Increasing Seed of Wildflowers Valuable to Pollinators: Xerces Society and Seed Producer Partnerships

Since 2008, the Xerces Society for Invertebrate Conservation has worked to develop native plant solutions for pollinator and beneficial insect conservation. A critical challenge facing pollinator conservation is a lack of seed for some high value wildflower species. To address this need, Xerces works with native seed produces to identify plants of special conservation value and make the seed of those species more readily available to the conservation community. Our partnerships with the native seed industry and USDA NRCS- Plant Materials Center are a cornerstone of this effort.

Some of our priorities include plant species of extremely high nectar or pollen value, uncommon host plants for butterflies, plants that have incredible tolerance to drought or other climate-related conditions, and more.

In the case of plant species that are not currently available from established seed producers, we provide support in locating wild sources of foundation seed, and technical assistance in unlocking the propagation, harvest, and seed cleaning systems necessary to make large-scale production possible.

Our work also extends to improving the yields of important species that are already in commercial production. We do this through ecologically-based research and development support to overcome crop management challenges such as herbivore and pathogen-pressure, stand longevity, and more.

Highlights of Our Work

Project Milkweed

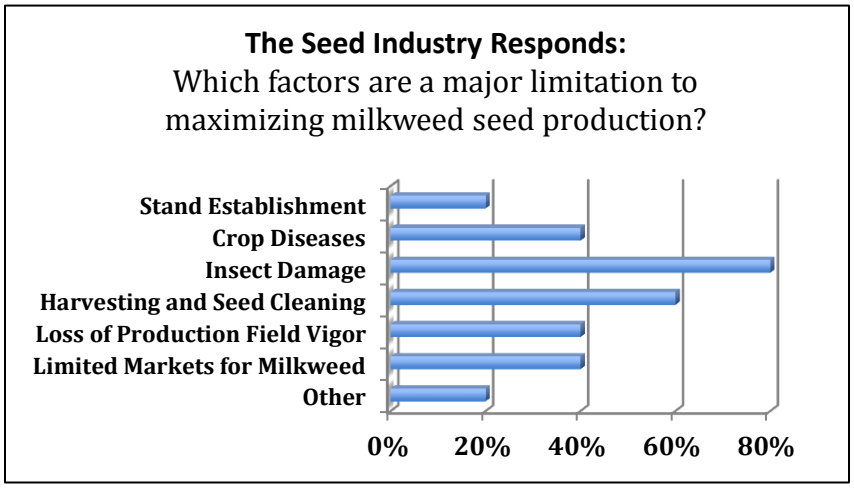
The widespread decline of milkweeds (*Asclepias* spp.) across the United States is believed to be a critical factor in the long-term decline of monarch butterflies (*Danaus plexippus*) in North America. To recover monarch populations, scientists and government agencies including the U.S Fish and Wildlife Service, the U.S. Department of Agriculture, and the U.S. Geological Survey, now recommend intensified planting of regionally appropriate native milkweed species. However, a scarcity of milkweed seed in many regions has limited opportunities to include the plants in regional restoration efforts.

To address this seed shortage, the Xerces Society launched *Project Milkweed* in 2009, with support from the Monarch Joint Venture, a USDA NRCS Conservation Innovation Grant, and private foundations. Through *Project Milkweed*, we worked with the native seed industry, the NRCS Plant Materials Program, and community partners to first locate wild populations of target milkweed species for sustainable seed harvest. Then, working with the USDA's network of Plant Materials Centers, test plots using the wild-collected seed were established to better understand the growth requirements and develop proper techniques for managing these milkweeds as seed crops. Finally, we harvested seed from test plots and transferred it, along with production protocols, to private-sector native-plant nurseries for commercial seed production.

As a result, new seed sources are now available for California, the Great Basin, Arizona, New Mexico, Texas, and Florida, regions where milkweed seed was previously unavailable. To date, more than 60 million seeds of have been brought to market for species such as woolypod milkweed (*Asclepias eriocarpa*), narrowleaf milkweed (*A. fascicularis*), showy milkweed (*A. speciosa*), heartleaf milkweed (*A. cordifolia*), antelope horns (*Asclepias asperula* ssp. *capricornu*), green milkweed (*Asclepias viridis*), rush milkweed (*Asclepias subulata*), spider milkweed (*Asclepias asperula* ssp. *asperula*) and more.

Integrated Pest Management for Milkweeds

To better understand the factors currently limiting milkweed seed availability, in 2011 Xerces conducted a nationwide survey of commercial native seed producers to identify major challenges of milkweed seed production. Insect damage was a barrier to increasing seed yields for 80% of respondents:



Major Pest Feeding in Milkweed Seed Production Plots
Cobalt beetles feeding on foliage (upper left) and long-horn beetle larvae on roots (upper right). Milkweed bugs (bottom right) and oleander aphids (bottom left) feed on sap.

Protection of monarch larvae in seed production fields
Monarch caterpillars have been present in all of the milkweed production fields we surveyed, in some cases, estimated in the thousands. This situation places large numbers of monarchs at risk when growers make the decision to use insecticides to control aphids and other herbivores.

Among the insects identified as causing significant yield losses are several species of root- and foliage-feeding beetles, two species of seed-feeding true bugs, and the non-native oleander aphid.

While yield loss can be difficult to quantify, seed growers reported crop loss estimates of 25 to 50% from these insects, prompting some growers to use insecticides for herbivore control. Complicating this situation is the widespread occurrence of monarch caterpillars in milkweed production fields, placing many monarchs at risk of insecticide exposure.

Responding to this situation, we are working with seed producers in Iowa, Minnesota, and California to develop a first of its kind, reduced-risk, integrated pest management (IPM) system for milkweeds. This decision-support tool includes preventative strategies such as enhancing natural biological control of pests, as well as crop scouting protocols and data sheets for milkweed, pesticide application thresholds, and recommended reduced-risk pesticides. This model IPM system is being developed into a free downloadable toolkit to both improve yields of growers who adopt the system and simultaneously protect thousands of monarchs from insecticides.

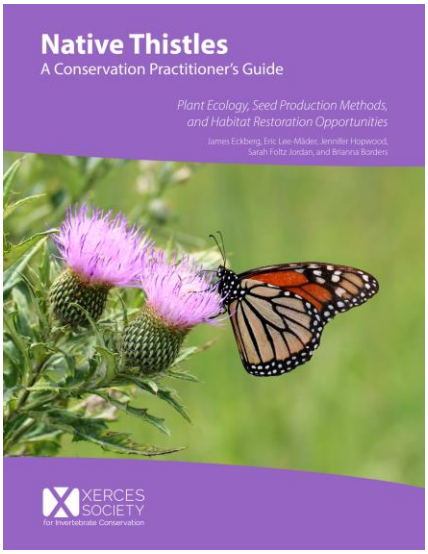
Native Thistle Working Group

Native thistles are a largely forgotten and wrongly maligned group of wildflowers. Yet these diverse plants fill unique niches, providing food for songbirds, small mammals, and insects. Research from several regions has shown extremely high flower visitation to native thistles by bees and butterflies. For example, a nine year survey of floral use by monarch butterflies found that 63% of flower visits by monarchs in eastern Nebraska's tallgrass prairies were to native tall thistle, *Cirsium altissimum* (T. Burk 2016, unpublished data). Additionally, research has demonstrated the importance of thistles for gold finches: the seed of various thistles can form up to 50% of their diet (Gluck 1985).

Unfortunately, North America's thistles have declined significantly due to habitat loss, leaving a number of native species now threatened with extinction. The spread of invasive, non-native thistles, as well as confusion between our native thistle species and invasive thistles, is also a large threat to these beautiful and important plants. Additionally, the intentional release of exotic thistle-eating insects that devour invasive and native thistles alike has had devastating consequences for some native thistle populations (Louda et al 1997).

Over the past decade, there have been few attempts to cultivate and market native thistle seed for habitat restoration projects. Responding to this need, the Xerces Society launched a partnership with native seed producers in Minnesota and Indiana to establish production fields of field thistle (*Cirsium discolor*), tall thistle (*C. altissimum*), Flodman's thistle (*C. flodmanii*), Hills thistle (*C. pumilum* var. *hillii*) and swamp thistle (*C. muticum*). Through this partnership, Xerces conducted wild collection of foundation seed, and is providing ongoing research and development to address native thistle production challenges.


Field thistle production plot (Minnesota)



Along with new commercial sources of native thistle seed, one of our first major accomplishments is the publication of the new book, Native Thistles: A Conservation Practitioner's Guide. This book (to be released by Xerces in early 2017) provides a comprehensive overview of native thistle ecology and conservation, seed production methods, and the use of thistles in habitat restoration.

As awareness of these valuable plants slowly increases, we are using this program to empower and inspire new efforts to restore thistles to the landscape. Over the coming years, we will increase our outreach and technical support to additional stakeholders and work to increase the marketability of these important wildflowers.

Climate-Ready Pollinator Plants

One of the critical challenges facing habitat restoration professionals today is the potential adaptability of native plants to climate change and climate variability. In California alone, the work of Xerces and other conservation organizations has been challenged in recent years by long-term drought conditions, which severely limit the establishment of some species and often necessitate supplemental irrigation of newly established habitat projects. Responding to the need for climate-ready native plants, we have been expanding our focus on species that offer robust drought or flood tolerance, as well as species that provide bloom at critical times of the year when few other native plants are flowering.

In California, this work includes a partnership with the native seed company Hedgerow Farms to increase the availability of California bladderpod (*Isomeris arborea*) and Pacific aster (*Symphyotrichum chilense*). Bladderpod is a small statured desert shrub adapted to a wide range of conditions, from roadsides to desert arroyos to xeric coastal bluffs. It exhibits extreme drought tolerance, as well as showy, long-lasting, and highly pollinator-attractive blooms. These factors have made it a plant of significant interest for Xerces' pollinator hedgerows and other habitat projects as rainfall has become increasingly uncertain and unreliable.


Bladderpod


Pacific aster

Our other California species, Pacific aster, fills a unique ecological role as one of the state's most reliable late season blooming wildflowers, flowering through summer and into autumn when few other pollen and nectar resources are available. Unlike many of the state's showy annual wildflowers, the perennial lifecycle of Pacific aster results in a deep and extensive root system with a greater ability to persist through variable or irregular precipitation. Once established, this species is long lived and is highly attractive to a wide range of butterflies and native bees, often putting on a dramatic show of insect activity when it is the only flowering species late in the year.

The southern plains is also challenged by periodic drought, and while a relatively good supply of native seed is available in the region, historically the emphasis has been on selecting species for soil conservation and livestock compatibility. Attention to the needs of pollinators is a relatively new focus for the region's seed industry. To expand the diversity of pollinator-attractive seed options available, we took a two-part approach: first we looked for extremely deep-rooted, long-lived perennials that could persist in extended periods of drought, and second, we looked for rapid growing annuals that could immediately establish and provide prolific flowers following bursts of precipitation. Using

these criteria, we narrowed our focus to white rosinweed (*Silphium albiflorum*), a new perennial for the market, and Leavenworth's eryngo (*Eyringium leavenworthii*), for a rapid growing annual.

White Rosinweed

White rosinweed is slow growing and has a small native geographic range within central Texas. Despite these limitations, the plant is extremely long-lived and has expansive taproots (exceeding 15 feet in length) that allow it to persist in extremely dry and harsh soils. We also felt that the uniqueness of the plant (it is the only white-flowered member of its genus, and has the reputation as a Texas 'legacy plant') gave it valuable marketing potential and could help generate customer demand. Like other *Silphium* species, it is extremely attractive to numerous unique native bees (including specialist sunflower bees such as *Dieunomia* spp.), as well as various beetles and many species of southern prairie butterflies. Partnering with the company Native American Seed in Junction, Texas, we collected one pound of seed to establish a 0.13 acre plot in 2014. Yield of this slow growing plant is progressively increasing with 0, 0.1, and 6 pounds of seed produced from year one to three.

Leavenworth's eryngo

Marketing appeal was also a factor in the selection of our annual species for the region, Leavenworth's eryngo. The brilliant purple-blue flowers and foliage of the plant give it a striking appearance, and the compound flowers are highly attractive to a wide range of small native bees, beneficial wasps, flies, and butterflies. Partnering with Native American Seed farm, we grew and harvested 2 pounds of eryngo.

Yellow Beeplant

In the dry climate of eastern Washington and Oregon, there has been strong interest in USDA conservation programs targeting pollinators, such as CP-42, the pollinator enhancement option available through the Conservation Reserve Program. With less than 12-inches of annual rainfall in some areas however, planting options have extremely limited. Working with Humble Roots Nursery in eastern Oregon we located wild sources of foundation seed for yellow beeplant (*Cleome lutea*), and Columbia tickseed (*Coreopsis tinctoria var. 'atkinsonia'*). Nearly 4 pounds of beeplant (over 300,000

seeds) were produced across two years. In the case of Columbia tickseed, over one-half pound of seed were even used for a habitat restoration project in the landing approach area of a regional airport. These efforts have helped establish reliable sources of these species for dry climate habitat projects across the inland Northwest.

While drought is a growing concern in parts of the West, other regions are increasingly subject to extreme rain events and flooding. In looking for new commercially viable pollinator plants for the Southeast and Midwest that could thrive in these conditions, we focused on floodplain and similar plant communities where conditions could range from dry sand deposits to complete seasonal inundation. One species found widely across these types of locations is wingstem (*Verbesina alternifolia*). In our initial observations of this plant in natural settings, we noticed that it consistently attracted some of the greatest pollinator abundance and diversity of any plants found within the same plant communities. Interestingly, further investigation revealed that wingstem had formerly attracted significant historical attention from beekeepers as evidenced in numerous beekeeping books and journals from the late 1800s and early 1900s. In fact, in a few cases, historical references made note of early attempts to mass propagate the plant as a honey bee forage resource, with seed of the plant sometimes advertised in older beekeeper magazines under the name 'golden honey plant.' Based upon this evidence, and the species vigorous-growth habit (seemingly competitive with common weeds and invasive species found in the same ecological niches), we worked with the native seed company Cardno Native Plant Nursery in Walkerton, Indiana to search for and collect wild sources of foundation seed. This partnership has led to the production of over 25 pounds of live seed, over 3.5 million seeds.

Wingstem

While these 'climate-ready' species are adding an important new range of options for habitat restoration, there is still much important work to be done. Looking ahead, this emphasis on highly-adaptive pollinator attracting plants is expected to become a large part of our research and development support for the native seed industry.

Meadow Blazingstar: An Unparalleled Monarch Resource

Along with the need to increase milkweed as a larval host plant, recent monarch butterfly conservation efforts are highlighting the need to identify and increase monarch nectar resources of significant importance. Beginning in 2009, reports by Xerces ecologists from multiple states repeatedly identified the presence of large monarch numbers on meadow blazingstar flowers (*Liatris ligulistylis*). In many cases, the numbers of monarchs attracted to this species seemed disproportionately high, given the limited amount of flowering biomass and the presence of other monarch-attractive plants flowering in close proximity (such as various species of Joe Pye weed and other *Liatris* species).

Meadow blazingstar with monarchs

To evaluate the attractiveness of this species to monarchs, we worked with the seed company Minnesota Native Landscapes to establish a 0.7 acre production plot from wild collected seed which yielded over 170 pounds of seed (1.7 million seeds) across four years. While the plot had some persistence challenges (including weed pressure, winter damage, and an unknown root rot of the *Liatris* corms), it attracted approximately 1,000 nectaring monarchs when the plants bloomed. In fact, at peak bloom it was typical to see monarchs congregating in the meadow blazingstar plot, while several acres of much showier (and healthier) production blocks of prairie blazingstar (*Liatris pychnostachya*) remained virtually free of monarchs. Amazingly, monarchs remained attracted to the meadow blazingstar crop even after peak bloom, even congregating around seed cleaning equipment when the crop was being processed in an open barn.

These indicators continued to confirm our initial assessment of meadow blazingstar as an unparalleled monarch resource. Since our first work to help bring this species into commercial production, we now continue to work closely with Minnesota Native Landscapes, focusing on more effective management of root disease and weed control in production stands. Recognizing the growing interest in this species, our partner has expanded production of this species. We are confident that over the next few years, understanding of this species will lead to more effective management for maximum yields. For the time being, we are including this species in mass plantings on farms and corporate campuses in the Upper Midwest, and we see it as an important potential 'homing beacon' to attract monarchs to safe restored breeding habitats where they can also find milkweed host plants and a refuge from pesticides.

Partners

Our partners in the NRCS- Plant Materials Centers and native seed industry play a critical role in our seed development program. These partnerships leverage experience in pollinator conservation and seed production, accelerating the commercialization of many high value wildflowers. The Plant Material Centers supported our initial seed collections, evaluation, and amplification. This plays to the strength of Plant Material Centers. For over 75 years the Plant Materials Center have worked to identify, evaluate and develop plant materials for conservation practices including soil health, wildlife habitat, water quality and more. Partnering Plant Material Centers for *Project Milkweed* included Brooksville (Florida), Great Basin (Nevada), and Los Lunas (New Mexico) Plant Material Centers. Partnering with the native seed industry we developed production methods and brought seeds to market. Our partners in the native seed industry included Cardno Native Plant Nursery (Indiana), Ernst Conservation Seeds (Pennsylvania), Gunnell Farms (Utah),

Hedgerow Farms (California), Humble Roots Nursery (Oregon), Minnesota Native Landscapes (Minnesota), Native American Seed (Texas), and the Tallgrass Prairie Center (Iowa).

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Louda, SM, D Kendall, J Connor, and D Simberloff. 1997. Ecological effects of an insect introduced for the biological control of weeds. *Science* 277: 1088-1090.

Photographs

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Keith Fredrick, Minnesota Native Landscapes – "Monarchs on meadow blazingstar" (p. 1)
John Anderson, Hedgerow Farms – "Cobalt beetles feeding on foliage", "Oleander aphids" (p. 3)
Eric Eldredge, NRCS – "Long-horn beetle larvae on roots" (p. 3)
Greg Hume, Wikimedia Commons – "Milkweed bugs" (p. 3)
Sarah Foltz Jordan, The Xerces Society – "Monarch caterpillars" (p. 3), "Meadow blazingstar with monarchs" (p. 8)
Cassandra Bush, Minnesota Native Landscapes – "Native thistle production field" (p. 4)
Emily Allen, Hedgerow Farms – "Bladderpod", "Pacific Aster" (p. 5)
Clarence Rechenthin, USDA NRCS PLANTS Database – "White rosinweed" (p. 6)
Anne Stine, The Xerces Society – "Leavensworth eryngo" (p. 6)
Kristin Currin, Humble Roots Nursery – "Yellow Beeplant" (p. 6)
Nancy Adamson, The Xerces Society – "Wingstem" (p. 7)

More Information

To learn more about native seed research and development at the Xerces Society, contact Jim Eckberg, Agronomist/Plant Ecologist at jim.eckberg@xerces.org
Or Eric Lee-Mäder, Pollinator Conservation Program Co-Director at eric@xerces.org

Species Profiles: Working with the native seed industry over the past three years has revealed as much insight as questions on producing seeds of high-value pollinator wildflowers. Below we highlight management strategies and ongoing challenges for producing seed of these pollinator-friendly wildflowers.

Wingstem
Verbesina alternifolia **(L.) Britton ex Kearney**

Photo credit: Nancy Adamson, The Xerces Society

Growth form: Perennial

Production Conditions: Moist to mesic soils with partial to full sun. Speices is native through much of eastern North America.

Production Strategies and Challenges: Crop may fail after an initial year of high seed productivity. Potential causes of plot die-off include full sun conditions and mold. Establishing a row of fast-growing willow or poplar adjacent to wingstem to provide partial shade may ensure plot survival. Also, interseeding a grass companion crop may reduce the incidence of mold.

Field Thistle
Cirsium discolor **(Muhlenberg ex Willdenow) Sprengel**

Photo credit: James Eckberg, The Xerces Society

Growth form: Short- lived perennial flowering once in lifetime.

Production Conditions: Full sun with moist well-drained soil. This species is tolerant of partial shade but less productive in such conditions. Species is native throughout much of eastern North America.

Production Strategies and Challenges: Flowers in second year of production. This species has few disease issues. A diverse group of stem-mining and flowerhead-feeding insects can attack *C. discolor* and related native thistles. Many of these species specialize on *Cirsium* species. Rotating *C. discolor* with other plants may interrupt insect life cycles and prevent build-up of pest populations on native thistles. Goldfinches also feed voraciously on the seed heads. Harvesting when the florets are brown can allow seed ripening while limiting some seed predation. Native thistles may also serve as a trap crop to limit goldfinch predation of other highly valuable wildflowers including meadow blazing star.

Yellow Beeplant
***Cleome lutea* Hook.**


Photo credit: Kristin Currin, Humble Roots Nursery

Growth form: Deeply tap-rooted annual

Production Conditions: Yellow beeplant grows in desert to riparian areas with fine to coarse textured soils. Plants tolerate a wide pH range, 6.0-8.0, but require well drained soils with open sun. Once established, the deeply tap-rooted plants are tolerant of dry soil conditions. Species is native to Intermountain West.

Production Strategies and Challenges: This plant is highly productive yet its indeterminate flowering can complicate harvesting. For example, harvesting all seed of a 200 plant stand produced nearly 3 lbs of seed (over 250,000 seeds) in Mosier, Oregon. Given the prolonged flowering and maturation period, harvesting all seed is time intensive. Much of the seed is ripe and ready for harvest near the end of the flowering period. Harvesting a single time near the end of the maturation yielded one-third as many seeds yet cut labor by approximately 6 times. Allowing seed to fall to the ground will reseed plots for the next season.

USDA- NRCS Plant Guide: https://plants.usda.gov/plantguide/pdf/pg_cllu2.pdf

Pacific Aster
***Symphyotrichum chilense* (Nees) G.L. Nesom**


Photo credit: Emily Allen, Hedgerow Farms

Growth form: Rhizomatous perennial

Production Conditions: Grows in a wide range of wet to dry conditions, shows tolerance to high salinity. Once established, plants are generally drought tolerant. Species is native to coastal regions of North America.

Production Strategies and Challenges: Plots of pacific aster can persist and be productive for over 10 years. Pests including aphids can cause complete crop failures as we observed for a 15 year old plot. Interseeding companion plants in the understory or in rows may attract natural enemies of aphids boosting biological control and protecting yields.

USDA-NRCS Plant Fact Sheet: https://plants.usda.gov/factsheet/pdf/fs_sych4.pdf

White rosinweed
***Silphium albiflorum* A. Gray**

Photo credit: Clarence Rechenthin, USDA NRCS PLANTS Database

Growth form: Deeply taprooted, long-lived perennial

Production Conditions: Grows well on shallow sandy or gravelly soils. Wild populations often found on limestone (calcareous) outcrops. With a taproot up to 15 feet deep, established plants are highly drought tolerant. This species is native to central Texas.

Production Strategies and Challenges:
The plant has quick germination and emergence yet slow growth and flowering. For example, emerging plants grew less than one foot tall during their first year in a production plot in Junction, Texas. Yield of this plot was also low, only 2 ounces (approximately 1,620 seeds) were produced through the second year production from a 0.125 acre plot. Production of this species ramps up in the third year and because this is a long-lived species we anticipate that plots can persist over the long term. There are no major insect pests or diseases to date.

Meadow blazing star
***Liatris ligulistylis* (A. Nelson) K. Schumann**

Photo credit: Keith Fredrick, Minnesota Native Landscapes

Growth form: Perennial, forms corm

Production Conditions: Adapted to moist or mesic soils and open sun. This species is native to upper the Midwest and Great Plains.

Production Strategies and Challenges:
This species can be highly productive yet plots may be susceptible to die-off. In Foley, Minnesota a 0.7 acre plot yielded 120 pounds of seed (1.2 million seeds) in a single year, yet only 35 pounds the next year after most of the plants died off during the winter. While the cause of the die off is not clear, contributing factors likely include a corm rot and lack of ground cover protecting corms over winter. Plots should be established in well drained soils. Using a winter annual cover crop or perennial grass (e.g. side oats grama, *Bouteloua curtipendula*) may protect corms from harsh winter conditions. The production lifespan and strategies to extend plot longevity require further investigation. Seeds can be heavily predated by sparrow and finches.