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PLANNING A PROJECT

Selection And Acquisition of Woody And Herbaceous Plant Species and Materials for Riparian Corridor, Shoreline, and Wetland Restoration and Enhancement

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Introduction

Opportunities for restoration, revegetation, improvement, or creation of woody and herbaceous plant communities abound throughout the West. The use of woody and herbaceous wetland plants in place of or in conjunction with structural erosion control methods is receiving major emphasis from local, state, federal, and private entities because of the recent increased interest on water quality, aesthetics, wildlife, riparian zones, and fisheries.

Establishment of woody and herbaceous plants depends on accurate planning, good reconnaissance of the site, selection of suitable species, finding appropriate plant materials, proper handling of the plant materials, and establishment techniques. All of these steps, in conjunction with each other, will significantly increase the chances of a successful planting. To leave out or lessen any one of the steps is a guarantee of problems that can lead to failure. However, efforts made to address each of these steps will be rewarded with high establishment success rates.

This paper concentrates on woody and herbaceous plantings in riparian corridors, shorelines of reservoirs, lakes, ponds, or other water impoundments, and wetlands. Both riparian corridors and shorelines can be split into 3 areas: 1) the stream channel or waterline or the edge of the deep water in wetlands, 2) the bank or riparian or wetland area above the high waterline that is usually saturated, and 3) the surrounding upland topography. Each of these areas has specific site problems and opportunities that need to be addressed in the planning process.

Objectives

One of the most important aspects of any vegetation project is the identification of objectives. By having firm objectives for the project, the chances of success increase dramatically. The **whole** project is considered and potential problems anticipated. More effort is made to determine exactly what is needed, how much it will cost, and what equipment and manpower is necessary. The need for extra support (labor, money, equipment, etc.) can be ascertained especially if it is over and above what can be provided locally. Once the objectives are determined, a list can be

assembled of potential vegetation, both woody and herbaceous, that might fit the site. Be realistic as to how far-reaching the objectives are. Be as accurate and inclusive as possible.

Several factors that should be considered when deciding objectives are:

* If a decrease in water temperatures and improvement of fish habitat are a part of your objective, more shade will be produced with tall and/or wide canopy species planted on the south side of the water rather than with shrubs or short trees.
* If wildlife habitat is desired, determine the species of wildlife and their needs. Habitat for food, cover, nesting cover, brood habitat, or hiding cover should be determined.
* Plant species that have low palatability if the site in an area where grazing (livestock or wildlife) is not desirable.
* If aesthetics are a part of the objectives, select species that have colorful flowers, species that flower in different months, or species that have colorful berries or fruits.
* If the revegetation site is between the public and the water, low growing shrubs might be more important than taller shrubs or short trees so the view is not limited.
* If bank stabilization is a part of the objectives, rhizomatous woody and herbaceous species planted together will give a much better "wall" of protection than single species will.
* Are permanent structures desirable, or should temporary structures that will disintegrate over time be used? Temporary structures will allow the vegetation to become well established before it is exposed to full wave action or other erosion forces.

Planning

Careful planning before planting is necessary to ensure that the fix does not create more problems than those already identified.

* First, management must be in-place to maintain or improve woody vegetation. Without proper management, planting efforts could be destroyed (Crouse and Kindschy 1984; Van Haveren and Jackson 1986).
* Second, check the soils at the site to establish the water table history to see if riparian species can survive.
* Third, if no woody plants are found in the vicinity, planting may not be a good option. Further investigation into soil problems, climate, water table, etc. should be done to determine why woody plants are not there.
* Fourth, woody plantings apply only to situations where the rehabilitation time frame is long enough to allow them to become established. Structures may be more appropriate in emergency situations.

A reconnaissance upstream and downstream from the site selected for revegetation may save time and effort. If woody vegetation is found on sites above or below the site, check the soil and site situations where they are growing and compare them to the conditions at the revegetation site. Plantings will be most successful on sites similar to these stable areas. Risk of mortality will increase as the soil, site, and water table parameters depart from those of the vegetated sites.

Site Inventory

In order to select plants that are ecologically adapted to the project site, it is necessary to inventory the site itself to establish on-site conditions that may limit plant growth (Johnson et al. 1990). Environmental, physical, and biological factors should be examined.

There are reasons for vegetation not growing on the disturbed site. Some parameters to inventory include: poor livestock grazing management, big game wintering range proximity, beaver activity, streamflow velocities, topography, vertical to near vertical or undercut banks, entire reaches bare of vegetation to the waterline, and evidence of mass soil slumping. When these parameters are present, revegetation can still be considered. However, the time period involved for stabilization increases, the replanting schedule accelerates, and additional soil losses will occur. These conditions indicate structures or bioengineering techniques, not covered in this paper, may need to be included in the planning considerations.

The amount and seasonal availability of water is important for the long term survival and range of plants. In addition, the plants may require additional moisture at establishment. In fact, many plants can survive with much lower precipitation amounts if they are established with supplemental moisture (Hoag et al. 1991*b*). In the semi-arid West, drought tolerance is a major consideration when selecting a plant species.

Regional extremes in temperatures will affect a plant's range of adaptability. A plant's hardiness is generally limited by latitude and elevation. Ecotypes should generally not range more than 100-200 miles of latitude from the planting site. Some species, however, are very cosmopolitan in their distribution and these limits will not directly apply. Differences in elevation are usually a problem when an ecotype is taken from a low elevation and planted at a higher elevation. Physiologically, the plant will not complete its typical cycle before the frost comes to the higher elevation. Plants brought down from a higher elevation to a lower elevation will often loose their leaves in the fall well before plants that are adapted to the area will. The growing season in the higher elevation is also much shorter, so establishment of low elevation plants at high elevation sites will probably be affected.

The USDA Plant Hardiness Zone Map (USDA Agricultural Research Service 1990) delineates zones in which day length, radiation, temperature, frost, heat, and rainfall are described. A plant's basic requirements are based on these factors. The zones are intended to indicate excellent adaptability of plants. Mere survivability does not constitute adaptation to the environment. Beyond the normal minimum temperatures, extremely cold temperatures can kill or injure ordinarily hardy plants. It is important to review temperature extremes that have been recorded in the project site area to ensure that the species that are planned for the site can survive the extremes.

Wind, either summer or winter, can adversely affect a plant's growth or survival. Strong winds in the summer combined with hot temperatures can cause severe desiccation of plants. Increased irrigation especially during establishment may be necessary to prevent injury or death. If used, irrigation should be infrequent and deeper than the root system to encourage root growth down to the water table. Winds during the winter months can also cause desiccation of trees, especially

evergreens. Plants survive when they are adapted to subfreezing temperatures which can increase with wind chill. Consideration of wind patterns at the revegetation site can increase the chances of survival for selected woody plant species.

Do not limit your research into climatic factors to a regional location because microclimates can be much different than regionally reported information. Microclimates are based on local physical and biological factors in relation to climatic factors. Presence and severity of microclimates at the project site should be considered in the planning phase of the revegetation project. For example, hot or cold pockets, blockage of solar radiation, wind turbulence patterns, and precipitation patterns, should be examined at the project site to see if potential problems might affect the planting (Johnson et al. 1990).

Soil factors to consider at the project site include: compaction, crusting, pH, fertility, organic matter, and special limiting conditions, such as, sodic, alkaline, calcic, etc. Droughtiness, fine or coarse textured soils, restrictive pans, wetness, shallow depths, toxicity, and nutrient imbalance are all limiting factors (USDA Soil Conservation Service 1981). Look at the slope, stoniness, amount and quality of surface materials. Infertile, inorganic, poorly drained, and subsoils make the establishment of woody plants very difficult.

Compacted soils are often saturated with high levels of carbon dioxide, deficient in oxygen, and waterlogged. Another problem with compacted soils is that the soil density is so high that penetration by woody plant roots is almost impossible.

Crusting of the soil makes the soil surface almost impermeable to water (at least initially), thus increasing the droughty nature of the soils. The soil pH, either high or low, can cause many problems from nutrient deficiency to toxicity (Jones and Lambe 1982).

Special limiting conditions, such as, sodic, alkaline, calcic, and saline soils, are detrimental to root and shoot growth. Few plants are tolerant of these conditions. Planting into soils that are affected by these conditions are rarely successful at the extreme end of the condition and only moderately successful if care is taken to utilize only tolerant plants.

Species Selection

During the reconnaissance, identify potentially useful (based on predetermined objectives) woody species, the soil and site conditions they are growing in, and the moisture regime. If species identification is a problem, at least identify the growth form and the conditions where it is growing. Species identification is important so that they can be matched at the revegetation site.

If spreading of planted species is seen as a potential problem, selection might include only male clones. Both willows and poplars have male and female plants. Selecting male plants will reduce spreading from seeds.

Flexibility of stems is important for species at waterline to mid-bank on streams with high stream velocities and high debris loads including ice flows (Parsons 1963; Platts and Rinne 1985).

Species with deep rooting systems or rhizomatous rooting systems might be better suited to streams or shorelines with severe ice flows (Platts and Rinne 1985).

Livestock and big game animals can adversely impact the riparian zone. Some species are more palatable than others. It may be advantageous to plant species, like hawthorn or buffaloberry that have thorns, on the mid-bank to top bank and floodplain areas rather than more palatable woody vegetation. Grazing can also reduce reproduction of young plants, particularly those plants that reproduce by seed. Species selection of strong suckering or rhizomatous species may be an advantage.

Aesthetics can usually be improved by selecting more than one species to provide differences in size, shape, color, and texture. However, the species planted at the waterline should be a single species for the full length of any one reach to ensure a consistent size and shape of the plants. Further diversity can be accomplished by planting in layers from the water level up to the top of the bank.

If the revegetation site is subject to potential fires, select woody plant species that are fire tolerant. Most species of willows and poplars have good fire tolerance, resprouting well after fires.

If flooding is a problem, select species that can withstand periods of inundation or saturated soils. Willows can withstand months of inundation, while chokecherry can usually tolerate only a week of flooding.

Type of Planting Stock

Cuttings, whips, plugs, conetainers, deep tube, bare-root, potted, and paper-sleeved planting stock are all viable alternatives (Carlson 1992; Dirr and Heuser 1987; Platts et al. 1987). Each has some advantages and disadvantages.

Stem cuttings are usually divided into 3 categories:

* softwood
* semi-hardwood (greenwood)
* hardwood

This paper will discuss only hardwood stem cuttings.

Hardwood stem cuttings can be divided into deciduous, narrowleaf evergreen, and broadleaf evergreen (Dirr and Heuser 1987). Hardwood cuttings of willow and poplar species are deciduous. Generally, they are recommended over other species of deciduous hardwood cuttings because of the high concentration of root primordia located throughout the length of the stems (Densmore and Zasada 1978, Hoag 1992).

Cuttings are recommended for most plantings at the water line to mid-bank. Cuttings of willows and poplars are also recommended on upper-banks and floodplains where the water table is

relatively deep. Cuttings usually provide the only means to reach this moisture and establish a high concentration of roots the entire length of the buried stem.

Cuttings have the additional advantage of being relatively inexpensive. They are easy to harvest and store. They are also much easier to plant. High mortality can occasionally occur, but this is somewhat offset by cheaper costs, the ability to rapidly plant large numbers, and the ease of replanting the following year. Generally, whips (less than 3/8 in. diameters) are not recommended as energy reserves in these small stems are limited.

Plugs, conetainers, bareroot, potted, and paper-sleeve rooted stock are best when used:

* on mid-bank to upper-bank or floodplain where long periods of inundation or water erosion are minimized.
* where adequate moisture is available -- i.e. natural precipitation is adequate for species selected or plants are irrigated.
* where there is no competing vegetation or a 30" diameter area around plant is scalped of competing vegetation at planting time.
* where plants have a low risk of physically being pulled or eroded out due to shallow rooting system during the first year after being planted.

Classes of Plant Materials

There are basically three classes of woody plant materials. First, there are native plant materials that can be collected from local sites adjacent to the project site. Many of these materials are not easy to grow. They may not set a seed crop each year. They may need special stratification, special growing conditions, and different light or watering requirements. Local nurseries may not know how to produce native plants. Even if the nurseries know how to produce them, they will generally have very few plants available because of low demand.

Second, ecotypes are collections of species that are made in a specific ecological areas. This area or range is defined as having similar physical and biological characteristics, such as, vegetation, climate, soils, fauna, and topography (USDA Forest Service 1978). It is not delineated by drainage lines, state or county lines, or artificial boundaries. When using these ecotypes, ensure the project site is located within their defined range.

Third, cultivars are plants that can be native or introduced species that have been developed and tested for a wide range of planting sites. These plants are often carried by nurseries and growers in volume. The important thing to remember about cultivars is they have what amounts to a pedigree. This testing history can be used to track exactly where the plants were tested and under what soil and climatic conditions. The specification of released cultivars is recommended because their expected performance can be determined with a much higher degree of accuracy than that of native collections or ecotypes.

When deciding on the appropriate plant materials for the revegetation site, the best guideline to follow is: when information is not available on ecotypes or cultivars that are adapted to the

project area, use native species that can be found in as close to the planting site conditions as possible. Extra planning and propagation time will be required if native plants are selected.

Season of Planting

Another important consideration when planning the revegetation project is when to plant. It is necessary to make arrangements with the grower, in advance, to produce the materials (other than cuttings) and have them ready when you need them. The window of opportunity or planting window is when the optimum conditions exist that will allow the best establishment of the woody plant materials. This period is generally either spring, summer, or fall.

Fall plantings allow a longer period of time for establishment before the hot, dry summer months. It also allows the plants to compete with weeds that inhabit the site. The plants will be ready to grow in the spring well before, in some cases, it is possible to get equipment on the site. Fall plantings are susceptible to frost heaving. This can cause damage to newly emerged roots. In addition, plants from nurseries and growers normally are not available in late fall or winter months unless special arrangements are made.

Spring plantings are advantageous because the water table or soil moisture profile is normally high. Weather conditions are usually better in the spring, not only for the plants, but also for planting crews. Flooding commonly occurs during the spring. This can radically affect the planting site conditions. Catching the right planting window in the spring is sometimes difficult. It is much narrower than the fall window. Hot and dry temperatures can come on very rapidly. An early spring can destroy a carefully planned plant delivery timetable. Planting before the high water runoff can be a problem because as the water comes up, it can rip out even the most carefully planted cuttings. Spring plantings should be scheduled as early in the season as possible based on access to the site and the type of planting stock (cuttings vs. containerized stock).

Summer plantings should normally be avoided. Hot temperatures, lack of moisture in many areas, and the shorter growing season for establishment, particularly at higher elevations, are factors.

Procurement of Plant Materials

Once the class of plant materials has been selected, a source must be found that can produce the volume, size, and type of plant materials needed. The specifications of the plant materials that will be needed should have been developed in the Objectives, Site Analysis, and Planning phase. Timing of the planting or planting "window" should also have been determined.

If cultivars or ecotypes exist for the project site, nurseries or other growers need to be located that actually produce these plants. If cultivars or ecotypes do not exist for the project site, local collections of seeds, propagules, or cuttings and their production need to be contracted or scheduled.

The procurement of the necessary plant materials, whether cultivars, ecotypes, or native collections, takes time. Advanced planning is extremely important in order to ensure the plant

materials will be available on the scheduled planting date. It can take as long as 2 years or more to produce woody plant materials that are large enough to survive in the wild, especially if native collections are involved.

Native collections will usually take the most time to produce for several reasons. First, how to grow the plants may have to be researched. If this knowledge is available, local growers should be able to produce the plants. If research is necessary, alternative species should probably be considered because of the time involved in the research and the expense. Again, during your objective development, alternative species should have been determined.

For native collections, time may also be required to collect seed. Some plants do not produce reliable seed every year. This means the collections would have to be made in the later summer or fall of a good seed year, planted out in the greenhouse assuming that no stratification is required (this may add up to 6 months), and grown to a survivable age. Many woody plants should be 2-3 years old before planting to ensure a better survival rate. Smaller plants can be used if much more intensive site preparation is completed. Some research indicates that smaller plants have better survival rates on harsh sites with the right site preparation.

Quality of Plant Materials

Once the appropriate plant materials have been located but before delivery, ensure that the quality of the materials is such that they will survive when planted out. Your quality standards need to be conveyed to the growers at the time the contract is signed.

The quality of the plant materials can generally be determined by looking at them. Look for healthy, vigorous appearance, and lack of obvious insect and disease damage.

Investigate the size of the roots and their shape. Take a random sample of plants and remove them from the pots. Examine the roots to see if they are large enough to support the top growth. Check for kinked or girdled roots. This kind of root damage will not support the plant once it is planted out. Also look for roots that circle around the pot. This is generally caused by not transplanting the stock to larger pots when the plants have outgrown the smaller pots. These roots can be cut off before planting to increase the chances of survival. The above ground materials may also need to be cut back if the roots are trimmed. A good rule-of-thumb is to have a 1:1 root to shoot ratio.

It is normal for a certain amount of the plants to die after planting out. A good rule-of-thumb is to plan for 10% mortality. This is important for 2 reasons: 1) contract or purchase about 10% more plants than the planting plan calls for, and 2) a maintenance plan for replacing the dead plants the following year is necessary to ensure that the plants that did survive will not get too big before replacements are planted.

Handling of Plant Materials

Once the plant materials have been grown or collected, they need to be handled in a manner that will ensure they survive the transplanting stress. Many problems associated with poor plant

survival occur from the handling of the plants between the production facility or collection site and the actual planting site. Generally, the plant material needs to be keep cool, moist, and shaded.

With containerized plants, one of the most important processes is hardening off the plants after they come out of the greenhouse and before they are planted out. Hardening off or acclimating the plants to the "real world" allows them to adjust from the almost perfect conditions in the greenhouse to the harsh outside conditions they will be planted in.

Hardening off can be accomplished by removing the plants from the greenhouse and placing them in a cool, partially shaded area for a 1 to 2 week period. This is generally a lathe or slat house. Lathe or slat houses can be constructed with snow fencing which has wooden slats woven together with wire. This type of structure allows a small amount of direct sunlight and solar radiation through the slats to the plants, but not enough to burn them. A partially shaded spot near the planting site will also work. It is important to keep the plants well watered and misted during the hardening off period.

With bareroot or unrooted cuttings, keep them cool, moist, and in the dark until they are ready to be planted. They can be stored in a large cooler at 24-32°F until just before planting. Cuttings can be stored in this manner for several months (Platts et al. 1987). The cuttings can be kept in a cooler, root cellar, garage, shop floor, or any place that is dark, moist, and cool at all times.

Prior to planting unrooted cuttings, whether they are coming out of storage or directly after harvesting in the spring, the cuttings should be soaked for a minimum of 24 hours (Hoag et al. 1991*a*; Hoag et al. 1991*b*; Hoag 1992). Some research recommends soaking the cuttings for as much as 10-14 days (Briggs and Munda 1992; Fenchel et al. 1988). The main criteria is that the cuttings need to be removed from the water prior to root emergence from the bark. This normally takes 7 to 9 days (Peterson and Phipps 1976). Soaking is important because it initiates the root growth process within the inner layer of bark in willows and poplars.

Only the bottom 1/3 of the cutting need be placed in water. However, soaking the entire cutting is not detrimental. Soaking can be accomplished in a garbage can, irrigation ditch, stream, pond, lake, or any other body of water that is deep enough. Soaking has been shown to significantly increase the survival rate of the cuttings (Briggs and Munda 1992; Fenchel et al. 1988; Hoag et al. 1991*a*; Hoag et al. 1991*b*; Hoag 1992; Peterson and Phipps 1976).

Native Plant Collection

Collection of wild plants or "wildings" is an excellent and inexpensive way to obtain adapted stock for planting at a revegetation site (Anderson and Shumar 1989). Some considerations before harvesting include:

* Always get permission from the landowner, public or private, before harvesting. Public agencies prohibit the collection of plant materials from federal or state lands without permission and/or a permit.

* When collecting, always watch for noxious or nuisance weeds that might be collected with the target plants. These weeds can be transported as seeds, roots, or small plants. Areas where weeds are observed should be scrutinized closely before and during harvest. After planting at the revegetation site, inspect the plants closely and continuously through the following growing season. Weed identification and eradication should be a major part of the maintenance program.
* When looking for potential native plant materials always select vigorously growing, healthy looking plants.
* Inspect potential collection plants for insect and disease damage. Most native stands are constantly exposed to insect and disease attacks. When compared to nursery grown stock, wildings will be much more susceptible to attacks because they are often stressed from previous attacks, drought conditions, and overcrowding.
* Wildings have a lower establishment success rate than nursery grown stock because of stress from harsh natural conditions they are growing in. Nursery stock are constantly watered, fertilized, sprayed, and trimmed.
* Harvest no more than 1/3 of the "mother plants" so that they will not be irrevocably damaged.
* Be constantly aware of the aesthetics of the collection site. Always harvest the native plant materials out of sight from the public. Take only a few cuttings from each plant and concentrate harvest toward the center of the plant.

Sources of Additional Information

Additional information on the selection and acquisition of woody and herbaceous plants can be obtained from a variety of sources. A few of the sources are:

- Cooperative Extension Agent
- State Forestry Department
- Universities or Colleges
- USDA Forest Service
- USDA Agricultural Research Service
- USDA Natural Resources Conservation Service
- State, Federal, and private nurseries
- USDA SCS Plant Materials Centers

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