crop is recommended

Seed Basics

- > Purchase quality Pure Live Seed (PLS)
- > Native seeding rate is 30 to 60 seeds per sq. ft.
- > Use a cover crop of oats and annual rye
- > The site will determine what species to use



Cover Crops

- > Cover crops provide quick coverage, offer limited erosion control and are used as a carrier for native seed.
- > *Avena sativa*, Common Oat – Germinates quickly 4-8 days - best used in spring as might rot over winter. More effective in upland plantings. We use a rate between 360 and 580 oz. per acre (8,125 seeds per oz.). Inexpensive .80 cents per lb.
- > *Lolium multiflorum*, Annual Rye – Germinates in 10 – 15 days-overwinters well. Provides good coverage. May persist for a few seasons. We use a rate between 100 and 300 oz. per acre (14,188 seeds per oz.). Inexpensive \$1.90 per lb.
- > *Elymus canadensis* – Canada Wild Rye – Germinates 30 to 60 days – short lived clump forming perennial. Upland planting 4,256 seeds per oz. Sometimes used as a cover crop. \$1.60 per oz.
- > *Elymus virginicus* – Virginia Wild Rye – Germinates 30 – 60 days. Short lived clump forming perennial. Moist soils and tolerates shade. 4,375 seeds per oz. Sometimes used as a cover crop \$ 1.25 per oz.



Seeding Costs

Quoted per 1 acre.

- > 1 application of herbicide \$ 350 - \$ 450 Price includes herbicide and labor.
- > Native seed mix ----- -\$ 500 - \$ 1,200
- > Drill seeded ----- \$ 300 - \$ 500
- > Mowing for 2 seasons -- \$ 500 - \$ 750 Priced at 5 mows, 3 the first season and 2 the second. Critical maintenance factor needed the first few seasons.

Price range per acre -----\$ 1,650.00 - \$ 2,900.00

This is a contractors' cost. If a firm was contracted to install and maintain a 1-acre planting.

If a parks dept. or entity has the ability to broadcast their own seed and cover the mowing, the out-of-pocket cost would be reduced, and they could potentially seed a larger area.

Cost Estimates:

The information needed to provide an accurate cost estimate

- > Company information; Who is paying the bill? Name, address, phone, e-mail, shipping address, billing address, contact name, tax information, purchase order policy, terms.
- > Project specification needed. No guessing.
- > When do you need the quote returned?
- > When will the material be needed?
- > Botanical names required.
- > How many, how much.....
- > What size is needed? Plug size, quarts, gallons....
- > The name of the project (or a name or number to keep it straight).
- > Where is the project location (general area)?
- > Are there geno-type restrictions?



Ordering Seed

- > After the quotation process is completed:
- > Before signing the quote, is everything correct? (species, amounts, shipping address, tax and terms)
- > Do you need special information on the seed label?
- > Deposits may be required to convert the quote into an order.
- > When will the seed be needed?
- > If seed testing submittals are required, they will be provided after the seed is pulled. Pulling seed tests may require an additional fee.
- > How do you want the seed mixed? Blend, small-medium-large, bag separate.
- > How will the seed be stored? Heat is a killer. Rodents are an issue.
- > Did you get an order acknowledgement?

Midwestern Native Species

Grasses

- > *Andropogon gerardii* (Big Bluestem)
- > *Bouteloua curtipendula* (Side Oats Grama)
- > *Carex sp* (Sedges)
- > *Elymus canadensis* (Canada Wild Rye)
- > *Panicum virgatum* (Switch Grass)
- > *Schizachyrium scoparium* (Little Bluestem)
- > *Sorghastrum nutans* (Indian Grass)
- > *Sporobolus heterolepis* (Prairie Dropseed)



Spring Flowering Species

- > *Amelanchier's* (Serviceberry)
- > *Amorphia fruticosa* (Indigo Bush)
- > *Anemone canadensis* (Meadow anemone)
- > *Aquilegia canadensis* (Wild Columbine)
- > *Baptisia's* (Wild Indigos)
- > *Caltha palustris* (Marsh Marigold)
- > *Cercis canadensis* (Redbud)
- > *Coreopsis lanceolate* (Sand Coreopsis)
- > *Iris virginica* (Blue Flag)
- > *Lindera benzoin* (Spicebush)
- > *Lupinus perennis* (Wild Lupine)
- > *Prunus americana* (American Plum)
- > *Salix* (Willow)

- > *Zizia aptera* (Heart-Leaved Meadow Parsnip)
- > *Zizia aurea* (Golden Alexanders)



Summer Flowering Species

- > *Agastache foeniculum* (Lavender Hyssop)
- > *Allium cernuum* (Nodding Onion)
- > *Amorpha canescens* (Lead Plant)
- > *Anemone cylindrical* (Thimbleweed)
- > *Asclepias's* (Milkweeds)
- > *Chamaecrista fasciculata* (Partridge Pea)
- > *Dalea's* (Prairie Clovers)
- > *Echinacea's* (Coneflowers)
- > *Eryngium yuccifolium* (Rattlesnake Master)
- > *Eutrochium maculatum* (Spotted Joe-Pye Weed)
- > *Filipendula rubra* (Queen of the Prairie)
- > *Helianthus's* (Sunflowers)
- > *Liatris's* (Blazing Stars)
- > *Monarda fistulosa* (Wild Bergamont)
- > *Rudbeckia sumtomentosa* (Sweet Black-Eyed Susan)
- > *Senna hebecarpa* (Wild Senna)
- > *Silphium's* (Rosin Weed) (Compass Plant) (Cup Plant) (Prairie Dock)
- > *Veronicastrum virginicum* (Culver's Root)



Fall Flowering Species

- > *Agalinis's* (False Foxglove)
- > *Ageratina altissima* (White Snakeroot)
- > *Chelone glabra* (Turtlehead)
- > *Conoclinium coelestinum* (Blue Mistflower)
- > *Coreopsis tripteris* (Tall Coreopsis)
- > *Eupatorium perfoliatum* (Common Boneset)
- > *Lobelia cardinalis* (Cardinal Flower)
- > *Lobelia siphilitica* (Great Blue Lobelia)
- > *Oligoneuron's* (Goldenrods)
- > *Pycnanthemum virginianum* (Common Mountain Mint)
- > *Solidago's* (Goldenrods)
- > *Symphyotrichum's* (Asters)
- > *Vernonia missurica* (Missouri Ironweed)



Ways to Help Bees Help You

- > Write a grower-beekeeper pollination contract to set expectations on both sides.
- > Let your beekeeper know in advance if you'll be applying pesticides when bees are in the crop.
- > In dry areas, provide bees with clean, pesticide-free water. Honey bees need clean water for cooling the hive on hot days.
- > Use integrated pest management (IPM) to make pest management decisions and reduce reliance on chemical pest control.
- > Avoid applying pesticides during bloom. If pesticides are needed, apply after dusk or before dawn when bees are less active. Avoid tank mixes.
- > Whenever possible, select pesticides that are less toxic to bees.

Ways to Help Bees Help You

- > Flowering plants, including trees and shrubs, can provide pollen and nectar for both managed and wild bees.
- > Natural areas can act as refuges, providing nesting and foraging areas that are protected from pesticides.
- > Reduce mowing, spraying, and disking of field edges to let wild plants bloom and to protect bees that nest underground.
- > Blooming crops can provide a feast for bees, but bees still need to eat and provide for their young before and after crop bloom.
- > Plant a diverse set of flowering plants that bloom throughout the season. Make sure areas with flowering plants are protected from pesticide drift and runoff.
- > Add blooming cover crops to provide more forage for bees.

Native Trees That Benefit Pollinators

- > Basswood (*Tilia americana*)
- > Black locust (*Robinia pseudoacacia*)
- > Dogwood (*Cornus florida*)
- > Kentucky Coffee Tree (*Gymnocladus dioica*)
- > Redbud (*Cercis canadensis*)
- > Serviceberry (*Amelanchier spp.*)
- > Tulip Tree (*Liriodendron tulipifera*)
- > Wild Black Cherry (*Prunus serotina*)
- > Willow (*Salix spp.*)



Native Trees That Benefit Pollinators



Bee Friendly Lawns

- > Bees and other pollinators are extremely attracted to clover flowers, and clover is an integral part of the delicate life cycle of honey bees. While a lawn teeming with bees may not be for everyone, it is a lot more interesting and interactive than most alternatives.
- > Clover was actually a part of the typical American lawn prior to World War II. Clover along with fescues, rye grasses, and Kentucky bluegrass.
- > Bumblebees, solitary bees and honeybees all visit dandelions for food, along with hoverflies, beetles, and butterflies such as the peacock and holly blue. Goldfinches and house sparrows eat the seed. Yet most of us gardeners miss out on the spectacle of watching wildlife feast on our dandelions because we wage such a war against them as weeds.



No-Till Drill Seeding into Dead Vegetation



No-Till Native Drill for Vegetated Sites

- > Broadcasts and firms seed into place in one pass
- > 3 seed boxes to calibrate the seed drop
- > Most effective way to sow seed into the soil
- > Effective in getting the seed to the soil line
- > Carefully calibrate the seed drop to cover the entire area
- > Don't drill too deep





May 2016



Mid August 2016



Seeding



Bare Soil Seeding Tips

- > Loosen firm soil with disc or ripper.
- > Firm loose soil with a roller or cultipacker.
- > Apply seed at design rates 30 to 60 seeds per square foot.
- > Roll again to press seed into soil.
- > Beware of existing weed seed bank that can produce a flush of weeds after soil disturbance.



Maintenance

Year 1

- > Mowing is critical in controlling weeds the first few years.
- > Most of your weed pressure comes from annuals. Keep them from re-seeding.
- > Keep vegetation mowed to a height of 4-6 inches and mow when the vegetation reaches 12 inches or before it goes to seed.

Year 2

- > Weeds will continue to be an issue in the second season.
- > In year 2, mow vegetation to 8 inches and mow when vegetation reaches 12 to 18 inches or before it goes to seed.

Year 3

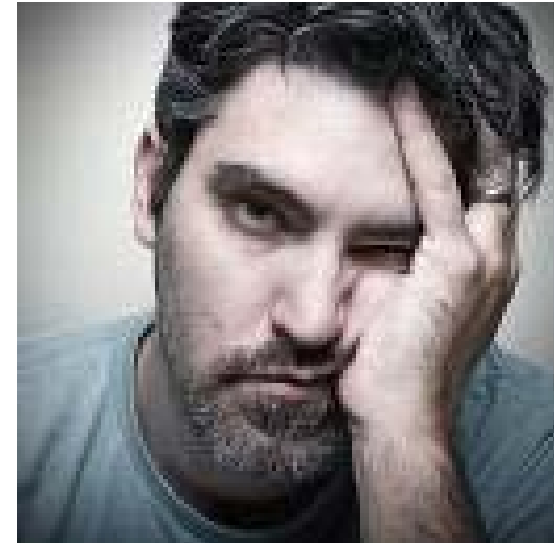
- > Use mowing as a weed control and establishment tool when needed.





Natives take time!

- > 1-3 or more years from seed
- > Plugs speed things up
- > Don't give up. Even the experts get frustrated!



Plant Diversity



Plant Diversity



What went wrong?

Common causes of seeding failure

- > Planting too deep. Native seed should never be covered by more than 1/4" soil.
- > Hydroseeding or applying native seed mixed with hydromulch
- > Poor quality seed: always specify PLS
- > Failure to maintain the planting
- > Failure is perceived due to the slow germination and growth of natives.

Recap - Pollinators

- > If you have more natural habitat, you have more bees
- > “Native bee management is really habitat management.”
- > Native bees make a big difference.
- > Plant a diverse set of flowering plants that bloom throughout the season.
- > The right plant in the right space
- > All plantings need maintenance
- > If you disturb the soil, fix it or an exotic will move in.
- > Don't forget about the other creatures that we inhabit this earth with.

Recap – Living Snow Fence That Benefit Pollinators

- > The role of a snow fence is to reduce the wind speed.
- > Determine the general wind direction
- > Fetch distance is 35 times the planting height
- > Row plantings can reduce the fetch area distance.
- > Combine grasses and rigid forbs with staggered bloom times for pollinator food sources and longer winter height stability.
- > Native flowering shrubs in combination with native grasses and forbs can be a very effective barrier that provides a food source and habitat.
- > When seeding where mowing is required the first few years, wait to plant the shrubs after the area is established to avoid mowing the shrubs.

Questions



Thank you

Mark O'Brien

Cardno Native Plant Nursery

Direct 574-586-2412 Fax 574-586-2718

Address 128 Sunset Drive , Walkerton, IN 46574

Email mark.obrien@cardno.com

Web www.cardno.com

www.cardnonativeplantnursery.com

Disclaimer

This presentation contains certain statements and projections provided by or on behalf of Cardno Limited with respect to the anticipated future undertakings. Any forward-looking statements reflect various assumptions by or on behalf of Cardno. Accordingly, these statements are subject to significant business, economic and competitive uncertainties and contingencies associated with the business of Cardno which may be beyond the control of Cardno which could cause actual results or trends to differ materially, including but not limited to competition, industry downturns, inability to enforce contractual and other arrangements, legislative and regulatory changes, sovereign and political risks, ability to meet funding requirements, dependence on key personnel and other market and economic factors. Accordingly, there can be no assurance that any such statements and projections will be realised. Cardno makes no representations as to the accuracy or completeness of any such statement of projections or that any projections will be achieved and there can be no assurance that any projections are attainable or will be realised.

Additionally, Cardno makes no representation or warranty, express or implied, in relation to, and no responsibility or liability (whether for negligence, under statute or otherwise) is or will be accepted by Cardno or by any of their respective officers, directors, shareholders, partners, employees, or advisers (Relevant Parties) as to or in relation to the accuracy or completeness of the information, statements, opinions or matters (express or implied) arising out of, contained in or derived from this presentation or any omission from this presentation or of any other written or oral information or opinions provided now or in the future to any interested party or its advisers. In furnishing this presentation, Cardno undertakes no obligation to provide any additional or updated information whether as a result of new information, future events or results or otherwise.

Except to the extent prohibited by law, the Relevant Parties disclaim all liability that may otherwise arise due to any of this information being inaccurate or incomplete. By obtaining this document, the recipient releases the Relevant Parties from liability to the recipient for any loss or damage which any of them may suffer or incur arising directly or indirectly out of or in connection with any use of or reliance on any of this information, whether such liability arises in contract, tort (including negligence) or otherwise.

This document does not constitute, and should not be construed as, either an offer to sell or a solicitation of an offer to buy or sell securities. It does not include all available information and should not be used in isolation as a basis to invest in Cardno.