NURSERY PROPAGULE COLLETION AND GROWING GUIDELINES TO AVOID GENETIC DEGRADATION ON RESTORATION SITES

GOLDEN GATE NATIONAL PARKS
Betty L Young, Program Director of Nurseries

In an ideal world, we would not plants container plants at restoration sites. It would be better to simply manage for natural recruitment of natives in sites to be restored, This is possible when there is sufficient native seedbank and the site is not subject to reinvasion by weeds. In this park we have both challenges, which make the planting of container plants, usually the most successful method. However, we take steps throughout the collection and growing season to provide the most “natural” plants possible.

There is a compelling body of evidence demonstrating the importance of using local propagule sources for restoration. A comprehensive literature review was completed by Yan Linhart, University of Colorado at Boulder. His conclusions showed the importance of maintaining local ecotypes, whether there is phenotypic variation or not. Also, research by EE Knapp and K Rice from University of California at Davis, demonstrates the ecotypic variation of species in different areas of the state.

This local variation also increases the probability of survival in a project by using plants best adapted to the particular site. In the park, we normally define local as within the same watershed. We don’t want to impact the local population with outside genes that may cause adverse effects. We want to preserve the unique genetic mix that has evolved at the site and is successful there. As a National Park, part of our mission is to preserve the unique genetic resource present in each species in each area of the park.

While we are collecting locally, we need to insure a broad enough to prevent genetic degradation; inbreeding, and genetic drift and allow natural selection and gene flow. In other words, we want to create a self-sustaining habitat. In order for plants to successfully reproduce and continue to evolve as the site conditions change, there must be sufficient genetic diversity within each species in the plant population at the site. When collecting within only one watershed, the collector and nursery must be careful to maintain genetic diversity within the population and avoid artificial selection in the nursery where possible. Therefore, we seek a balance, locally adapted plants, with as much genetic diversity within those plants as possible.

Seed and propagule collection

First, for these reasons, we use seed whenever possible. Unless a species is self-pollinated, each seed on a plant will be genetically different. The pollen fertilizing the ova, will be from a different male. Even if self-pollinated or if all flowers pollinated by the same male plant, each seed will be slightly different due to meiosis and the recombinant DNA in the fertilized zygote.

Just as each of your brothers and sisters is different, even when all of you have the same parents. Of course, in self-pollinated species, there is less genetic variation within a population but greater variation from one population to the next. Whereas, out crossing species will have more variation within a population but less from one population to the next. (Linhart)

Seed collecting in the field

Each of our rules for collecting is made in consideration of the above;.

- No seed is collected from the wild, except for an approved project. Please verify with the project manager that the project has received all required approvals and permits. Project Review or Restoration Acton Plan must be approved before seed collection begins.

- If a plant is to be reintroduced to an area, in which it no longer exists, a Reintroduction Plan must also be completed and approved, before planting.

- **Normally, only seed is used for propagation. It is collected from the watershed in which the project will be planted.** If there is insufficient seed source in that watershed, permission must be obtained from the Park Plant Ecologist to collect from another area. The plant ecologist may define a collection zone other than the watershed if knowledge of the species provides a better definition of "local" for that species.

- If you have not collected this species before, check the Park Restoration Database or the Nursery Manager for a description of what ripe seed looks like.

- We want to collect only the minimum amount needed to provide the requested plants for a project. Records are kept of the germination rate and survival rate in the nursery. Seeds per gram counts are kept of uncleaned and clean seed. **Calculate the number of grams of seed needed based on this information. Collection no more than this amount.**

- **Collect no more than 5% of the available seed from any species within that area.** (Unless this is a site that will be completely destroyed due to development). This leaves sufficient seed for natural regeneration in the collection area. We do not want to degrade a wildland natural remnant site for restoration. This is our most valuable habitat.

- Each project manager or nursery manager should keep records of where seed has been collected, so that no more than 5% of the seed of any species within the collection zone may be gathered. GPS collection sites where possible. Always GPS uncommon plant collection sites. Enter in Cybertracker to be GISed. We have a shareware program which allows us to use inexpensive PDAs and GPS units to fill out CNDDB forms and GPS locations. This GPS information can be imported into a GIS mapping system.

- **Collect from as many plants of a single species as possible throughout the collection area, but never less than 10 plants, 50 plants a minimum for herbaceous species.** Do not bother to collect from only one plant. If there are fewer than 10 plants

check with the plant ecologist, about whether to use just the available 5% or to go outside the watershed. To determine collection zones, the species breeding system, pollinators and seed dispersal mechanisms are considered

- **Collect each species for the project several times throughout the seed ripening period; early, mid and late ripening seed.** We don't want all late ripening seed, that may never ripen on the site if there is an early frost. The later seed should be combined with the early and mid seed, so that not just one portion of the seed. Then a random mix of seed will be sown. There will be a range of collection dates in the records for each seed batch.

- Look at the elevation, soil, slope and aspect at the site where planting will be done. Keep this in mind when collecting. Try to collect from similar conditions if there are sufficient numbers of plants to provide a good genetic mix.

- Complete required paperwork and return to the Nursery Manager or Seed Collector for the project. Complete:
    - Propagule Collection Record for each species collected within a collection area. You may have multiple dates of collection on a record. Enter this into the Park Restoration Database.
    - Fill out a Work Record with time spent collecting the seeds.

Sometimes, seed is not used for propagation. If a plants natural breeding system is clonal, like strawberries and willows, we propagate clonally. However, methods vary even with clonal propagation. Strawberries area self-pollinating genera. We normally, therefore, collect from a single population, to avoid genetic swamping by an outside population. Usually, a discussion is held, and a decision is made based on the site characteristics. Willows are wind pollinated and therefore vary within populations. We avoid producing one of just a few clones by collecting from as many individual plants within a populations and from all possible populations in the watershed. Even though clonal, the cuttings will be variable since they came from many individuals.

Hopefully, following these guidelines will give a local but genetically diverse batch of seeds for a species within a watershed.

Seed stratification

The avoidance of artificial selection does not stop at propagule collection. Reduction in genetic diversity can readily happen through nursery growing practices. Even on the coast of California, many species of seed are adapted for a cool wet winter. Most seed is collected in the summer and fall, dehydrated, and put in dry cold storage. We must provide moist cold conditions to break seedcoat or internal dormancy of our collected seeds. We could sow seeds in the fall and let that winter's cool temperatures stratify the seeds. The seeds that obtained enough cold temperatures to break their genetically determined dormancy period would then germinate. However, we would be selecting out seed that required a longer winter than this year's. We therefore, stratify in the refrigerator, at 38-40oF, Luckily in California, typical refrigerator temperatures mirror our winter nighttime temps. Yes, ideally, we would make some night colder and some warmer. However, usually seeds need a certain number of degreehours. The warmer temperature can be overcome by stratifying longer.

Any seed that germinates over a period of time, longer than 2 weeks, indicates that more stratification was needed than was given. Even grasses, which germinate fairly well without stratification are stratified for 2-3 weeks, simply to insure that all seed in the batch have the stratification they may require.

- Record in Species Information Records a range of stratification days. Begin checking seed when the shortest time has elapsed. Once radicles emerge, sow these seed.
- Return to the Seed batch in stratification once a week and sow new emergents, until the longest strat. period has elapsed and no additional seed has germinated. Sow all remaining seed.

Seed Germination

We try to mimic as closely as possible, the conditions when the species normally germinates. We also, must time each crop to be outplantable size by November 15. We may start a seed in the greenhouse earlier that its normal germination time, by putting on a heated bench. Depending on how quickly the plant grows, it may be started on a heated bench, unheated bench in greenhouse or outside.

One of the main reasons, direct seeding in the field seldom works in California, is that the rains seldom cooperate. If there is sufficient seed source, if its rains every third day and if temperatures stay moderate, direct seeding may be successful. We typically, need only 1/10 the amount of seed to grow nursery plants as is needed to direct seed a site. The secret to this is mist in the greenhouse. We can keep seeds from drying out before and after they germinate.

Here we wait until germination stops, before transplanting seedlings. Then we have early and late germinating individuals.

Seedling Transplanting

We usually ask the smallest student in education programs, are you less healthy or robust because you are shorter than your brother or sister? Just because a seedling is small, does not mean it isn't healthy and robust. Herbaceous seeds are usually started in a flat, unless very reliable germinators. We instruct staff, interns, volunteers, and students to transplant big and small seedlings. We, normally, transplant seedlings from the germination flat to their final container, usually Steuwe and Sons Deepot 16™. This avoids multiple transplant events that can further change the already altered root structure. For woody species, grasses and reliably germinating forbs, we usually direct sown seeds in the final tube. Leachtube 10 cu in for grasses, deepot 16 cu in for forbs, depot 40 cu in for shrubs and Treepot 4"x14" for trees. When culling extra germinates, we tell volunteers to keep the center seedling and cull or transplant to another pot any other germinants in the pot.

Volunteers transplanting seedlings

Growing on

From transplant until time for plants to go to the field, it is difficult to avoid conditions that degrade genetic diversity. In California, there is no summer water. CA species are adapted to dry summer conditions. They conpensate for thaving little =water available by mining vast areas with their root systems. Mycorrhizal associations (beneficial fungal symbiosis)expand the area from which a plant can mine water. In the nursery the plant has a little tube. We have to provide summer water. This will promote the survival of plants more adapted to having rootzone moisture. All we have found to do is provide an extremely well drained potting media, which provides moisture, but quickly drains to avoid any water-borne pathogens. We employ every cultural control we can think of to promote healthy plants; draining thoroughly between watering, spacing plants to promote air movement, intermixing crops to avoid large areas of a single tasty species, timing propagating properly to avoid a rootbound condition late in the season, compost tea, compost based potting mix, keeping plants on raised benches off of the soil, pulling weeds around the nursery and any in the pots.

We fertilize at very low rates of nitrogen, which will promote rapid vegetative growth and thin cellwalls susceptible to fungal attack. Cottonseed meal (6-2-1) and bonemeal (3-15-0) is used in the potting mix as the main nutrient sources. These both release slowly throughout the season. Very little supplemental fertilization is needed in our 6-9 month growing season.

Volunteers grooming plants

With the exception of trees, plants are pruned to keep a positive root to shoot ratio. This promotes survival through the dry summer after planting. Since water uptake needed to avoid wilting is directly proportional to the leaf surface area. We keep that area to a minimum that will allow to the plant to maintain a healthy state.

Hopefully, with these procedures, as much artificial selection as possible has been avoided. Those few plants that were particularly adapted to nursery conditions may be planted out but would be culled in the site by natural conditions the year following outplanting.

A commercial nursery would go broke if they followed all of these guidelines. However, we who serve the national parks, have the advantage of interns and volunteers. We can use these special methods because of our strong force of dedicated volunteers who donate almost 40,000 hours to the park's five nurseries. They help collect, transplant, water, prune, cull and maintain 120,000 genetically diverse and healthy plants each year.