The Use of Site-Specific Native Plant Species in Restoration Design to Benefit Pollinator Habitat

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Background

- Majority of native plants require some degree of insect pollination for successful reproduction.
- Pollination by insects such as bees, moths, and butterflies is essential to the ecological function of natural landscapes throughout the United States, including the arid west.
- Pollinators have co-evolved with the native vegetation within their specific habitats, hence are often site-specific for foraging habits, growing season, climate, and soils.

Background

- Resiliency = ability to withstand and/or recover quickly from perturbation (i.e., disturbance).
- Ecological resiliency is in strong part the result of a diverse and healthy ecological matrix that incorporates a broad diversity of species and habitats.
- Pollinators are essential for healthy ecosystems in terms of diversity and plant reproduction.

Background

- Successful restoration is dependent upon the existence of a diverse and sustainable population of pollinators.
- Likewise, a diverse and sustainable pollinator population is dependent on the existence of a vigorous and diverse community of native plants.
- Population decline in native bumble bees, European honey bees, and butterfly species threatens the health and sustainability of wetland and riparian habitats

Background

- Since 2006 there has been an average annual loss of 30% of honey bee colonies, compared to a historic loss of 15% per year.

- Known as Colony Collapse Disorder (CCD), die-off thought to result from loss of natural forage, mite infestations and diseases, loss of genetic diversity, and exposure to pesticides such as the neonicotinoids.

Background

- Native bees, especially native bumblebees are also undergoing significant decline with many of the 50 native bumblebee species demonstrating significant population reduction.
- Habitat protection, enhancement, restoration, and creation are believed to be the best way to prevent further population loss.
- Many other pollinator populations including some butterfly, moth, and skipper species are also undergoing significant decline.

Policy

- Policies of multiple agencies are changing to recognize the role of ecotypic vegetation. Includes NRCS Plant Materials Program, USFS Nurseries, and BLM Seeds of Success Program.

- “Essence” of the policy is to recognize that geographic origin is an important consideration for revegetation and to preferentially use genetically local native plant species for revegetation efforts whenever technically and economically feasible.

Policy

- Currently submitted to Congress: Draft National Seed Strategy for Rehabilitation and Restoration, through the Plant Conservation Alliance, as comprised of:

  * USDI Bureau of Indian Affairs (BIA)
  * USDI Bureau of Land Management (BLM)
  * USDOT Federal Highway Administration (FHWA)
  * USDI National Park Service (NPS)
  * Smithsonian Institution
  * United States Botanic Garden

Policy

* USDA Agricultural Research Service
* USDA Forest Service
* USDA National Institute of Food and Agriculture
* USDA Natural Resource Conservation Service
* USDI Fish and Wildlife Service
* USDI Geologic Survey

- Interfaces at a local level with consortiums such as the Southern Rockies Seed Network

Policy

- Point of all this: Knowledge of diet and habitat, as well as biological attributes (i.e., resilience, persistence , or vigor), should be used as a template for restoration plans to accurately restore ecosystem functions and services.

  * Requires an accurate understanding of ecological communities and species mosaics

  * Requires the reestablishment of diverse species mosaics, using proper species richness and percentage, representing the proper genetics.

Application

- With this paradigm began to analyze multiple sites and species relationships for a broad diversity of projects in both the public and private sector, and both nationally and abroad.

  * 20,000 known bee species worldwide, with ca. 4,000 native bee spp. in North America including 40 to 50 species of bumble bees (*Bombus*).

  * Honey bees (*Apies mellifera*) came over with first settlers and promptly escaped.

Application

* Most common native bee families in North America:
    - Apidae (bumble bees, carpenter bees, squash bees, southeastern blueberry bees, and cleptoparasitic bees)
    - Halictidae (sweat bees)
    - Andrenidae (miner bees)
    - Megachilidae (mason and leafcutter bees)
    - Colleitidae (solitary bees)

Bombus spp. – native bumble bee

Halictid bee - sweat bee on *Sidalcea candida*

Andrena milwaukeensis - miner bee

Megachile – leafcutter bee


Xylocopa sp. – carpenter bee
(solitary bee)

Application

* Syrphid Fly, Hover Fly, Bee Fly

  * Comprise insect family Syrphidae

  * About 6,000 spp. in 200 genera. Several hundred spp. in Rocky Mountains .

  * Believed to 2nd most important pollinator

  * Found on all continents except Antarctica.


syrphid fly, hoover fly, or bee fly

syrphid fly, hoover fly, or bee fly

What's that in my garden?

Large bee-fly

It's hairy like a bee, hovers and hums, and has a scary-looking spike at one end. Every year in spring the large bee-fly causes many people to contact the Museum's Identification and Advisory Service to find out what it is.

Scientists don't know much about how bee-flies live, so they're always trying to find out more. The specimen used for this 3D scan was collected from the Museum's Wildlife Garden.

Left: Large bee-fly *Bombylius major*.


syrphid fly, hoover fly, or bee fly

Application

* Morphologically bees fall into two groups: short-tongued and long-tongued.

short-tongued bees - shallow, open flowers (e.g. Asteraceae (composite family) or Apiaceae (carrot family)). bee e.g. = Apies mellifera (honey bee).

long-tongued bees - flowers with a deeper throat (e.g. Fabaceae (pea family)) or are more open and flat (e.g. Ericaceae (heath family). bee e.g. = *Bombus* (bumble bee).

Apies mellifera – European honey bee

Bombus spp. – bumble bee

Application

* A total of 946 bee species, representing 66 genera (plus 141 subspp.) recorded for CO. Natural History Inventory of Colorado, believes actual number of species closer to 1100.
    * (8 *Bombus* considered threatened)

* Generalist spp. (e.g., *Bombus*) tend to use a succession of plant species based upon sequential flowering period.

* *Bombus* thermo-regulate therefore active earlier and later than other pollinators.

Application

* According to a new paper in the Journal *Science* climate change is causing the tongues of certain bee species (alpine *Bombus*) to shrink…. Approx. 25% over 40 years.

    * Medium length tongues allow for pollination of broader diversity of spp., then long tongues, or short tongues.

    * Rising temperatures are causing floral diversity to decline, forcing bees to become more generalist in foraging habit.

Application

* Approx. 610 Lepidoptera spp. in CO (249 in Garfield County alone).

  * Includes butterflies, skippers, and moths.

  * Approx. 70 are currently tracked by CNHP.

  * Requires determination of both larvae and adult habitat and dietary requirements.

Application

* Differences between butterflies, skippers, and moths:

  * Butterfly: At rest holds wings in upward or vertical position above the body. Antenna that terminate in knobs.

  * Skipper: Erratic flight. Moth-like body. Holds wings near vertical above body. Antenna terminate in knobs with hook-like extensions.

Limenitis weidemeyerii - Weidemeyer's Admiral


Pyrgus communis - common checkered skipper

Application

* Differences between butterflies, skippers, and moths (continued):

    * Moth: At rest spreads wings flat or holds ‘pitched’ (like a roof). Heavy bodies through thorax and abdomen. Antenna thread- or plume-like. Erratic flight.

Hypercompe scribonia - giant leopard moth

Application

- Strong wetland nexus for many native pollinator spp. Many native bees, butterflies, skippers and moths are highly dependent on wetland and riparian areas.

  * This includes both diet and habitat.

    native bee examples:

    * *Osmia* (mason bee) or *Bombus* using *Carex* (sedge) stands for food and habitat.

    * *Adrena* (miner bee) in *Salix* (willow) stands for food and habitat.

Osmia spp. – mason bee

Bombus spp. – bumble bee

Application

native butterfly example 1:

* *Satyrium liparops* (striped hairstreak):
    * Habitat: Open deciduous forest, meadows, prairies, streamsides, bogs, acidic areas.
    * Larvae: woody members of rose family (Rosaceae) including American plum (*Prunus americanum*); heath (Ericaceae), oak (*Quercus* spp.), willow (*Salix* spp.), and other woody species.

Satyrium liparops – striped hairstreak

Application

* *Satyrium liparops* (continued):

  * Adult: Nectar from oak (*Quercus* spp.), milkweed (*Asclepias* spp.), dogbane (*Apocynum* spp.), goldenrod (*Solidago* spp.), staghorn sumac (*Rhus aromatica*), heath (Ericaceae family), legumes (Fabaceae family).

* Underlines the importance of diverse native plantings without creation of a monoculture of woody vegetation or grasses.

Application

native butterfly example 2:

* *Speyeria cybele* (Great Spangled fritillary)
  * Habitat: Open, moist areas including pastures, meadows, woodlands, and prairies.
  * Larvae: violet (Viola spp.)
  * Adult: Multiple spp. including vetch (*Vicia*), milkweed (*Asclepias*), purple coneflower (*Echinacea*), dogbane (*Apocynum*), vervain (*Verbena*), and bergamot (*Monarda*)

Speyeria cybele - great spangled fritillary

Application

- Pollinator habitat is benefited by:

  * Short-duration , low-level wildlife grazing with ample recovery to limit woody spp. succession, and to encourage growth of native perennials. and increasing structural diversity to create improved habitat

  * Rotational, low-intensity burning of small parcels in a manner that leaves refugia, nesting sites, and adequate forage

Application

- Pollinator habitat is benefited by:

  * Removing invasive species by hand without pesticides, especially neonicotinoids.

  * Using site-specific seed mixes with a strong-balance towards herbaceous dicots (forbs) and forb seeding rates in excess of 100 seeds/sq. ft.

  * Retaining snags, leaves, and litter for nesting and overwintering sites.

Application

- Pollinator habitat is benefited by (cont.)

  * Clean surface water (stream, pond, etc.).

  * Lack of surface disturbance (tilling, plowing, etc.).

  * Planting of native shrub hedgerows, windbreaks, or shelterbelts featuring species with pithy twigs (e.g. *Sambucus* – elderberry).

Application

- Project Example 1: Revegetation Recommendations based on Surrounding Ecological Factors including Dietary Requirements for Umbrella Species, Garfield County, CO

  * Specific foraging habits of pollinators were used to determine revegetation mixes, using all major native bee, butterfly, moth, and skipper genera.

  * Companion study used historic university data and agency bioassay analysis to determination revegetation mixes to promote sage grouse.

Purshia tridentata – antelope bitterbrush

Application

- Project Example 1 (continued):

    * Collected woody shrubs:
        * shrubby cinquefoil (*Dasiphora fruticosa*)
        * twinberry honeysuckle (*Lonicera involucrata*)
        * white gooseberry (*Ribes lacustre*)
        * mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*)
        * Saskatoon serviceberry (*Amelanchier alnifolia*)
        * Utah serviceberry (*Amelanchier utahensis*)
        * antelope bitterbrush (*Purshia tridentata*)

Application

- Project Example 1 (continued):

  * Recommended altering seed rates to:

    Mule deer = 22% grass, 23% forb, 55% woody
    Elk = 60% grass, 25% forb,15% woody
    Pollinators = 5% grass, 85% forb, 10% woody
    Sage-Grouse = 0% grass, 43% forb, 57% woody

    Overall = 29% grass, 44% forb, 27% woody
    Seed applied approximately 120 seeds/sq. ft.

Application

- Project Example 1 (continued):

  * Prioritized Collection and Increase of:

    38 Woody Species (6 primary)
    82 Herbaceous Dicots (24 primary)
    22 Graminoids (13 primary)

  * Site-specific ecotypic collections

  * Working to create searchable directory

Application

- Project Example 2: Pollinator Habitat Improvement Projects, White River NF, Garfield and Pitkin County, CO

1. Coal Basin
   * Dutch Creek Road Rehabilitation
   * Replicated Soil Amendment
   * Field Trial on Amended Soils (Stomp Lot)
   * Biodiversity Islands
2. Butterfly Burrell
3. Hope Mine
4. Gas Pad Reclamation Field Evaluation Plantings

Installation of Bio Diversity Islands

Application

- Project Example 2: (continued)

  * White River ‘Ecovars’ (ecotypic cultivars) developed and released into marketplace.

    * blue wildrye (*Elymus glaucus*)
    * sandberg bluegrass (*Poa secunda*)
    * mountain brome (*Bromus marginatus*)
    * slender wheatgrass (*Elymus trachycaulus*)

Application

- Project Example 2: (continued)

  * Additional spp. under collection and increase:

    Herbaceous dicots:

    * sticky geranium (*Geranium viscosissimum*)
    * hairy goldenaster (*Heterotheca villosa*)
    * horsemint (*Agastache uriticifolia*)
    * scarlet gilia (*Ipomopsis aggregata*)
    * Jacob's ladder (*Polemonium foliosissimum*)
    * varileaf Phacelia (*Phacelia heterophylla*)

Application

- Project Example 2: (continued)

  Herbaceous dicots (continued):

  * Richardson's geranium (*Geranium* richardsonii)
  * orange sneezeweed (*Hymenoxys hoopsii*)
  * largeleaf avens (*Geum macrophyllum*)
  * cutleaf groundsel (*Senecio triangularis*)
  * Rocky Mountain columbine (*Aquilegia coerulea*)
  * lupine (*Lupinus argenteus*)
  * yellow monkeyflower (*Mimulus guttatus*)
  * fireweed (*Chamerion angustifolium*)
  * alpine bluebells (*Mertensia ciliata*)

Application

- Project Example 2: (continued)

  * Woody Species :
    * shrubby cinquefoil (*Dasiphora fruticosa*)
    * twinberry honeysuckle (*Lonicera involucrata*)
    * white gooseberry (*Ribes lacustre*)
    * mountain big sagebrush (*Artemisia* tridentata ssp. *vaseyana*)
    * Saskatoon serviceberry (*Amelanchier alnifolia*)
    * Utah serviceberry (*Amelanchier utahensis*)
    * antelope bitterbrush (*Purshia tridentata*)

Application

- Project Example 2: (continued)

    * graminoid species:
        * *Elymus trachycaulus* – slender wheatgrass
        * *Bromus marginatus* – mountain brome
        * *Poa secunda* – Sandberg's bluegrass
        * *Elymus glaucus* – blue wildrye
        * *Achnatherum nelsonii* – Dore's needlegrass

Application

- Project Example 2 – goals:

  * Provide a demonstration and field evaluation planting area for local native materials.

  * Demonstrate tools and techniques to determine cost-to-benefit ratio.

  * Serve as a genetic repository and increase for site-specific ecotypes.

  * Improve habitat and benefit pollinators through increased cover, structure, and diversity.

Application

- Project Example 2 (continued):

  * Installed multiple sites with up to 325 “bioislands” in Coal Basin (Redstone), Butterfly Burrell (Meeker), and Hope Mine (Ashcroft).

  * Used various combinations of biochar and compost.

  * Installed randomized arrays of pollinator spp.

  * Currently obtaining and interpreting data.

Recommendations

- Stop using neonicotinoid pesticides.
- Increase spp diversity within restoration plantings, especially of ecotypic herbaceous dicots.
- Use habitat driven revegetation using reference sites and Ecological Site Descriptions.
- Kick-start native plant industry through grants, technology transfer, and coordinated opportunities.
- Update agency and industry policy, manuals, responsibilities, and protocols.

Recommendations

- Emphasize cultural research such as germination, cultivation, seed cleaning, and establishment.
- Better understand species transfer zones and reproductive biology through common gardens.
- Develop gene analysis to determine ecological source and genetic fit.
- Offer native plant horticulture classes at University level. Develop accredited native production programs.

Recommendations

- Create enough market opportunity to enable maturity of a restoration industry with reasonable pricing and predictable career path.
- Use innovative planting and propagation programs such as SWIFT (State Wildland Inmate Fire Team).
- Facilitate information exchange, including methodologies, successes and failures within literature, industry, and conferences.