The Target Plant Concept

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The first native plant nurseries in North America were gardens of plants transplanted from the wild by indigenous people. Specific plants were irrigated and otherwise cultured in these gardens to produce seeds, leaves, roots, or other desirable products (figure 2.1). As native people collected seeds from the largest or most productive plants, they were making the first genetic selections that resulted in new cultivated varieties. Plants that could not be easily domesticated were cultured at their natural sites by pruning to increase seed or fruit production.

Among the first contemporary native plant nurseries were forest tree nurseries that were established in the early 1900s. The objective of the nurseries was to reforest and restore forests and protect watersheds after timber exploitation or forest fires. The process was very simple: nurseries produced seedlings that were shipped for outplanting. Foresters took what they got without much choice. Tree planting was a mechanical process of getting seedlings into the ground in the quickest and least expensive manner. Not much thought was given to seedling quality, different stock types, or the possibility of matching seedlings to outplanting site conditions.

THE TARGET PLANT CONCEPT

The Target Plant Concept is a new way of looking at nurseries and the uses of native plants. After working with forest and native plant nurseries for almost

William Pink of the Pechanga Band of the Luiseno Indians in California by Kate Kramer.

Figure 2.1—*Native Americans cultured many native plants, such as camas, for nutritional, medicinal, and other cultural uses.* Image PG38-1062 courtesy of Special Collections and Archives, University of Idaho Library, Moscow, Idaho.

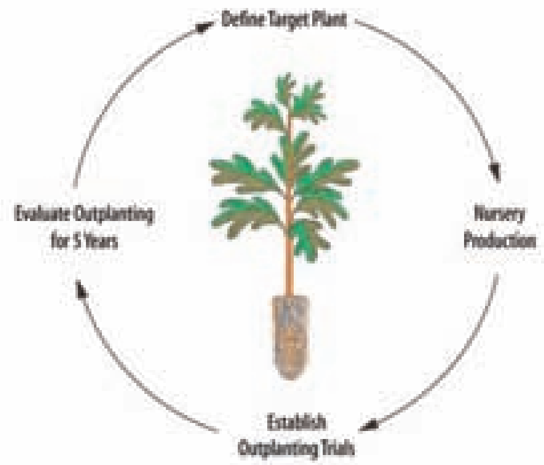


Figure 2.2—*Information from the client defines the initial target plant and outplanting performance then fine-tunes these specifications.* Illustration by Jim Marin.

30 years, I believe this concept is one of the critical aspects to understand when starting a new nursery or upgrading an existing one. The Target Plant Concept is based on three simple but often overlooked ideas.

1. Start at the Outplanting Site

Without the concept, a nursery produces a crop of plants that are provided to clients. In this one-way system, clients have little control over the type or quality of plants they receive. With the concept, the process is approached in a completely different manner: starting with the characteristics of the outplanting site, clients specify exactly what type of plant material would be best.

2. The Nursery and Client Are Partners

Without the concept, clients seek plants solely by price or availability. With the concept, the client specifies the ideal type of plant for the project, the nursery grows the plants, and they are outplanted. Based on performance of this first crop, the client and nursery manager work together to make necessary changes to improve survival and growth. Using these revised target plant characteristics, the nursery grows another crop that is again evaluated on the project site (figure 2.2). This feedback system fosters good communication between native plant customers and nursery managers, builds partnerships, and ensures the best possible plants for the project.

3. Emphasis on Seedling Quality

Without the concept of quality, inexperienced growers and clients think there are cheap, all-purpose native plants that will thrive just about anywhere. With the concept, it is clear that *plant quality cannot be described at the nursery, but can only be proven on the outplanting site.* A beautiful crop of plants in the nursery may perform miserably if they are inappropriate for conditions on the outplanting site.

DEFINING TARGET PLANT MATERIALS

The Target Plant Concept consists of six sequential but interrelated steps, which are illustrated in figure 2.3 and described below.

Step 1 — What Are the Project Objectives?

This step may seem obvious but it is all too often overlooked. Exactly what is trying to be accomplished? Native plants are grown for a variety of reasons and project objectives have an overriding effect on the best types of plants to produce. Native American tribes want native plants for many purposes, including reforesting after timber harvest, ensuring local supplies of cultural or medicinal plants, restoring plant communities, controlling invasive species, creating wildlife habitat, producing native foods, educating young people, and developing small businesses.

A few tribes have productive forestland and grow seedlings of commercial trees to replant after timber harvest. For example, the Red Lake Band of the Chippewa

Indians grows red pine and eastern white pine in their greenhouse in Minnesota to reforest after timber harvest (figures 2.4A and B).

One of the most mentioned objectives for Native American tribes is to produce native plants having cultural or spiritual significance. Often, these plants are getting harder to find and grow only in remote locations that are difficult to access, especially for elders. For example, many Indians use sweetgrass in their ceremonies. Unfortunately, some do not have access to this species, so tribes could grow sweetgrass in their nursery or purchase it from another tribe. The Confederated Tribes of the Umatilla Indian Reservation use tule for floor mats and other utilitarian purposes (figure 2.5A). Basketry is an important cultural heritage and Native Americans use many different native plants for basket materials. The Mohawk and other tribes of the Northeastern United States use black ash (Benedict and David 2003), whereas the Pechanga Band of the Luiseno Indians of southern California use dogbane. At the Redwood Valley Rancheria in northern California, white-root sedge was propagated and then outplanted in gardens to make collecting for baskets much easier and more convenient (figure 2.5B). Establishing these cultural plant gardens also protects wild plants from the stresses of overcollection.

Healing the earth is a subject that is very important to Native Americans. Restoring plant communities along streams and rivers is particularly important because many have been damaged by overgrazing, and several tribes have expressed an interest in growing native

Figure 2.3—*The process of defining the target plant materials for a specific outplanting site consists of six steps.* Illustration by Jim Marin.

Figure 2.4—*(A) The Red Lake Band of Chippewa Indians grow commercial conifers in their greenhouse. (B) The conifers are used to reforest lands after timber harvest.* Photos by Ronald Overton.

Figure 2.5—*(A) Damon McKay of the Confederated Tribes of the Umatilla Indian Reservation in Oregon collects tule for a variety of purposes. (B) Women collecting roots of white-root sedge for basket making at the Redwood Valley Rancheria in California.* Photo A by Tara Luna, B by Chuck Williams.

Figure 2.6— *(A) Dawn Thomas-Swaney collects hardwood willow cuttings. (B) The cuttings are used by the Confederated Salish and Kootenai Tribes for riparian restoration projects along the Flathead and Jocko rivers in Montana.* Photo A by Joyce Lapp, B by Dawn Thomas.

plants to restore these communities. The Confederated Salish and Kootenai Tribes of Montana have established a native plant nursery to produce rooted cuttings and seedlings for 200 acres (80 ha) of riparian restoration projects along the Flathead and Jocko rivers (figure 2.6).

One common use of native plants is for revegetation after the removal of invasive weeds. On the Hopi Reservation in northern Arizona, riparian areas have been overtaken by Russian-olive and saltcedar. These aggressive woody exotics have replaced the native willows, cottonwoods, and other riparian plants along streams,

Figure 2.7—*(A) Many riparian areas on the Hopi Reservation in Arizona are overgrown with the invasive weed trees Russian-olive and saltcedar. (B) Chuck Adams of the Hopi tribe is collecting seeds of native cottonwoods and willows to grow plants that will be used to reintroduce these natives after the exotics have been removed.* Photos by Thomas D. Landis.

washes, and springs. In some locations, these invasive trees have grown so thick that the tribe's cattle and horses cannot pass through them (figure 2.7A). The Hopi are collecting seeds and cuttings of native cottonwoods and willows (figure 2.7B) so that plants can be grown for outplanting after the removal of the Russian-olive and saltcedar.

Many tribes have voiced concern about the loss of plants and animals because of habitat degradation. Native plants can be used to restore or create new habitat on which other organisms depend. A good example is a project on the Paiute Reservation to restore wetlands that are critical to the survival of the northern leopard frog. Native wetland plants were grown in a nursery and outplanted (figure 2.8A), and, after only a few years, a viable wetland community was reestablished (figure 2.8B).

From both a cultural and health standpoint, Native Americans are trying to reintroduce traditional foods into their diets. Historically, native plants were a principal food source (see figure 2.1). Besides being the State flower, bitterroot (figure 2.9A) was an important food staple of tribes in Montana. After being dug, cleaned, and dried, the root provided a lightweight, nutritious food that could be stored. Tremendous potential exists for tribes to grow other traditional food plants in nurseries for outplanting into food gardens.

In the Pacific Northwest region of the United States, salmon forms the central part of the diet of many tribes and much of the recent decline in salmon runs

Figure 2.8—*(A) To create breeding habitat for the northern leopard frog, the Paiute Tribe of Nevada grew wetland plants for outplanting on degraded riparian areas. (B) Native plants quickly improved the habitat.* Photos by J. Chris Hoag.

can be attributed to habitat destruction. The Stillaguamish Tribe of Washington State has started a native plant nursery to produce stock for restoring streams and rivers that are essential to the survival of young salmon and steelhead (figure 2.9B).

One of the most rewarding objectives for growing and outplanting native plants is the education of young people. Many tribes have expressed interest in starting a native plant nursery with a primary objective of environmental education. The Blackfeet Nation and Confederated Salish and Kootenai Tribes have nurseries as part of their schools and use them to teach young people the names and uses of native plants. The Hopi have established a cultural plant propagation center at the Moencopi Day School in Tuba City, Arizona (figure 2.10). Science teachers at the school use the greenhouse in their classes. The plants are used for many purposes including restoration projects on surrounding Hopi and Navajo lands.

Of course, one objective of a native plant nursery is to sell plants for profit and some tribes are doing this. The Santa Ana Pueblo of New Mexico grows a variety of desert native plants in containers suitable for landscaping (figure 2.11). This practice would be most appropriate for tribes close to large population centers but a market for selling to tourists would be possible in any location.

Figure 2.9—*(A) Traditional food plants such as bitterroot could be produced in native plant nurseries. (B) Plants are also needed to help restore the riparian habitat that is critical for salmon, a cultural food staple of many tribes of the Northwestern United States.* Photo A by Tara Luna; B by Jeremy R. Pinto.

Figure 2.10—*One of the most exciting uses of native plants is environmental education. Discussing the tribal plant names and uses is an excellent way to get young people enthused about nature. Many tribes have located their nurseries at schools to foster this education. Steven Lomadafkie teaches children at Moencopi Day School on the Hopi Reservation in Arizona.* Photo by Tara Luna.

Figure 2.11—*The Santa Ana Pueblo of New Mexico operates a retail native plant nursery where it sells native plants in large containers for landscaping and other ornamental purposes.* Photo by Jeremy R. Pinto.

Step 2 — What Type of Plant Material Will Meet Project Objectives and Site Characteristics?

After the best plant species have been determined, the next decision is what type of plant material would best meet project objectives. The term "plant material" is commonly used to describe any plant part that can be used to establish new plants on the project site. Common plant materials include seeds, root stock, and nonrooted cuttings as well as traditional nursery stock types, such as rooted cuttings, bareroot seedlings, and container seedlings (table 2.1). Native plant nurseries are currently growing, or could grow, any or all of these categories of plant materials.

Seeds are an ideal type of plant material that are easy to handle, store, and outplant (figure 2.12A). The effectiveness of direct seeding on the project site varies with the species of plants, the harshness of the site, the objectives of the project, and the project timeframe. Directly broadcasting seeds offers three principal advantages: (1) seeds are inexpensive compared with other plant materials, (2) spreading seeds is relatively easy, and (3) seedlings from broadcast seeds develop a natural root system (table 2.1). Many drawbacks, however, exist as well. Native plant seeds from the proper species and origin are often difficult to obtain or are very expensive; some species do not produce adequate seed crops each year; and seeds of other species, such as the white oaks, do not store well.

Seeds of many diverse species require special cleaning and processing before they can be sown. Even if the proper seeds can be obtained and properly distributed over the site, predation by birds and rodents, competition from weed species, and unpredictable weather often reduce establishment success (Bean and others 2004). Finally, with direct seeding, it is difficult to control species composition and plant spacing over the project area (Landis and others 1993).

Direct seeding is most successful for grasses, forbs, and some woody shrubs, the seeds of which can be easily produced in bareroot beds in nurseries (figure 2.12B). Seeding with native grass species after wildfires is standard procedure to stabilize soils and prevent erosion (figure 2.12C). In California, the direct seeding of native oaks has been quite successful and the Department of Fish and Game has direct seeded cosmopolitan bulrush for the restoration of wetland wildlife habitat in the Sacramento River Delta (Landis and others 1993). Wild rice is an important food and cultural plant for the Ojibwa and other tribes from the northern Great Lakes region and is traditionally propagated by seeds (Luna 2000).

Root stock refers to specialized roots, such as bulbs and corms, and to modified underground stems, such as rhizomes and tubers (figure 2.13). Root stock can be used for the vegetative propagation of certain grasses and wetland plants. Grass and sedge rhizomes and root sections have been successfully used for wildland outplantings, such as a restoration project at Jepson Prairie in California (Landis and others 1993). Because of difficulties with seed dormancy, the Mason State

Table 2.1—Many different types of native plant materials can be grown in nurseries

Plant Materials	Examples	Characteristics
Seeds	Wild rice	Small and easy to outplant Seeds of many native plants can be stored for long periods Plants develop natural root structure
Root stock	Camas	Can be stored under refrigeration Excellent survival after outplanting
Nonrooted cuttings	Willows Wormwood	Used for live stakes and structures for soil stabilization along streams Efficiently and economically produced in nursery stooling beds or from container stock plants
Rooted cuttings	Willows Cottonwoods Redosier dogwood	Can be grown in a variety of different container types and sizes Good option when seeds are unavailable or have complex dormancy
Bareroot seedlings	Most species, including: Ponderosa pine Turkey oak Bitterbrush	Nurseries require good soil Efficient way to produce large numbers of plants Not as practical for small native plant nurseries Shorter lifting window Store best under refrigeration
Container seedlings	All species	Require high quality and pure seeds Nurseries can be on harsher soils and climates Use artificial growing media Handling and storage are less demanding

Nursery in Illinois produces rooted cuttings and root divisions of several species of prairie forb, woodland understory, and wetland plants (Pequignot 1993).

Many riparian and wetland species can be successfully propagated on the project site by collecting cuttings and planting them immediately without roots (**nonrooted cuttings**). Under ideal conditions, planting nonrooted cuttings can be a very cost-effective means for establishing certain vegetation types. Nonrooted cuttings are prepared from long whips collected from dormant shrubs or trees on the project site or from stock plants at a nursery. If a large number of cuttings will be needed for several years, plants can be established at a local nursery and cuttings collected each year. Whips should be collected during the dormant season when the potential for new root formation is highest. Whips are cut into cuttings that range from 12 to 24 in (30 to 61 cm) in length and 0.4 to 0.75 in (10 to 19 mm) in diameter (figure 2.14A). When outplanted properly in moist soil and under favorable conditions, these cuttings will form new roots that follow the receding water table down as the young plant develops during the first growing season. Nonrooted cuttings of willow or cottonwood are often used as "live stakes" in riparian restoration projects (figure 2.14B). Often, however, nonrooted cuttings initially produce leaves but eventually die because of moisture stress or canker diseases.

Pole cuttings are an interesting type of nonrooted cutting that are sometimes used in riparian restoration projects (Hoag and Landis 2001). These cuttings are

Figure 2.12—*(A) Seeds are the best plant material type for many grasses and forbs. (B) Native grass production fields. (C) These fields produce source-identified seeds that can be applied immediately after wildfires to stop soil erosion.* Photos by Thomas D. Landis.

Figure 2.13—*An uncommon type of plant material, known as root stock, is used to establish some grasses, sedges, forbs, and wetland plants that cannot be direct seeded or outplanted as seedlings.* Photo by Thomas D. Landis.

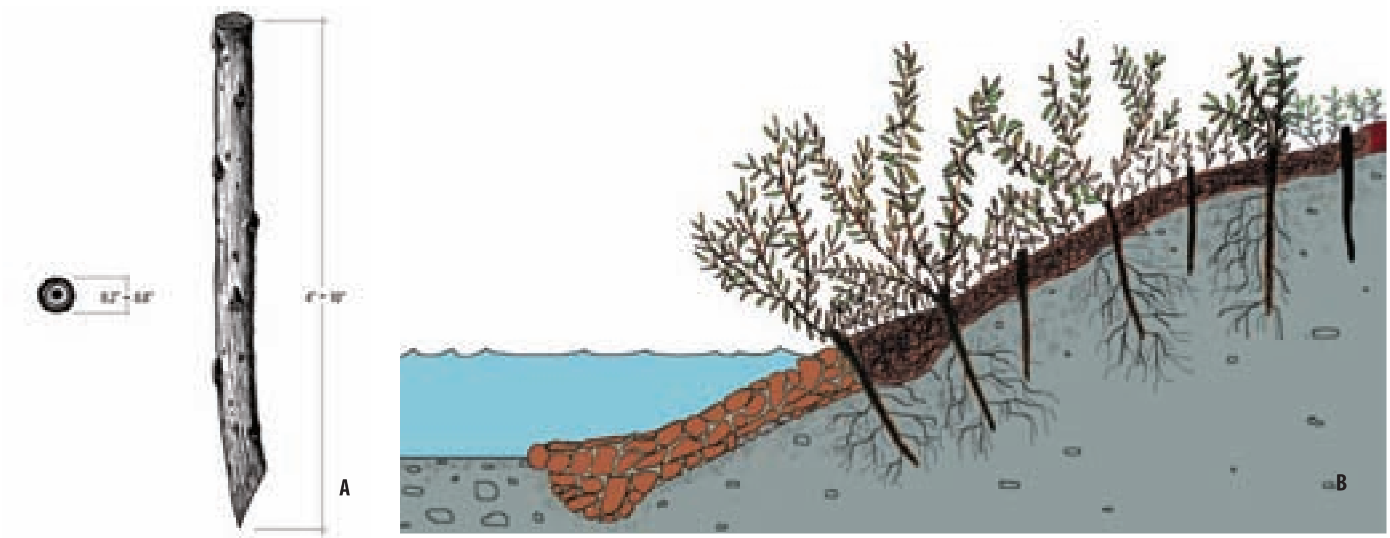
often 6 ft (1.8 m) in length and 8 to 12 in (20 to 30 cm) in diameter and are obtained by cutting the major branches or stems of cottonwood or willow trees (figure 2.14C). The key to success is to outplant the poles deep enough so that the butt ends remain in contact with the water table. Pole cuttings are very effective in stabilizing stream or riverbanks because they resist erosion (figure 2.14D). When large numbers of poles are required, they should be grown in stooling beds in nurseries to avoid the negative impact of collecting from wild "donor" plants on the project site.

Often, it is more effective to root cuttings in a nursery before outplanting them on the project site. The type and size of cuttings used in nursery propagation to produce **rooted cuttings** is much different from those used as nonrooted cuttings. A much shorter stem section can be used (2 to 4 in [5 to 10 cm]; figures 2.15A and B) but it should have a healthy bud near the top (Dumroese and others 2003). See Chapter 9, *Vegetative Propagation*, for more information about collecting and culturing rooted cuttings.

Bareroot seedlings are grown in the ground and harvested without soil around their roots (figure 2.16). Because they require a considerable amount of high-quality soil and often take longer to reach shippable size, fewer species of native plants are grown as bareroot stock. One serious drawback of bareroot stock is that seedlings need much better storage and postharvest care than container stock does.

Container seedlings are a newer stock type than bareroot and continue to increase in popularity. Many different types of containers are being used, and all require artificial growing medium. The distinguishing feature of container seedlings is that, because the roots are restricted, they bind growing media into a cohesive "plug" (figure 2.17A). "Single-cell" containers are more popular for growing native plants than "block" containers because individual seedlings can be sorted or consolidated (see Chapter 6, *Containers*).

Container seedlings are the stock type of choice for most tribal nurseries because of lower land requirements and startup costs. When small amounts of many different native plants are desired, container propagation is the best option. Another advantage is that container stock is more tolerant and hardy during handling, shipping, storage, and outplanting. Compared with bareroot stock, container seedlings can be



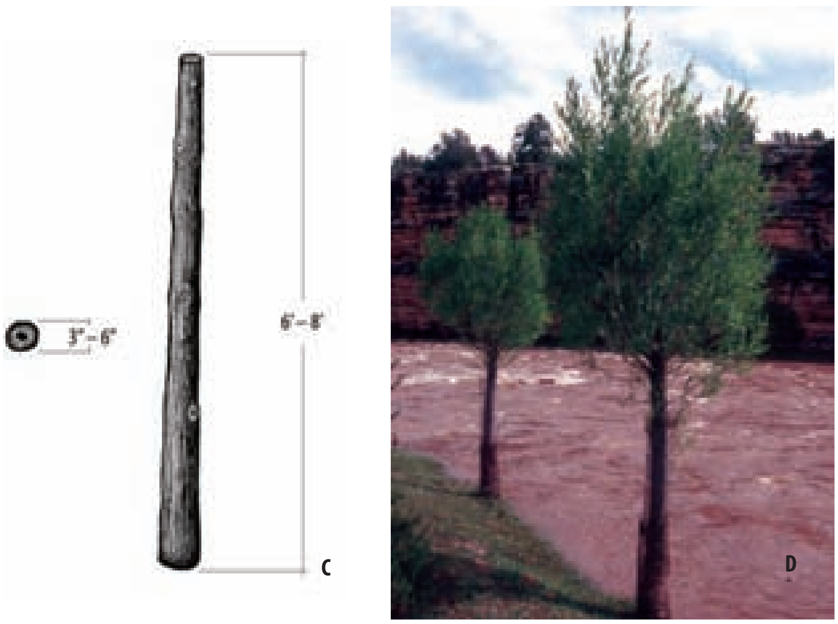


Figure 2.14—*(A) Nonrooted cuttings of willows and cottonwoods. (B) These cuttings are a popular and inexpensive type of plant material that is used for live stakes in riparian restoration. (C) Poles are very large cuttings. (D) Poles are used along stream and riverbanks where water erosion would damage conventional nursery stock.* Photo by Thomas D. Landis, illustrations by Steve Morrison.

harvested at almost any time of the year, which creates a wider outplanting window. See Chapter 13, *Harvesting, Storing, and Shipping*, for further discussion about this topic. The compact root systems of container plants make outplanting easier, especially on harsh sites, and the cylindrical plugs offer more surface area for root egress (figure 2.17B).

Step 3 — What about Genetic or Sexual Considerations?

The third component of the Target Plant Concept concerns the question of genetic and sexual diversity.

Local Adaptation

Native plants have a "sense of place" and so, when collecting seeds, cuttings, or other plant materials, it is important to identify their origin. We know that plants are genetically adapted to local environmental conditions and, for that reason, plant materials should always be collected within the same area where the plants will be outplanted. "Seed zone" and "seed source" are terms that foresters use to identify their seed collections. A seed zone is a three-dimensional geographic area that has relatively similar climate and soil type (figures 2.18A and B). Native plant nurseries grow plants by seedlots and might have several lots of the same species that they identify and keep separate.

Local adaptation can affect outplanting survival and growth in a couple of ways: growth rate and cold tolerance. In general, plants grown from seeds or cuttings collected from higher latitudes or elevations will grow

Figure 2.15—*(A) Rooted cuttings use a shorter section of stem with a bud. (B) Cuttings quickly grow into large plants under nursery culture, such as this redosier dogwood.* Illustration by Steve Morrison, photo by Thomas D. Landis.

Figure 2.16—*Bareroot seedlings are grown in raised seedbeds in fields and are harvested and shipped with no soil surrounding the roots. Because of the many limitations of bareroot stock, tribes prefer to grow their plants in containers.* Photo by Thomas D. Landis.

slower but tend to have more cold hardiness during winter than those collected from lower elevations or more southerly latitudes. This concept has been proven with research trials on commercial conifers (St. Clair and Johnson 2003). Although tests have not been done on other native plants, it makes sense that the same concepts may apply. Therefore, always collect plant materials from the same geographic area and elevation in which the nursery stock is to be outplanted.

Genetic and Sexual Diversity

Target plant materials should also represent all the genetic and sexual diversity present on the outplanting site. To maximize genetic diversity in the resultant plants, seeds should be collected from as many plants as possible. The same principal applies to plants that must be propagated vegetatively. Cuttings must be collected on or near the outplanting site to make sure they are properly adapted. On restoration projects with widely separated sites, be sure to collect plant materials from each location to ensure a good mix of genetic attributes (figure 2.19). Of course, collecting costs must be kept within reason and so the number of collections will always be a compromise. Guinon (1993) provides an excellent discussion of all factors involved in preserving biodiversity when collecting plant materials, and he suggests a general guideline of 50 to 100 donor plants. See Chapter 7, *Collecting, Processing, and Storing Seeds*, for a complete discussion on this topic.

Dioecious species, such as willows and cottonwoods, are challenging because they have male and female plants. Therefore, all vegetatively propagated plants will be the same sex as their parent (figure 2.19), which can be particularly important on sites where populations of plants are geographically separated. Therefore, when collecting cuttings at the project site, care must be taken to ensure that both male and female plants are equally represented. Rooted cuttings or other vegetatively propagated stock types should be labeled by sex so that males and females can be outplanted in a mixed pattern to promote seed production.

Step 4 — What Factors on the Project Site Could Limit Survival and Growth?

The fourth aspect of the Target Plant Concept is based on the ecological "principle of limiting factors" that states that any biological process will be limited

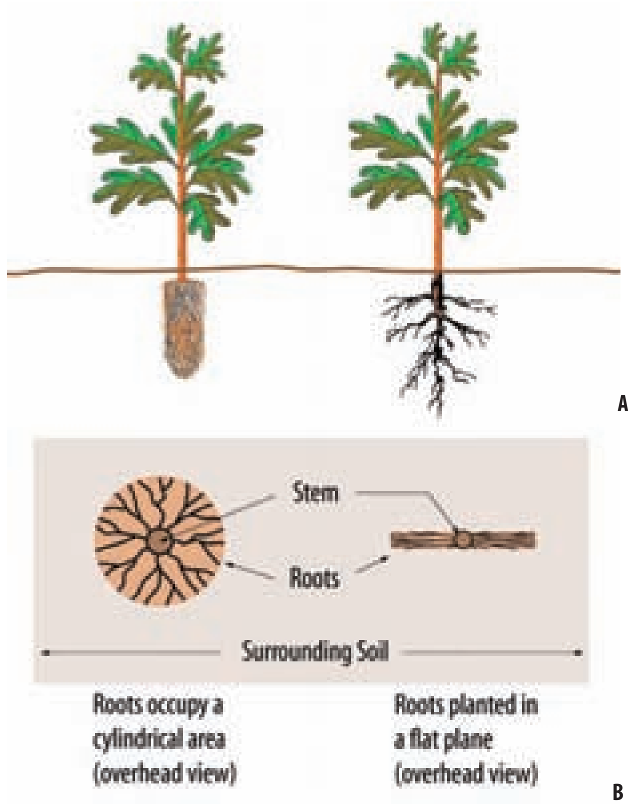


Figure 2.17—*(A) Container plants come in many types and sizes but all form their roots into a plug. (B)This tendency allows container stock to be harvested and outplanted with less disturbance to the root system and increases the area of root-to-soil contact.* Illustrations by Jim Marin.

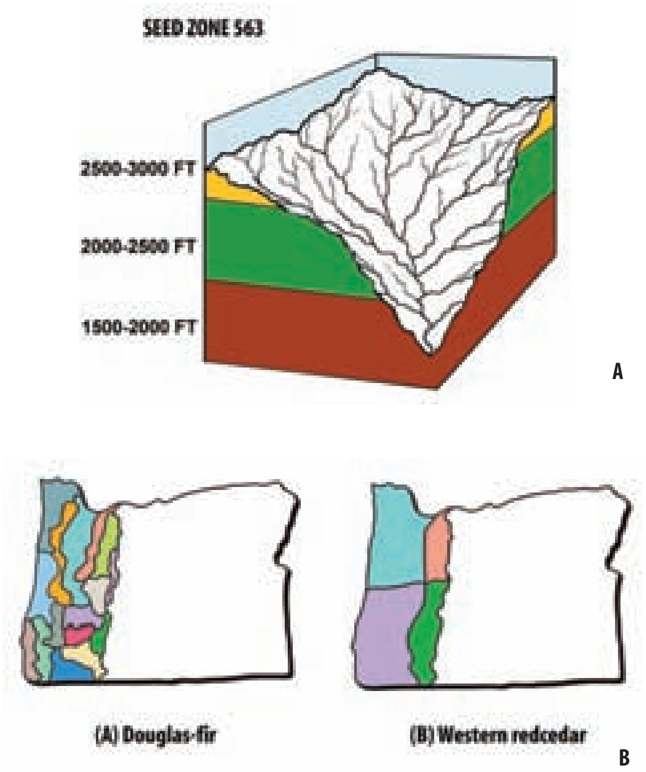


Figure 2.18—*(A) In forest management, seed zones are used to make certain that seeds are collected from the same geographic area and elevation zone. (B) The size of seed zones varies with plant species. For example, in western Oregon, Douglas-fir seed zones are smaller and more numerous compared with western redcedar.* Modified from St.Clair and Johnson (2003).

by the factor present in the least amount. Therefore, each outplanting site should be evaluated to identify the environmental factors that are most limiting to survival and growth (figure 2.20A). Foresters do this procedure when they write "prescriptions" for each harvest unit specifying which tree species and stock type would be most appropriate. This same procedure should also be done for any project using native plants.

On most outplanting sites, native plants must quickly establish root contact with the surrounding soil to obtain enough water to survive and grow. For example, water is usually the most limiting factor on southwest slopes where sunlight is intense (figure 2.20B). On northern aspects or at higher elevations or latitudes, however, cold soil temperatures may be more limiting (figure 2.20C). On these more shaded sites, melting snow keeps soil temperatures cold and research has shown that root growth is restricted below 50 °F (10 °C). Therefore, a reasonable target plant for these sites would be grown in a relatively short container to take advantage of warmer surface soils (Landis 1999).

Restoration sites pose interesting challenges when evaluating limiting factors. For example, after a wildland fire, soil conditions are often severely altered and mining sites have extreme soil pH levels. Riparian restoration projects require bioengineering structures to stabilize streambanks and retard soil erosion before the site can be planted with native species (Hoag and Landis 2001). In desert restoration, low soil moisture, hot temperatures, high winds with sand blast, and heavy grazing pressure have been listed as limiting factors (Bainbridge and others 1992). Where populations of deer or other browsing animals are high, animals may be the most limiting factor, and nursery plants may have to be protected with netting or fencing.

One limiting factor deserves special mention—mycorrhizal fungi. These symbiotic organisms provide their host seedling with many benefits, including better water and mineral nutrient uptake, in exchange for food produced by the host plant. Reforestation sites typically have an adequate complement of mycorrhizal fungi that quickly infest outplanted seedlings,

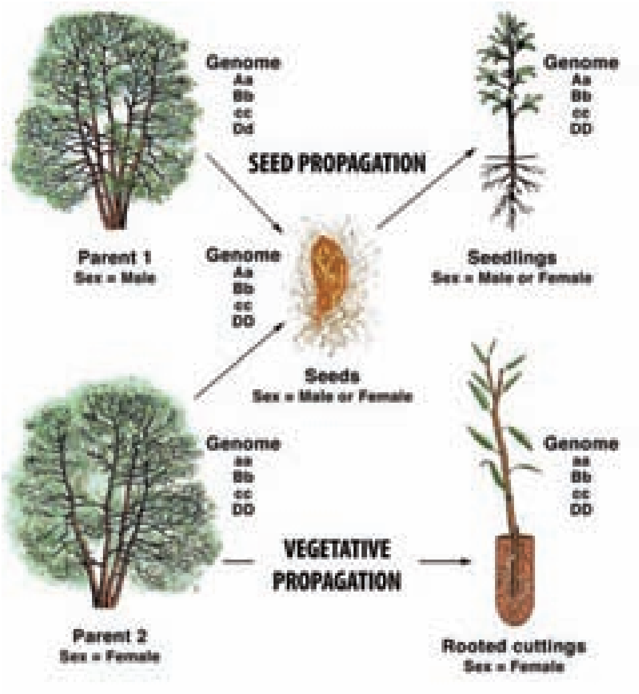


Figure 2.19—*When collecting cuttings from dioecious plants, such as willows and cottonwoods, the sex of the parent plant must be considered to ensure a mixture of both males and females.* From Landis and others (2003).

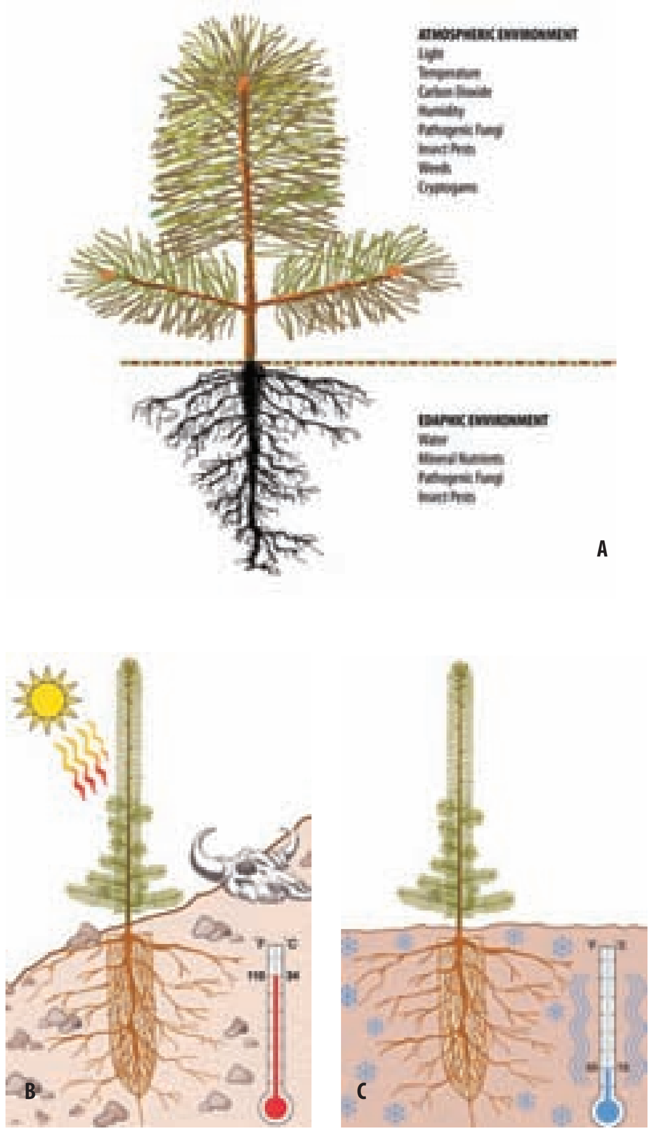


Figure 2.20—*(A) Outplanting sites should be characterized by which environmental factors are most limiting to plant growth. (B) On a sandy hillside with a southern exposure, water is most limiting. (C) At high elevations and latitudes, cold soil temperature restricts root growth.* Illustrations by Jim Marin.

whereas many restoration sites do not. For example, severe forest fires or surface mining eliminate all soil microorganisms including mycorrhizal fungi. Therefore, plants destined for severely altered sites should be inoculated with the appropriate fungal symbiont before outplanting. See Chapter 14, *Beneficial Microorganisms*, for a complete discussion on this topic.

Step 5 — What Is the Best Season for Outplanting? The "Outplanting Window"

Conditions on most native plant project sites are harsh and nursery stock often suffers severe "transplant shock" (figure 2.21A). Each site has an ideal time when chances for native plant survival and growth are greatest; this is known as the "outplanting window." This time period is usually defined by the limiting factors discussed in the previous section, and soil moisture and temperature are the usual constraints. In most of the continental United States, nursery stock is outplanted during the rains of winter or early spring when soil moisture is high and evapotranspirational losses are low (figure 2.21B).

One real advantage of container plants is that they can be started at different dates and then cultured to be physiologically conditioned for outplanting during various times of the year. For the traditional midwinter outplanting window, nursery stock can be harvested and stored until the outplanting site is accessible. In recent years, a renewed interest in autumn outplanting has developed because of the availability of specially conditioned container stock. Summer outplanting is a relatively new practice that has been developed in the boreal regions of Canada (Revel and others 1990) and has since found some application at high-elevation

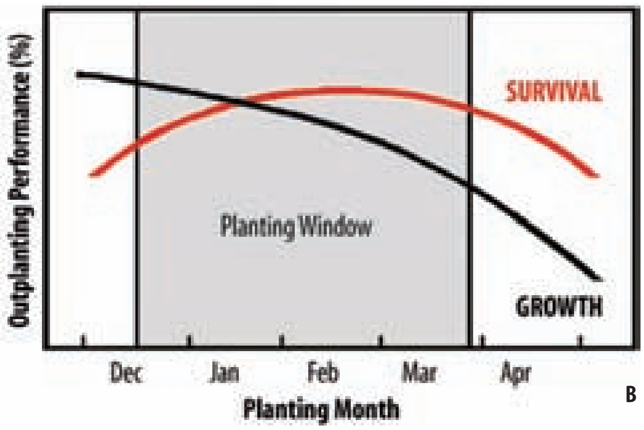


Figure 2.21—*(A) Transplant shock. (B) One way to minimize the chances of transplant shock is to identify the outplanting window, the period of time in which site conditions are least stressful. In much of the United States, the outplanting window occurs during the rainy period of midwinter.* Photo A by Thomas D. Landis, B modified from South and Mexal (1984).

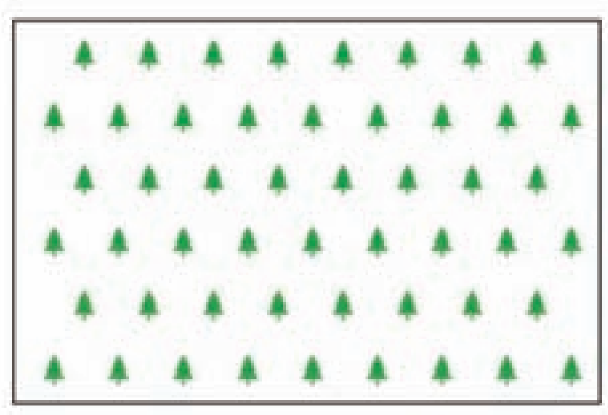
sites in the Rocky Mountains (Page-Dumroese and others, in press). Target plant characteristics are similar for both summer and autumn outplanting: hardened container stock with minimal handling and storage.

Step 6 — What Are the Best Outplanting Tools and Techniques for the Project Site?

Each outplanting site is different in terms of climate and soil type, so tools and outplanting techniques must be considered in the Target Plant Concept. All too often, foresters or restoration specialists develop a preference for a particular implement because it has worked well in the past. No single tool or technique, however, will work well under all site conditions. Hand tools such as shovels and planting hoes ("hoedads" in figure 2.22A) have been very popular for outplanting native plants on a variety of sites. In large planting projects or projects planted by inexperienced planters, it may be best to have one person locate the planting spot and excavate a hole with a power auger (figure 2.22B). Be careful when selecting planting tools and ask other project managers for their opinions about planting tools if you do not have hands-on experience. The dibble was developed as an easy and quick way to outplant container seedlings. Experience has shown that dibbles work reasonably well on sandy soils, but, in silt or clay soils, dibbles compact soil around the outside of the hole, which inhibits root egress. Dibbles are ideal for outplanting wetland plants because they work well in standing or running water. Kloetzel (2004) does an excellent job of discussing the various outplanting tools that are available and the site conditions that are best for each tool.

Different types of native plant materials may require specialized outplanting equipment. Nonrooted cuttings—even poles—can be successfully planted with specialized equipment such as the waterjet stinger (Hoag and others 2001). The "tall pots" used in many restoration projects require specialized outplanting equipment. Again, nursery managers must work closely with reforestation or restoration project managers to make certain that their target plants can be properly outplanted in the soil conditions on the project site.

The type of outplanting tool must be given special consideration when working with volunteers or other inexperienced planters. Many of these people lack the skills or strength to properly plant native plants on wildland sites. One option is to have a professional excavate planting holes with a machine auger (figure 2.22B) and let volunteers insert plants and tamp them into place. This technique has several benefits: the professional chooses the proper planting spot, creates the desired pattern, and makes certain the planting holes are large and deep enough so that the seedlings can be planted properly.



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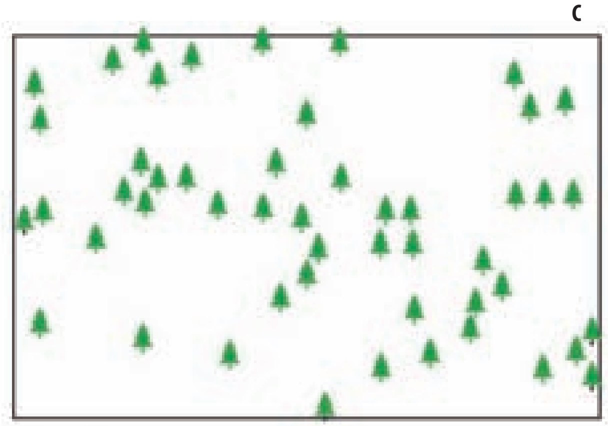

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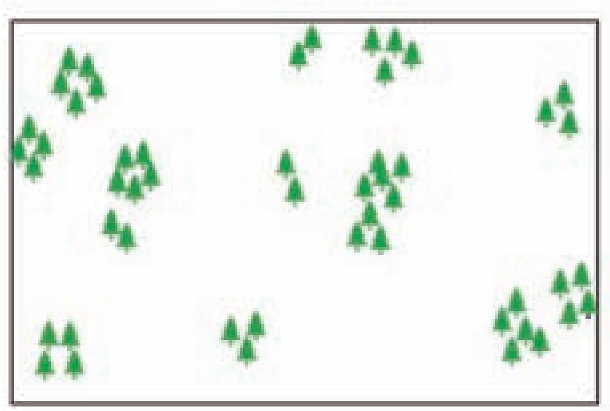

E

Figure 2.22—*(A) The type of outplanting tool and planting design are critical to the Target Plant Concept. Traditional tools such as the hoedad are designed for steep slopes or rocky soils. (B) Power augers work well on level sites and when working with groups. (C) Most restoration projects do not want the "cornfield" look. (D) To prevent this look, plants are spaced in more random patterns, (E) or in clumped patterns that mimic natural conditions.*
Photos by Thomas D. Landis, illustrations by Jim Marin.

The pattern and spacing of outplanted nursery stock should reflect project objectives. In commercial forestry projects where timber production is the primary objective, plants are outplanted in a regularly spaced pattern (figure 2.22C). A similar pattern is used for Christmas tree plantations, where tree growth and form are main concerns. Where ecological restoration is the objective, however, outplanting plants randomly (figure 2.22D) or in random groups (figure 2.22E) will result in more natural vegetation patterns. Again, project objectives must be considered. Regular spacing is required when quick crown closure is desired to shade out invasive species or when machinery access is needed for controlling weeds after outplanting (Davenport 2006).

For planning purposes, nursery managers must know in advance which planting tools will be used so they can develop proper plant material specifications, especially root length and volume or cutting length and diameter.

SUMMARY AND RECOMMENDATIONS

The Target Plant Concept is a way to think through the entire nursery and outplanting process and to encourage communication between clients and nursery managers. Describing an ideal plant for a particular restoration project and following a series of sequential steps will also be a useful exercise for native plant nurseries and plant users. Instead of the traditional linear process that begins in the nursery and ends on the outplanting site, the Target Plant Concept is a circular feedback system in which information from the project site is used to define and refine the best type of plant material.

The Target Plant Concept is not static, it must be continually updated and improved. At the start of the project, the supervisor and nursery manager must agree on certain specifications. These prototype target plant materials are then verified by outplanting trials in which survival and growth are monitored for up to 5 years. The first few months are critical because plant materials that die immediately after outplanting indicate a problem with stock quality. Plants that survive initially but gradually lose vigor indicate poor planting or drought conditions. Therefore, plots must be monitored during and at the end of the first year for initial survival. Subsequent checks after 3 or 5 years will give a good indication of growth potential. This performance information is then used to give valuable feedback to the nursery manager, who can fine-tune target specifications for the next crop.

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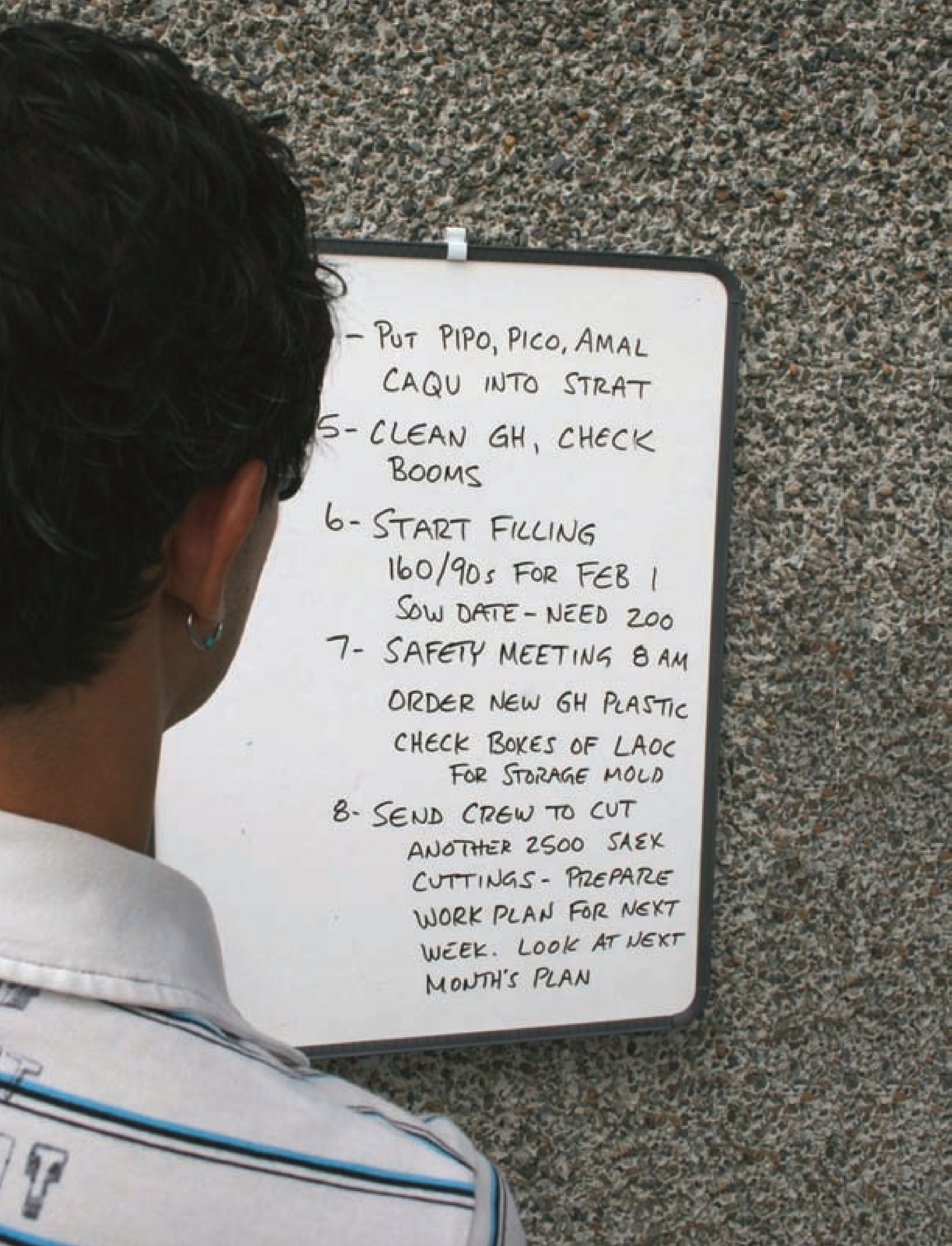
APPENDIX 2.A. PLANTS MENTIONED IN THIS CHAPTER

bitterbrush, *Purshia* species
bitterroot, *Lewisia rediviva*
black ash, *Fraxinus nigra*
camas, *Camassia quamash*
cosmopolitan bulrush, *Schoenoplectus maritimus*
cottonwood, *Populus* species
dogbane, *Apocynum* species
Douglas-fir, *Pseudotsuga menziesii*
eastern white pine, *Pinus strobus*
oaks, *Quercus* species
ponderosa pine, *Pinus ponderosa*
red pine, *Pinus resinosa*
redosier dogwood, *Cornus sericea*
Russian-olive, *Elaeagnus angustifolia*
saltcedar, *Tamarix ramosissima*
sweetgrass, *Hierochloe* species
tule, *Schoenoplectus acutus*
turkey oak, *Quercus laevis*
western redcedar, *Thuja plicata*
white oaks, *Quercus* species
white-rooted sedge, *Carex barbarae*
wild rice, *Zizania palustris*
willow, *Salix* species
wormwood, *Artemisia* species


- PUT PIPO, PICO, AMAL CAQU INTO STRAT
5- CLEAN GH, CHECK BOOMS
6- START FILLING 160/90s FOR FEB 1 SOW DATE - NEED 200
7- SAFETY MEETING 8 AM
ORDER NEW GH PLASTIC
CHECK BOXES OF LAOC FOR STORAGE MOLD
8- SEND CREW TO CUT ANOTHER 2500 SAEX CUTTINGS - PREPARE WORK PLAN FOR NEXT WEEK. LOOK AT NEXT MONTH'S PLAN