Case Study Tech Note

Building Seed Supply of Early-Emerging Milkweeds and Late-Season Nectar Plants for Monarchs in California's San Joaquin Valley

Background, Purpose, and Rationale

This case study presents a summary of the main activities, methods, and outcomes from a three-year collaborative project between the Xerces Society, Great Valley Seed, and California Bureau of Land Management. The objectives were to increase the commercial supply of native plant materials for western monarchs, specifically early-emerging milkweeds and late-season nectar plants of San Joaquin Valley ecotypes. As further context, Great Valley Seed was in the early years of emerging as a new venture of Bowles Farming Company during this project period.

Early-season milkweeds, such as woollypod milkweed, are an essential component of supporting declining monarch butterfly populations in California. (Photo: Xerces Society / Scott Black.)

Approach, Methods, and Outcomes

Data Collection Design (Seed Collections, Production)

What we did and what happened
For seed collections, we used a simplified version of the Bureau of Land Management's Seeds of Success collection form. The data included species identity, date of seed collection, and location of seed collection. At a minimum, the location was the county name, or at a closer scale the property name or coordinates. Estimates of the number of individual plants in the population were recorded, as well as the number of plants that seeds were collected from.

Great Valley Seed initially kept records in spreadsheets of targeted species, seed collection sources, seed collection quantities, propagation methods, seeding and/or transplant dates, seed harvest dates, and seed yield. However, with the goal of traceability for ecotypes throughout the production and storage cycles, Great Valley Seed transitioned to a software-based database for records and continues to develop and customize this system.

Successes

- We have basic information for the source populations, which are used to maintain the ecotype identity throughout production and to match seed lots with habitat projects.
- We have improved our record-keeping system, so we can track our production cycles and efficiency and we can maintain the identity of ecotypes throughout production steps.

Challenges

- A value that contract seed collectors provide is seed collections from multiple, appropriate, wild source populations. The challenge that comes along with this is communicating the

XERCES SOCIETY for Invertebrate Conservation

GREAT VALLEY SEED CO

Authors: Stephanie Frischie, Xerces Society for Invertebrate Conservation, and Doug Iten and Emma Debasitis, Great Valley Seed.

November 2023

importance of recording the population information related to the seed collection and receiving that information from the collectors.

- Producers manage multiple field and office operations, in addition to tracking records. Integrating different software or platforms is another challenge that native seed producers manage.

Species Selection

What we did and what happened

We assembled a list of 19 species that were native to the San Joaquin Valley of California that are host or nectar plants for monarchs (ecological traits) and that were likely to be suitable and available for production through seed farming (agronomic traits). This list was further refined to five early-season milkweeds and four late-season nectar species.

- The milkweeds were California (*Asclepias californica*), heart leaf (*A. cordifolia*), woollypod (*A. eriocarpa*), desert (*A. erosa*), and woolly (*A. vestita*).
- The nectar species were coyotebush (*Baccharis pilularis*), saltmarsh baccharis (*B. glutinosa*), mulefat (*B. salicifolia*), and Western vervain (*Verbena lasiostachys*).

Early-season milkweeds were defined as breaking bud dormancy before the end of April. Late-season nectar species bloom in July–November.

Successes

- We assembled a targeted list from a larger species pool, using data from Calscape, California Native Plant Society, Xerces Monarch Nectar Database, Western Monarch Milkweed Mapper, and expert observations.

Challenges

- Not all trait data of interest are known or available, so we were not able to do an entirely systematic filtering of the species pool.
- Increased participation in community science and academic research is needed to build these datasets for future identification of plant traits and species of particular value for invertebrate wildlife habitat.

Scouting and Collecting G0 Seeds from Wild Populations

Collection

Great Valley Seed worked with regional partners and specialty collectors to identify, track, and collect target species from wild populations in southern San Joaquin Valley counties. Our partners worked with landowners to secure permission to collect on private properties through their networks. This effort required coordinated scouting and seed collection across variable flowering and seed ripening periods in the wild. We made the following Generation 0 (G0) seed collections as origins for seed multiplication: 44 grams of *A. californica*, 106 grams of *A. eriocarpa*, 322 grams of *A. erosa*, and 15 grams of *B. salicifolia*.

Doug Iten of Great Valley Seed prepares to empty bags of milkweed fruits collected from wild populations and hand clean the seeds for temporary storage. (Photo: Xerces Society / Stephanie Frischie.)

Successes

- We worked with three contract or volunteer seed collectors to collect seeds from several populations of most of the targeted species.
- We expanded our network of partners to find populations and ethically collected these seed lots.

Challenges

- Wild seed collections require time and effort to communicate and coordinate with landowners, collectors and other experts.
- The collectors were not able to locate and collect all targeted species due to weather, phenology, lack of information, or limited access.

Pesticide Risk Assessment (PRA)

What we did and what happened

The Xerces Society's focus on invertebrate conservation includes reducing the effects of pesticides on non-target organisms. Great Valley Seed seeks to manage their production fields and on-site natural areas for wildlife, while maintaining healthy crops and maximizing seed yields. With these shared goals, Xerces staff developed a Pesticide Risk Assessment and Mitigation Plan for Great Valley Seed. Prior to the project summarized in this tech note, Xerces and Great Valley Seed collected leaf samples at several natural preserves adjacent to the farm and submitted them for lab analysis of pesticide residue. The results indicated the presence of three types of pesticides at concentrations above the LD50 for monarchs, although none of these pesticides had been applied directly to the field. One possible explanation was contamination through a chemigation system that was shared with neighboring fields of tomato production where two of these pesticides had been applied. Great Valley Seed mitigates the risk of pesticide contamination in their seed plots by practicing integrated pest management, including scouting, and through establishing isolation distances from vegetable crop production.

Oleander aphids frequently feed on milkweed plants, in this case, desert milkweed. Great Valley Seed conducted routine scouting to check whether pests had reached management thresholds. (Photo: Great Valley Seed.)

Successes

- Great Valley Seed built a program to track the presence and pest pressure of invertebrates that are most common in the milkweed seed plots. These include:
  - Spider mites (Tetranychidae); early season.
  - Oleander aphids (*Aphis nerii*); mid–late season.
  - Large milkweed bugs (*Oncopeltus fasciatus*); year round.
  - Small milkweed bugs (*Lygaeus kalmii*); year round.
- Great Valley Seed worked with local crop advisors and information from Xerces to establish thresholds for treatment and non-chemical management options. For example, gleaning fallen seeds or other plant parts from the milkweed plots to reduce the winter reservoir populations of the small milkweed bug.

Challenges

- Native seed production fields are "mini-monocrops" where pest populations may boom. As a niche industry, pest management information is often scarce for both the pest and native seed crop species.
- Routine scouting is an important part of field production, and the need to dedicate time and staff to this is multiplied by the number and variety of small plots.

Seed Production: Propagation, Field Operations, Harvest, Cleaning, Storage, and Availability

What we did and what happened

<u>Propagation</u>

For the milkweeds, approximately half of each seed lot was given a cold stratification pre-sowing treatment of 30 days in moist sand in a refrigerator (~38°F). The other half (control) of each lot remained in dry storage at room temperature (~68°F) prior to sowing. Estimated counts were made of the final proportion of viable seedlings (Table 1).

We sowed approximately 5,520 total seeds from 10 ecotypes of three early-season milkweed species at the propagation nursery (greenhouse). Seeds were sown in sterile mix in cell trays (one seed per cell). Of the seeds started, about 3,500 successfully grew to plug size.

Seedlings of desert milkweed grow in germination cell trays at the propagation nursery. (Photo: Great Valley Seed.)

<u>Table 1</u>. Estimated viable seedling proportion of total seeds sown for three milkweed species, by pre-sowing treatment. More details at RNGR Propagation Protocol Database.

	A. californica	*A. eriocarpa*	*A. erosa*
Control	42%	63%	43%
Cold stratification	59%	70%	51%

Seeds of *B. salicifolia* and *B. glutinosa* were sown in cell trays, without any pre-sowing stratification treatment. The *B. salicifolia* seeds did not germinate. The seeds may not have been viable, or the seeds were dormant.

Seed harvest of saltmarsh baccharis with a mini pull-behind brush harvester at Great Valley Seed production plots. (Photo: Great Valley Seed.)

<u>Field Operations</u>

The seed production field was in transition to organic, which shaped the field prep and crop management practices. The field was pre-irrigated and cultivated for weed control in April. Then 60-inch-wide beds were prepared and the transplants were planted in two lines, with an average spacing of 24 inches between plants. We hand transplanted and then set the transplants with sprinkler irrigation for the first few weeks to carefully manage soil moisture. Once the roots grew out of the root ball, we switched to deeper irrigation from the buried drip irrigation lines. We cultivated the beds multiple times throughout the season and dedicated labor to hand weeding throughout the season. *Baccharis glutinosa* (G1) established well from transplanting.

<u>Harvest</u>

Harvest dates varied widely by both species and ecotype and we harvested each plot multiple times as seeds ripened. We hand harvested milkweeds and used a mini pull-behind brush harvester for *B. glutinosa*. The quantities harvested in year 2 of the project (2022) were:

- *A. californica*: 1.44 lbs of G1 seed.
- *A. eriocarpa*: 0.74 lbs of G1 seed and 3.24 lbs of G2 seed.
- *A. erosa*: 3.82 lbs of G1 seed and 11.66 lbs of G2 seed.
- *B. glutinosa*: 20 lbs of G1 seed.

Additional quantities of these species were harvested in 2023. Exact amounts are not available as of this publication date.

Clean milkweed seeds, ready for cold, dry storage and to be added to available inventory at Great Valley Seed. (Photo: Xerces Society / Stephanie Frischie.)

<u>Cleaning</u>

For the milkweed species, the hand-harvested seed pods were air dried in plastic totes for multiple days. The seeds were then processed in a modified tumbler with a mesh screen bottom. The tumbler breaks up the seed pods and the seeds fall through the screen into a container. The floss and other inert matter was periodically vacuumed up as part of separating the seeds.

<u>Storage</u>

Once cleaned, the seed was stored in a temperature- (~65F) and humidity- (~ <25% RH) controlled container.

<u>Commercial Availability</u>

We now have sufficient stock seed to expand amplification of these species pending contract grow-outs to align with future needs. None of these species had a yield from this project to get to a commercial scale. They did, however, produce enough seed to go into larger acreage in coming growing seasons. We anticipate that these future grow-outs will provide commercial yields to make these key species available to the public and restoration practitioners.

Successes

- Milkweed germination was acceptable. We learned that the cold stratification treatment resulted in higher germination.
- Successfully established stands with transplants through basic propagation in the nursery.
- Increased seed quantity by 3x (*A. eriocarpa*), 4x (*A. erosa*), and 19x (*A. californica*).

Challenges

- Mulefat (*B. salicifolia*) germination failed. Something we would do differently in the future would be to test the seed for viability and to research and apply pre-sowing treatments.
- The low purity of the saltmarsh baccharis (*B. glutinosa*) seed lot required hand sowing in the propagation cell trays.
- Expensive production; very labor intensive to seed, transplant, hand weed, and hand harvest.
- Difficult to replicate at commercial scale without specialty equipment.

Resources

Borders, B. D., B. L. Cypher, N. P. Ritter, and P. A. Kelly. 2011. The challenge of locating seed sources for restoration in the San Joaquin Valley, California. *Natural Areas Journal* 31(2):190–199. https://doi.org/10.3375/043.031.0213.

Calflora. 2021. https://www.calflora.org/index.html. Accessed: February 18, 2021.

CCH2 Portal. California Consortium of Herbaria. 2021. https://www.cch2.org/portal/index.php. Accessed: February 18, 2021.

Laws, A., S. Jepsen, J. K. Cruz, A. Code, S. McKnight, E. Pelton, S. Marcum, and S. H. Black. 2019. *A Quick Guide to Monarch Habitat on Farms in California's Central Valley*. 12 pp. Portland, OR: Xerces Society for Invertebrate Conservation. https://xerces.org/publications/guidelines/quick-guide-to-monarch-habitat-on-farms-in-californias-central-valley

"Pre-Variety Germplasm Program," California Crop Improvement Association. 2023. https://ccia.ucdavis.edu/quality-assurance-programs/pre-variety-germplasm. Accessed: November 20, 2023.

Propagation Protocol Database, Native Nursery Network, National Center for Reforestation, Nurseries, and Genetic Resources. 2023. https://npn.rngr.net/aboutNPN. Accessed: October 30, 2023.

Seeds of Success Technical Protocol (Bureau of Land Management, 2015), 24–25, https://www.blm.gov/sites/blm.gov/files/program_nativeplants_collection_quick%20links_technical%20protocol.pdf. Accessed: March 3, 2021.

"Western Monarch Call to Action," Xerces Society for Invertebrate Conservation. 2021. https://xerces.org/western-monarch-call-to-action. Accessed: November 20, 2023.

Western Monarch Milkweed Mapper. 2021. https://www.monarchmilkweedmapper.org/. Accessed: February 18, 2021.

Xerces Society Monarch Nectar Plant Database. 2023. Data accessed from the Monarch Nectar Plant Database, a project by the Xerces Society. Accessed: October 30, 2023.

Acknowledgments
The authors would like to thank the following Xerces Society staff: Deedee Soto and Jessa Kay Cruz for their advice in early stages of the project and for help locating wild populations for seed collection; and Emily May, Sharon Selvaggio, and Sarah Hoyle for leading the pesticide risk assessment portion.

This project was funded by the California Bureau of Land Management through Funding Opportunity L20AS00044. BLM staff provided orientation and mapping related to BLM conservation priorities.