Identify obstacles

It is important to assess operational constraints, identify problems, and resolve conflicts during the planning phase. Think about and discuss the following questions with advisors and organizational partners:

- How much money, time, and energy are available for this project?
- Is the budget adequate for the size of the project?
- Do you have a good understanding of demands on resources to accomplish key activities throughout the project (from planning, to planting, to weed control and maintenance)? Can you realistically meet those demands in a timely way, considering your other commitments, health, and access to and skill in using equipment and tools? If not, is there money in the budget to hire help?
- What conflicts might arise with adjacent land uses (e.g., farming or grazing), and how can these be resolved?
- Is there good access to the planting site, and can you move in any needed equipment or supplies?
- Does the site location allow frequent visits for monitoring and maintenance, or will you visit the site only occasionally?
- How will you determine project success? What are the consequences of an unsuccessful planting?

The scale of the project is also an important consideration. Small projects (e.g., dozens to a few hundred trees) allow use of a wider range of techniques, such as hand-cutting competing vegetation, that might be prohibitively expensive on larger projects. As the project's size and complexity increase, so does the need for cost-effective methods of site preparation, planting, and vegetation control. Balance the scale of your project with the budget, time, and other resources available.

Design your project

Although it is helpful to look at other plans and projects, be sure to design a riparian planting that is specific to your site, reflects identified goals, and can be accomplished with available resources.

Your design will need to address many features:

- Width and position of the planting
- Species to plant and type of planting materials
- Plant spacing and arrangement
- Access for people and equipment (for maintenance and monitoring)
- Fencing or other protection from livestock and wildlife

You also need to decide how to prepare the site for planting, how to protect seedlings from weed competition, and how to maintain the planting. The following sections provide more information on these topics. Also see Appendix C (page 24) for additional project design considerations.

Checklist for Step 2: Select and obtain plant materials

Species, source, and stock type are important considerations.

- ☐ Identify species that will provide the key riparian functions you identified during planning.
- ☐ Choose species that are well adapted to your site. Consider tolerance to shade, flooded or waterlogged soils, and drought.
- ☐ Select locally adapted, genetically diverse seedlings or other plant materials that fit your site conditions, management constraints, and budget.
- ☐ Plan ahead. Order seedlings and other types of planting stock well in advance.

STEP 2. SELECT AND OBTAIN PLANT MATERIALS

Species selection

Your plant selections will affect the appearance and function of your riparian planting for decades. Trees and shrubs must be able to survive and prosper when planted and also provide the functions you need in the future. Tables 1 and 2 list characteristics of native trees and shrubs.

Site adaptation

Choose species that are well adapted to site conditions. Moisture—either the lack or excess of—is often the most important factor in both planting success and long-term survival. Consider how the local climate and soils affect moisture, and select species on the basis of moisture needs and flood and drought tolerance. Start by identifying native species growing on similar sites nearby.

Conifers, such as Douglas-fir or western redcedar, are often a priority for riparian plantings in mountainous areas because they provide dense shade and durable, large wood. However, many conifers are not as well adapted to riparian areas in the Willamette Valley that are flood prone or poorly drained and should be selected with caution.

Tolerance to floods and poor drainage

Areas along the stream channel and banks as well as sloughs and swales may be subject to frequent or prolonged flooding. Species selected for these areas must have high flood tolerance. Black cottonwood, bigleaf maple, western redcedar, red alder, white alder, and Oregon ash tolerate flooding (figure 6).

Table 1. Characteristics of riparian and bottomland tree species for the Willamette Valley.

Species	Tolerance to			Comments
	Flooding	Drought	Shade	
Bigleaf maple *Acer macrophyllum*	Medium	Medium	High	Medium-lived tree. Provides early season food for seedeaters and good structural habitat.
Black cottonwood *Populus trichocarpa*	High	Low	Low	Large, fast-growing tree. Prefers moist, well-drained soils. Well-suited for shade and bank stabilization. Popular nesting platform for some birds. Roots well from cuttings.
Douglas-fir *Pseudotsuga menziesii*	Low	Medium	Medium	Tall, long-lived tree. Provides dense shade, durable dead wood, and structural elements. Does not tolerate flooding.
Grand fir *Abies grandis*	Medium	Medium	High	Fast-growing tree. Source of woody debris.
Oregon ash *Fraxinus latifolia*	High	Medium	Medium to High	Slow-growing, medium-height tree. Tolerates poorly drained, heavy clay soils. Older trees provide cavities.
Oregon white oak *Quercus garryana*	High to Medium	High	Low	Slow-growing, medium-height tree. Tolerates poorly drained, heavy soils. Wood ducks and other wildlife eat its acorns.
Ponderosa pine *Pinus ponderosa*	Medium	High	Low	Large, long-lived tree. Moderate growth rate. Provides durable dead wood and structural elements. Native Willamette Valley race is highly tolerant of both poorly drained and droughty soils.
White alder *Alnus rhombifolia*	High	Low to Medium	Low	Fast-growing, medium-height tree. The more common alder in the Willamette Valley and other interior valleys. More tolerant than red alder of poorly drained soils and warm Valley climate. Nitrogen fixer.
Red alder *Alnus rubra*	High	Low	Low	Fast-growing, medium-height tree. Likes moisture, but good drainage. Often struggles on poorly drained sites and in Willamette Valley climate. Nitrogen fixer.
Western redcedar *Thuja plicata*	High	Low	High	Likes moisture, but good drainage. Grows in Willamette Valley riparian areas but may struggle. Premium source of large, woody debris.

A related but often separate problem is soil drainage. Soils on higher terraces in the Willamette Valley often have heavy, fine-textured (clayey) soils with very poor drainage and poor aeration during the rainy season, regardless of whether they flood regularly (table 3). These are essentially wetland soils. Plants on these soils are subjected to saturated conditions for much longer periods than during surface flooding.

Poorly drained soils may be more limiting than floods for plant selection, and planting the wrong species on saturated sites is a common cause of planting failure around the valley. Plants associated with moist conditions in the mountains, such as western redcedar and red alder, may seem appropriate but often grow poorly on heavy (clayey) soils and in hot summer conditions. Trees that do best under these conditions include Oregon ash, Oregon white oak, white alder, black cottonwood, and the native Willamette Valley race of ponderosa pine. Shrubs that do well include Douglas spirea, snowberry, red-osier dogwood, and willow.

Areas along natural river levies and higher edges of floodplains will also flood, although less frequently and for shorter durations. These sites may have well-drained soils and are suitable for a larger group of plants with medium flood tolerance.

Figure 6. Black cottonwood is well suited for giving shade and stabilizing stream banks.

Photo by Brad Withrow-Robinson, © Oregon State University.

Table 2. Characteristics of riparian and bottomland shrub and small tree species for the Willamette Valley.

Species	Tolerance to			Comments
	Flooding	Drought	Shade	
Cascara buckthorn *Rhamnus purshiana*	Medium	Medium	Medium	Small tree with cherry-like berries favored by many birds.
Douglas hawthorn *Crataegus douglasii*	High	Medium	Medium to High	Small tree. Produces berries in late summer.
Douglas spirea *Spiraea douglasii*	High	Medium	Low	Low, dense shrub. Provides good cover. Spreading. Roots well from cuttings.
Elderberry, blue *Sambucus caerulea*	Medium	Medium	Medium to High	Large, vigorous shrub. Berries ripen in late summer.
Elderberry, red *Sambucus racemosa*	High	Medium	High	Medium shrub. Produces berries in early summer.
Mock orange *Philadelphus lewisii*	Medium	Medium	Medium	Tall understory shrub.
Oregon crabapple *Malus fusca*	High	Medium	Medium	Large, thicket-forming shrub or small tree.
Osoberry *Oemleria cerasiformis*	Low to Medium	Medium	High	Medium shrub. Blooms very early. Fruits ripen in late spring.
Pacific ninebark *Physocarpus capitatus*	Medium to High	Low	Medium to High	Tall understory shrub. Roots from cuttings.
Red-osier dogwood *Cornus stolonifera*	High	Low	Medium	Tall understory shrub. Roots from cuttings.
Salmonberry *Rubus spectabilis*	High	Medium	High	Common mountain riparian species sometimes seen in Willamette Valley. Produces berries in late summer.
Serviceberry *Amelanchier alnifolia*	Medium	Medium	Medium	Large, thicket-forming shrub.
Snowberry *Symphoricarpos albus*	Medium	Medium	High	Low shrub. Roots from cuttings.
Thimbleberry *Rubus parviflorus*	Low	Low	High	Common mountain riparian species sometimes seen in Willamette Valley. Produces berries in late summer.
Vine maple *Acer circinatum*	Low	Low	High	Common mountain riparian species sometimes seen in Willamette Valley.
Willow *Salix* spp.	High	Low	Low	Some willows are tree size; others are large shrubs. Root very well from cuttings. Well suited to bank stabilization and bioengineering projects.

Table 3. Common wetland soils of the Willamette Valley.
Wetland (hydric) soils form when saturation, flooding, or ponding occur for long enough during the growing season that anaerobic conditions develop in the upper part of the soil. Anaerobic conditions are challenging for many species and often a limiting factor for tree and shrub growth.

This table shows Willamette Valley soils listed as hydric. There are other somewhat poorly drained to poorly drained soils (e.g., Amity silt loam) that, while not hydric, can limit species selection and growth of trees and shrubs.

Name	Landform
Awbrig silty clay loam	Terraces
Bashaw clay	Floodplains and terraces
Brenner silt loam	Floodplains and swales
Concord silt loam	Terraces
Conser silty clay loam	Terraces
Courtney gravely silty clay loam	Stream terraces
Cove silty clay loam	Floodplains
Dayton silt loam	Terraces
Grande Ronde silty clay loam	Terraces
Huberly silty loam	Swales and terraces
Panther silty clay loam	Low hills, slumps
Verboort silty clay loam	Floodplains
Wapato silty clay loam	Floodplains
Waldo silty clay loam	Floodplains
Whiteson silt loam	Floodplains

Source: USDA Natural Resources Conservation Service; survey area version date: 12-23-2006. (*http://www.or.nrcs.usda.gov/technical/soil/hydintro.html*)

Drought tolerance

The Willamette Valley has hot, dry summer weather, and moisture stress is often a limiting factor in seedling survival. Sites close to major rivers can actually be quite dry for new seedlings. These riverbanks and levies often have sandy or gravely soils with low nutrient-and moisture-holding capacity, and they dry out rapidly each summer once the rains stop.

Although mature black cottonwood trees thrive along the sandy banks of the Willamette River, this species has relatively low drought tolerance and may be difficult to establish on such sites until its roots reach moisture deep in the soil. In some situations, you can offset this issue with weed control and irrigation.

Shade tolerance

Fast-growing riparian tree species, such as willow, cottonwood, and alder, quickly colonize disturbed areas after floods. But these trees are intolerant of shade and not suitable for planting in the understory of existing trees. Oregon ash, bigleaf maple, grand fir, western redcedar, and many shrub species are tolerant of shade and more suitable for such areas (tables 1 and 2).

Shade tolerance also comes into play as young trees grow and begin to compete with each other for light and other resources. Slower-growing and smaller tree species will tend to fall behind in growth; if these species are not shade tolerant, they will likely die and disappear from the stand. Such competition is part of a natural process but can lead to less diversity and a simpler stand structure than planned for or desired. Address this issue with thoughtful species selection, appropriate spacing and planting arrangements (see Appendix C, page 24), and selective thinning.

Local plant materials

Many species you select for your planting likely grow in many locations in Oregon and North America. For instance, white alder is plentiful in southwest Oregon, and ponderosa pine is abundant in central Oregon. However, plants of the same species from different environments can perform very differently on your site. It is important to find seedlings and planting stock grown from Willamette Valley sources. Buying from a local nursery is not necessarily enough; it is where the seed (or other parent material) comes from that counts, not the place where seedlings are raised.

See "Seed sources and genetic issues" (page 10) for more information.

Table 4. Characteristics of seedling and stock types for riparian plantings.

Stock type	Size (stem caliper and height)	Unit cost range	Comments
Bare root	0.1–0.5 caliper 8–24 inches	$0.15–$0.65	Wide availability. Winter planting. Roots vulnerable to drying. Requires extra care in handling.
Container plugs	0.05–0.3 caliper 6–20 inches	$0.25–$0.80	Fall to spring planting. Requires less skill in handling. Easier for rocky sites.
Container: 1- to 5-gallon pots or 3- to 4-inch by 18- to 24-inch PVC pipe	0.2–2.0 caliper 12–60 inches	$1.00–$10.00	Fall to spring planting. Requires less skill in handling. Survives on droughty sites. Expensive to plant.
Cutting: cane or whip	0.25–1.0 caliper 12–72 inches	$0.20–$0.30 per foot or labor and transport	Presoaking advised. Can cut from local sites. Tolerates flooding. Does not tolerate early weed competition. Grows rapidly.
Cutting: pole	1.0–4.0 caliper 48–96 inches		
Ball and burlap (B&B)	1.5–5.0 caliper 36–240 inches	$25.00–$250.00	Expensive. Instant landscape.

Figure 7. Examples of different stock types. From left: Douglas-fir container plug, 2-0, 1-1, and ponderosa pine plug-1.

Photos from Rose, R., and D.L. Haase. 2006. *Guide to Reforestation in Oregon*. Corvallis, OR: Oregon State University College of Forestry. Reproduced by permission.

Planting stock

Several types of seedlings and stock types are used in riparian plantings (table 4). Consider these characteristics when selecting a stock type:

- Availability
- Handling sensitivity
- Cost
- Ease of transport and planting
- Survival and growth potential

In general, bigger is better. Bigger stock is less likely to be overtopped by competing vegetation and recovers better when browsed. However, it is also more expensive to buy and plant. Ensure that bigger stock has an adequate root system to support the large shoot system.

Bare-root seedlings (figure 7) are grown in nursery beds, usually for 2 years, and then dug and planted during the winter dormant season. They perform well if they receive proper care and are the foundation of many riparian restoration projects.

Common designations for bare-root seedlings:

- 2-0—2-year-old tree grown only in a nursery bed
- 1-1—2-year-old tree grown 1 year in a nursery bed and 1 year in a lower-density transplant bed
- Plug-1—bare-root seedling that started out as a small container seedling and was transplanted to an outdoor nursery bed and grown for 1 year

The 1-1s tend to be larger than 2-0s and have denser, more fibrous root systems. They also cost more. Plug-1 seedlings have characteristics of container and bare-root seedlings and well-developed, fibrous root systems. They are more expensive than other bare-root seedlings.

Advantages of bare-root seedlings:

- Low cost
- Easy to transport
- Wide availability of many forest tree (and some shrub) species

Disadvantages of bare-root seedlings:

- Narrow planting window (winter dormant season)
- Requires skill during planting
- Greater sensitivity to improper handling and planting (e.g., root drying and other damage)

See *Selecting and Buying Quality Seedlings*, OSU Extension publication EC 1196 (*http://extension.oregonstate.edu/catalog*), for more information about stock types.

Container stock (figure 8) is grown in containers and planted with soil intact around the roots. Small container seedlings commonly are referred to as plugs. Sizes range from "Styro-10s" (10 cubic inches of soil in the plug) to 1-gallon pots to large plugs grown in 24-inch-long PVC pipe.

Advantages of container stock:

- Longer planting window (fall through early spring)
- Less skill needed during planting
- Less potential for damage during handling and planting
- Easier than bare-root seedlings to plant on rocky or otherwise difficult sites (plugs)
- Better survival on droughty sites (plugs)

Disadvantages of container stock:

- More difficult to transport to and around the site as size increases
- Potential for introducing weeds
- High cost

Cuttings (figure 9) are dormant sections of hardwood trees and shrubs. They have no leaves or roots. Large cuttings are called whips, canes, or poles. Cuttings are used in the field and in nursery production of container stock. When conditions are right, cuttings root after planting; willow and cottonwood root better than other species. Cuttings are available in sizes from 1 to 10 feet long. For best results, generally select young (i.e., current-year and 1-year-old) wood and soak cuttings before planting.

Figure 8. Large container stock at Stone Nursery, Central Point, Oregon.

Photo by Max Bennett, © Oregon State University.

Figure 9. Cottonwood and willow cuttings, ready for planting. Note that the two cuttings in the foreground have begun to root.

Photo by Chris Van Schaack.

Advantages of cuttings:

- Relatively low cost
- Easy to plant
- Flood tolerance

Disadvantages of cuttings:

- Greater vulnerability to dry conditions
- High sensitivity to weed competition during establishment
- Potential narrowing of genetic diversity (each rooted cutting is a clone)

Ball-and-burlap (B&B) stock has a large ball of soil around the root system held in place with a burlap wrap. These tend to be much larger, much more expensive trees that are generally inappropriate for most restoration situations but may be used in park settings and other green spaces in or near urban areas.

Advantages of ball-and-burlap stock:

- Provide an "instant tree"
- Good survival and growth

Disadvantages of ball-and-burlap stock:

- High cost
- More difficult to plant than other stock types

Many commercial forest nurseries in the Pacific Northwest grow plants suitable for riparian restoration projects. The popularity of these projects, and the demand for planting stock, has grown enormously in the past decade. Most nurseries grow some stock on speculation (i.e., based on expected demand), which they sell on a first-come, first-served basis. These supplies don't always meet demand, so order early for the best availability of species, seed source, and stock type.

You can also contract with nurseries to grow plants to your specifications. This gives you the greatest control of seed source. A minimum number of seedlings (e.g., 2,000) is required for such contracts, and you will likely need to start this process 2 years before your anticipated planting date.

Many local soil and water conservation districts and some chapters of the Oregon Small Woodlands Association have annual plant sales, which are a good place to purchase smaller numbers of plants. Be sure to ask about seed source.

Use the following resources to find nurseries that sell or specialize in native plants:

- *Sources of Native Forest Nursery Seedlings* (publication from the Oregon Department of Forestry): *http://www.oregon.gov/ODF/privateforests/docs/ForestNurserySeedlingSources.pdf*
- Oregon Association of Nurseries: *http://www.nurseryguide.com/*
- Oregon State University Extension forester
- Oregon Department of Forestry stewardship forester

Seed sources and genetic issues

To ensure that plants are adapted to your site, select planting stock grown from a local seed source. How local is "local"?

Because climate varies so much over short distances in northwest Oregon, there is no rule of thumb (e.g., 50 miles) for how far trees and shrubs can be moved safely from their source. Instead, seed zones have been established to minimize risk.

Seed zones are geographic areas with fairly uniform temperature, rainfall, and other climatic factors. If the area includes major elevation changes, elevation bands within each zone further define areas with important similarities in conditions.

Trees can be planted safely within their zone of origin based on both the geographic seed zone and the elevation band. Planting in a higher or lower elevation band from the zone of origin increases the risk that the plant will adapt poorly to its new environment.

Specify the seed zone and elevation (to the nearest 500 or 1,000 feet) when ordering seedlings.

Seed zones have been established for most conifer species, red alder, and black cottonwood. Relatively little is known about genetic variability among other native riparian hardwoods and shrubs. In the absence of specific zones for a species, use basic westside zones to guide seed transfer in other hardwood and shrub species (figure 10). Seed transfer should be relatively safe within these zones. In practice, planting stock is not always available from your desired seed zone and elevation.

- Moving between two adjacent seed zones, especially close to their boundaries, may pose little risk, as long as there is relatively little difference in temperature and precipitation.
- Avoid moving seed across major environmental divides, such as from the interior valleys to the coast and vice versa.
- Moving up in elevation (more than 1,000 feet) increases the risk of frost damage. Moving down in elevation poses less risk, although growth may be slower.
- Regardless of zone boundaries, plants will be vulnerable to drought stress if seed is moved from areas of high precipitation (i.e., above 60 inches) to areas of low precipitation (i.e., below 30 inches).

For more information, see *Selecting Native Plant Materials for Restoration Projects*, OSU Extension publication EM 8885 (*http://extension.oregonstate.edu/catalog*).

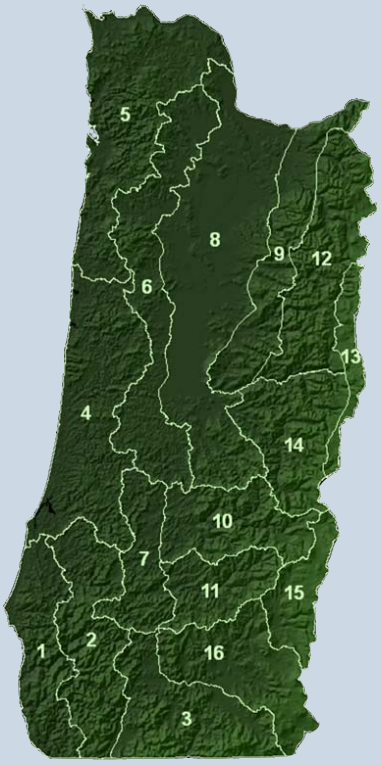

Figure 10. Basic seed zone map for western Oregon. Use for hardwoods and other species that do not have their own designated seed zones.

Image by Glenn Howe, © Oregon State University.