# Additional Resources for *Matching Appropriate Seed to Conservation Goals* Webinar

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## To plant or not to plant? (If not, thin and/or burn?)

Melvin, Norman. 2003. "Decision sequence keys" for wooded and herbaceous wetlands in *Wetlands restoration, enhancement, and management*. USDA NRCS Wetland Science Institute. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_010838.pdf

Thinning. http://nac.unl.edu/ The National Agroforestry Center has a lot of publications highlighting forest management that provides benefits for wildlife

Prescribed fire. http://www.goodfires.org/ While this site is southeast-centric, the benefits of fire they highlight are relevant globally.

## NRCS Plant Materials Program

This links to information about as well as photos of plant materials developed and released from the Plant Materials Program: http://www.nrcs.usda.gov/wps/portal/nrcs/phreleases/plantmaterials/technical/cp/photo/

To learn about plant materials developed for your region, find the Plant Material Center closest to you at http://www.nrcs.usda.gov/wps/portal/nrcs/main/plantmaterials/pmc/

## Local ecotypes, plant conservation, & seed calculators

McKay, J. K., Christian, C. E., Harrison, S. and Rice, K. J. 2005. "How Local Is Local?"—A Review of Practical and Conceptual Issues in the Genetics of Restoration. Restoration Ecology, 13: 432–440. doi: 10.1111/j.1526-100X.2005.00058.x

Plant Conservation Alliance—a consortium of public and private organizations and individuals working to conserve native plants http://www.nps.gov/plants/

Native American Seed. 2015. Responsible beauty: The Wildflower Issue (seed catalog). http://www.seedsource.com/NAScatalogfall/index.html [Note: Tells the story of being introduced to and making American basketflower, *Centaurea americana*, seed available.]

Seed calculators

- South Carolina NRCS http://efotg.sc.egov.usda.gov/references/public/SC/SC327_Conservation_Cover_JS_Monarch_Habitat_October_2015.pdf. A copy is also posted with the webinar replay.
- Iowa NRCS
  - Iowa's Native Seed Calculator http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/ecoscience/?cid=nrcs142p2_008193
  - Jennifer's Native Plant Community Query Tool and template native plant community seed mixes (in Iowa's Native Seed Calculator) http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/technical/?cid=nrcs142p2_008160
- Illinois NRCS https://efotg.sc.egov.usda.gov/references/public/IL/327Calculator_ver2.4_11-19-2015.xlsx
- NRCS Tools http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=STELPRDB1257225&ext=xls
- Xerces Society http://www.xerces.org/wp-content/uploads/2009/11/XERCES-SEED-MIX-CALCULATOR.xls

Native Seed Network Glossary http://www.nativeseednetwork.org/article_view?id=13

## Restoring longleaf pine

VA NRCS Restoration and Management of Rare and Declining Habitats: Longleaf Pine Establishment and Restoration (Virginia Conservation Practice Job Sheet 643) http://www.dgif.virginia.gov/quail/643-Long-Leaf-Pine.pdf

The Longleaf Alliance http://longleafalliance.org/

Large Flower Partridge Pea in Longleaf Pine Plantings: The Plant, Issues and Answers http://www.forestrywebinars.net/webinars/large-flower-partridge-pea-in-longleaf-pine-plantings-the-plant-issues-and-answers

## Farm management that restores soil health & diversity

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/

Plant Enhancement Activity – PLT16 – Intensive management of rotational grazing http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd328681&ext=pdf

Winter grazing—a better way to feed https://www.youtube.com/watch?v=PIHDmlUQ-1o

Jay Fuhrer—Integrating livestock into a cropping system for sustainability and soil health webinar https://www.youtube.com/watch?v=lk2kq46qcHI

Mob grazing produces healthy soil and livestock (includes video) http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ia/home/?cid=stelprdb1186272

Conservation Biological Control webinar http://www.conservationwebinars.net/webinars/conservation-biological-control-habitat-management-to-control-pests

Farming for Beneficial Insects http://www.conservationwebinars.net/webinars/farming-for-beneficial-insects-pollinators-predators-and-parasitoids/?searchterm=pollinators

Herzberger, A. J., Meiners, S. J., Towey, J. B., Butts, P. A. and Armstrong, D. L. 2015. Plant–microbe interactions change along a tallgrass prairie restoration chronosequence. *Restoration Ecology*, 23: 220–227. doi: 10.1111/rec.12165 . http://csis.msu.edu/sites/csis.msu.edu/files/Herzberger.pdf

## Floristic Quality Assessment & plant guilds

Universal FQA Calculator http://universalfqa.org/ Floristic Quality Assessments (FQAs) are assessments for comparing the conidition (or quality) of natural areas.

Duckworth, J., M. Kent, P.M. Ramsey. 2000. Plant functional types: An alternative to taxonomic plant community description in biogeography? *Progress in Physical Geography* 24: 515-542. http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.0040001

Allain, L., L. Smith, C. Allen, M. F. Vidrine and J. B. Grace. 2004. A floristic quality assessment system for the coastal prairie of Louisiana. *Proceedings of the North American Prairie Conferences*. Paper 62. http://digitalcommons.unl.edu/napcproceedings/62http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1061&context=napcproceedings

Mortellaro, S., M. Barry, G. Gann, J. Zahina, S. Channon, c. Hilsenbeck, D. Scofield, G. Wilder, and G. Wilhelm. 2012. Coefficients of conservation values and the floristic quality index for the vascular plants of south Florida. *Southeastern Naturalist* (11, Monograph 3):1-62. https://www.fws.gov/verobeach/Home/S1029%20Mortellaro%20monograph.pdf

Rainer, T. and C. West. 2015. *Planting in a Post-wild World: Designing Plant Communities for Resilient Landscapes* Timber Press, Portland, OR. https://www.timberpress.com/books/planting_post_wild_world/rainer/9781604695533

## Techniques for competing with exotic invasives

Funk, J. L., Hoffacker, M. K. and Matzek, V. 2015. Summer irrigation, grazing and seed addition differentially influence community composition in an invaded serpentine grassland. *Restoration Ecology*, 23: 122–130. doi: 10.1111/rec.12162

Wheeler, M. M., Neill, C., Loucks, E., Weiler, A., Von Holle, B., Pelikan, M. and Chase, T. 2015. Vegetation removal and seed addition contribute to coastal sandplain grassland establishment on former agricultural fields. *Restoration Ecology*, 23: 539–547. doi: 10.1111/rec.12253

## Strategies for establishment in drought-prone areas

Wilson, S. D. 2015. Managing contingency in semiarid grassland restoration through repeated planting. *Restoration Ecology,* 23: 385–392. doi: 10.1111/rec.1220

## Additional responses to questions from webinar

Following are a few additional notes regarding questions not fully answered in the webinar or not already addressed in the sections above. Jennifer also provided a terrific set of reference articles in a separate file, also posted with additional resources, that address many of the questions below.

1. ***Would grazing help on the Alamo switch and partridge pea where it is too thick? You may need to shred it first so that young tender shoots are available to cattle.***
    a. Sudie: Good ideas. The landowner with the switchgrass problem has asked around for help from cattle farmers but no one wants anything to do with the switchgrass for fear of it spreading to their land. He asked them about cutting it for hay, but am not sure grazing it was discussed. They are on the 3rd year of chemical treatment and it is still growing strong. There may have been some ineffective treatment applied along the way. The plan is to eradicate the switchgrass and replant the longleaf, particularly since land is under a CRP contract. Unfortunately, the whole deal has given the landowner a bad impression of longleaf. Guilty by inappropriate association.
    b. Jennifer: My recommendation is a chemical burn down and replanting.

2. ***Seed calculator questions (see links included above for SC, IA, IL, and Xerces calculators).***
    a. Nancy: Some states have developed their own seed calculators based on their own plant communities,

but not all. NRCS is working on regional seed calculator tools. Posted links above. Sudie adapted hers from one developed by Mimi Williams, Florida NRCS.

b. Jennifer: Chris Taliga with the PMC in Colorado is working on a team that's developing a national seeding calculator.
c. From K. Macy, a participant: Have you seen Gene Barickman's 643 calculator on IL eFOTG? I think it mirrors many of these recommendations, and also specifies species to dry mesic, mesic, and wet mesic sites, including savannahs in Illinois. (in links above)

3. ***How do you suggest dealing with seed with high levels of hard seed? Won't it affect establishment? If you have to wait additional seasons for the high hard seed to germinate won't you be creating the opportunity for other species to take over or create the 'gaps' the presenter mentioned, or further erosion?***
    a. Sudie: Seeding in the fall or dormant season helps with scarification of hard seed.
    b. Jennifer: I agree with Sudie, if there's a high percentage of hard seed, then seed in a manner that will fulfill the germination requirements to break dormancy. This will take some research. Prairie Moon Nursery in MN has a free catalog that lists the germination requirements for many native species. Re initial 'gaps', this is a good example of why conservation planning is necessary to ensure success. A nurse/cover crop to hold a site may be a good option until it can be seeded to natives at the "right" time. I've successively used Canada wildrye as a cover crop for a site that was interseeded with a diverse mix of hand collected natives over 3 years' time. I've used oats to hold a site temporarily (< 1yr), making sure to clip the heads before it goes to seed so it doesn't self sow.
    c. Nancy: If planting small quantities, hard seeds can be scarified to improve germination, but as Sudie and Jennifer mention, fall planting allows for cold moist stratification that tends to soften the hard seed coat over winter and improve germination come spring. Prairie Moon has lots of great concise info, both "How to Germinate Native Seeds" and a cultural guide that lists the germination requirements for more than 800 native species. Re initial 'gaps,' it's good to remember the guilds Jennifer spoke about, early colonizers, matrix, and conservative not only for planning the mix, but for expecting change in how your planting will look over time. One thing we didn't talk about in depth was that it usually takes 3 years for a planting to look pretty good. It's important to recognize (and communicate to clients) that it may look very different each year, especially for the first 4 or 5 years, as a somewhat more stable population establishes, and some of the slower growing plants (*Baptisia*, for example) appear.

4. ***If a species seed size is very small compared to a species in the mix that is very large won't that skew the actual plant community planted?***
    a. Sudie: The seed calculator incorporates seed size through seed per lb. The ratio of each species in mix is based on number of seeds per species in mix. Also, as Jennifer wrote, a carrier mixed with seeds when planting will help more evenly distribute fluffy and small seeds. Recommended carriers when broadcasting include: clay bentonite (kitty litter), pelletized lime, sand, sawdust, soy hulls, cracked corn (some guidance calls for dampened carrier). Use at least 3 times as much carrier as seed; the more the seed is diluted, the better it will be distributed. Carriers like oats, cracked corn, or rice hulls are sometimes used to facilitate movement of fluffy and small seed through seed drills.
    b. Jennifer: When seeding a mix with both large and very small seed, you may need to adapt your seeding technique to ensure even coverage. For example, use a carrier with a tackifier, use a drill with a separate box for small seed, or plant the small seeded species and large seeded species separately. Otherwise, the small seed will settle to the bottom and drop out at the beginning of planting. This is true for aerial seeding as well, the small seed will drop out right away and won't be evenly dispersed.
    c. Nancy: If you have fluffy seeds, those also may need to be handled separately. The seed calculators are used to develop a mix based on numbers of seed per square foot because of the great variability in seed size and number (which is harder to address with weight measurements unless always using the same types of seed) in seed mixes with diverse forbs (wildflowers). Traditional upland bird mixes that are recommended in pounds per acre were also developed using seed calculators, but because they became

standard mixes, could be translated into pounds per acre. Because some wildflower seeds may number in the millions per pound, while others may have 50,000, seed calculators help ensure enough seed for good coverage but not too much that seed is wasted. For broadcasting, most diverse wildflower and grass mixes should be seeded at 40-60 seeds per square foot, or 30-40 if using a drill (but care must be taken not to plant too deeply with a drill).

5. ***Not all suppliers, especially for native forbs, have PLS info.***
    a. Jennifer: Reputable suppliers will have tested seed and a seed tag. Most of the time, they will develop a PLS mix upon request. If the supplier doesn't have this info, it's a red flag.
    b. Sudie: Suppliers should also be able to provide information on the intended purpose of species "cultivars", "varieties" and "selections"; this information can help in the development of an appropriate seed mixture.
    c. If buying seed, it is important to use a reputable supplier, as Jennifer and Sudie both discussed during the webinar. For sites where you want to use truly local ecotypes and the planting is small, you may want to harvest seed from nearby sites. Sometimes people harvest "hay" from a native meadow. This can be a wonderful way to utilize local ecotypes, but because seeds mature at different times, and harvesting might depend on the same factors as harvesting regular hay, there are limitations, including testing for viability. If weather conditions are too wet, you may not be able to choose the "optimal" time for a species you are targeting; a fall harvest misses species that mature in early summer; and many other variables cannot be controlled. Despite all these drawbacks, there are nevertheless great advantages to trying to utilize locally harvested seed in some situations (but probably not those receiving financial assistance).

6. ***So, a good rule of thumb is to shoot for biodiversity in the seed mix?***
    a. Jennifer: Absolutely! But it's more than just biodiversity, the species chosen have to be to be genetically adapted, appropriate for the restoration site and the mix must have a spread of early to late successional species represented and must be functionally diverse. One can throw a lot of species in a mix, but if the species chosen are not appropriate and balanced, the stand may ultimately fail.

7. ***Any thoughts on the survivability when seeding restoration areas? Do you think that it is better to over-seed for survivability? So, diversity is Key to Survivability?***
    a. Jennifer: Iowa NRCS has been seeding herbaceous mixes with great establishment for over 20 years. The trick is using PLS seed of appropriate species that are well suited for site conditions and are planted at the correct times and rates. Overseeding is warranted where you expect establishment to be a challenge. Typically 40-60 PLS seeds/ft2 will do the trick.

8. ***It can be useful to clump them in small areas rather than trying to evenly distribute across the site.***
    a. Jennifer: This is true if you're trying to establish species that are hard to get going by seed. Seed the rest of the area with species that establish well from seed, then clump plant the more finicky species. You can also introduce species diversity of existing plant stands by clump planting. Typically, this is labor intensive and expensive.
    b. Sudie: Clumping is recommended when planting for the benefit of pollinators where clumps of the same blooming species may more easily attract them.
    c. Nancy: This can also be useful for pockets of very different site conditions, such as wet spots in the middle of mainly upland areas. For pollinator plantings, we often recommend clumping to help pollinators locate patches by sight or smell.

9. ***In species 'richness' are you describing by weight or by seed size? Do you have a reference(s) for the research about the success of under-represented species and the evenness of seed mixes? Could you provide links to research on uneven seed mixes going extinct?***

a. Jennifer: Species richness is the number of different species, regardless of their abundance. Species diversity, dominance, or evenness calculations take into account species richness + abundance. For a seed mix, these diversity measures are typically on a PLS seeds/lb basis. In established plant stands, abundance can be measured as % cover, number of racemes, number of stems, basal area, etc., per unit area.
b. A few references (see separate list, as well)
    i. Mace, Georgina M., Ken Norris, and Alastair H. Fitter. 2012. Biodiversity and ecosystem services: a multilayered relationship. Trends in Ecology & Evolution 27.1: 19-26.
    ii. Shea, K. and P. Chesson. 2002. Community ecology theory as a framework for biological invasions. TRENDS in Ecology and Evolution Vol. 17 No. 4:170-176.
    iii. Simpson, Thomas B. 2005. Ecological Restoration and re-understanding ecological time. Ecological Restoration: 46-51.
    iv. Wilsey, B.J. and H. Wayne Polley. 2002. Reductions in grassland species evenness increase dicot seeding invasion and spittle bug infestation. Ecology Letters 5:676-684.

***10.*** [Jennifer received these questions following the webinar. Responses are hers.] ***You mention the species richness and species diversity/evenness terms. I was wondering how you came up with a percentage mark on the species diversity? Do you have a good aiming point for species diversity/evenness? The two examples you provided on the webinar came out to 87% and 50%… Obviously the 87% is better, but what is a good shooting point? What is a number you never want to be below?***

A lot of this is based on personal experience, trial and error, knowledge and familiarity with how the species in the mix will behave during and after establishment, and scientific literature inference. It's kind of like a chef saying a pinch of this, a tad of that.

See the list of reference articles. Many of them cover the topic of seed mix development. I'd recommend reading through the relevant articles and dabbling with a few seed mixes to see what works best for the communities you're restoring.

As for species diversity, 16-24 species should be the absolute minimum. My mixes generally consist of a minimum 10 graminoid species (@ 20 PLS seeds/ft2) and 20 forb species (@20 PLS seeds/ft2) that are all natural community based. Once I have the correct species chosen for the community and all relevant functional groups are represented:

First, I shoot for complete evenness on a seeds/ft2 basis within the grass and forb portions of the mix, respectively.

Secondly, I reduce the number of seeds/ft2 of aggressive species. Typically, the big prairie grasses, several of the sunflowers (Helianthus sp.), some Asters (*Symphyotrichum* sp.), partridge pea, etc., need to be reduced.

Thirdly, I decrease the number of seeds/ft2 of very expensive species so the mix cost is acceptable, but not to the point at which I fear they'll go extinct in the stand.

Lastly, I evenly bump up the seed count of the remaining species and/or add new species to the mix to make up for the losses in steps 2&3. Typically, I start getting leery of an evenness < 70%.

Per floristic quality of the mix, I shoot for a mean coefficient of conservatism of 3.0 and an FQI>20. These two numbers reflect the richness and seral stage representation of the mix.

The seeding calculator I developed for Iowa NRCS calculates all of these indices for you. Look at the second to last tab called "643Rst&ManR&DeclHab Check Sheet". I'll be discussing how to use this and other tools during another webinar next October.

NOTE: Jennifer's webinar "Restoring Native Plant Communities: Soil and Hydrology Suited Planning Tool (Iowa Case Study)" is scheduled for October 25, 2016 at 2 p.m. Eastern time. Visit http://conservationwebinars.net/ about a month before for more details.