3.6 Using Icebergs

Site preparation includes installing icebergs where they are appropriate. Icebergs are large natural objects found at your project site, such as rocks or logs, that are buried with about one-third of the mass aboveground and at least two-thirds belowground. Arrange icebergs so they appear to be natural (figure 3–74).

Figure 3–74—Icebergs (deeply buried rocks) are an effective tool for discouraging overnight use of closed campsites. In this example from the Desolation Wilderness, CA, crews artfully selected and placed two rocks that blend well with natural patterns, but make the site undesirable for camping.

Icebergs are installed for several reasons—to deter users from camping in a restoration site, to shrink a campsite, and to provide microsites where vegetation can become established. Logs (figure 3–75) provide habitat for fauna and fungi. Although it is more difficult to make artificial snags look natural, trees can be buried upright (figure 3–76) to deter use on a site.

It is tempting to install icebergs that have sharp points so visitors won't sit on them. Doing so is counterproductive unless the iceberg blends in with the surrounding rock and is sunk deeply into the ground. Industrious visitors will simply grab hold of the iceberg and yank it out.

Figure 3–75—This punky log looks like it has been at this site in the Desolation Wilderness, CA, forever. My, but that restoration crew is clever!

Figure 3–76—Restoration crews at Olympic National Park, WA, are clever, too— the stump in the center of the photo looks like it grew here, but it was installed to discourage campers from using this site.

Moving large rocks to make icebergs can be a challenge. The U.S. Department of the Interior National Park Service moves rock from nearby talus slopes with helicopters (figures 3–77a and 77b). Primitive methods include using a grip hoist or making litters to support the rock so workers are able to walk in an upright position while sharing the load (figure 3–78).

Figures 3–77a and 77b—At Olympic National Park, WA, helicopters (top) have carried talus to harden campsites or close restoration sites (bottom). The National Park Service sometimes uses helicopters as the minimum tool when managing wilderness.

Figure 3–78—Litters can be improvised to move rock. Grip hoists can be used to drag larger rocks, but doing so would damage vegetation.

Icebergs also can be used to attract use. In places you want people to use, a large rock with a flat surface is like a piece of furniture (figure 3–79). Lest providing such furniture offends your wilderness sensibilities, consider this: the rock provides a hardened place for people to sit, set up their camp kitchen, or lean their packs. If the rock is within a hardened site, this tactic helps concentrate impacts in the impacted area. Otherwise, campers are drawn to other nearby rocks or trees that will serve the same function, widening the zone of impacts.

Figure 3–79—Rock added as "Flintstone furniture" helps confine use within the impacted perimeter of designated campsites. Flat rocks can serve as a kitchen, a place to sit, or a place to lean backpacks.

3.7 Site Delineation

Visitors to public lands often are oblivious to the ease with which vegetation can be damaged. Visitors may walk, sit, camp, and tie up their animals on fragile, vegetated areas. Visitors can and will take the shortest or most interesting route possible, even when it means leaving hardened surfaces that could resist trampling. An important method for subtly—or not so subtly—channeling use is site delineation (Scott 1998). Barriers are installed during site preparation because installation requires disturbing the area.

Figure 3–81—Rows of rock keep users on the Pacific Crest Trail in the John Muir Wilderness, Sequoia-Kings Canyon National Park, CA.

3.7.1 Barriers

You can delineate where you would like to keep users out (an exclosure). For instance, the rail fence in figure 3–80 is intended to keep visitors from using a restoration site. Or you can delineate where you would like to keep visitors in (an enclosure), such as when you define the edges of a campsite or trail (figure 3–81).

The size of the barrier and the materials it is made from are intended to match the awareness level of users. Remember minimum requirement principles, because barriers may not always seem like a light-handed technique in wilderness. In locations with informed users, plantings may be the barriers—tree seedlings could block a path, for instance. Low-profile barriers, such as a row of rocks that lines trails or small-diameter logs (figures 3–82a and 82b) pegged into

Figure 3–80—Barriers can help keep visitors from using a restoration site. This fence (commonly known as a jack fence) is near a road pullout at Natural Bridges National Monument, UT.

Figure 3–82a and 82b—These low-profile log barriers (top) delineate a trail through a closed restoration site. The barriers also serve as silt dams for backfilling the restoration sites. Log carriers (bottom) placed underneath the log are useful when transporting log barriers.

place along a trail, are slightly more obtrusive, but will keep visitors out of your restoration sites in some areas. With enough attention, these barriers can be designed so they are not obtrusive (figure 3–83).

Figure 3–83—The rocks and log used to block this social trail in the Desolation Wilderness, CA, blend in so well that the average user may not notice them.

You may determine that hefty fence-like barriers are needed for your visitors. Ruth Scott, a veteran restoration practitioner at Olympic National Park, has learned through experience that large logs or rocks often are needed to corral users.

3.7.2 String Fences

String fences are commonly used to delineate restoration sites. String fences are inexpensive, easy to transport, and easy to install. Their height can be adjusted easily by changing the length of the stakes. Unfortunately, string fences are a high-maintenance item, easily collapsed by snow or unknown dark forces. In addition, string fences have a less natural appearance than native materials. String fences are certainly not a long-term solution for site management. However, they are a good short-term fix to funnel use in areas where the vegetation will soon take over or when other options are not practical.

A Restorationist's Tale

One weekend day, while on patrol at Snow Lake in the Alpine Lakes Wilderness, I stepped within earshot of one of our recently closed and treated restoration sites. The site was covered with jute matting (figure 3–84) that had plugs of native vegetation poking through. A string fence, installed to block the site from use, had fallen into disrepair. Two people had plunked themselves down in the middle of the site to enjoy their picnic lunch. Just as I felt my ire rising and I was searching for words of diplomacy, I heard the woman in the group say, in a loud shrill voice, "Isn't it nice that they put down a mat so that we have a nice clean place to sit?"

—Lisa Therrell

Figure 3–84—The scene of the crime. String fences can discourage visitors from using restoration matting as a seat cushion.

If you use a string fence, (figures 3–85a, 85b, and 85c), it is best to construct it from parachute cord or heavier cord. Stakes need to be made from 1- by 2-inch (25- by 51-millimeter) lath or bigger material to withstand snow and marauders. Small Lexan or Rite-in-the-Rain paper "Restoration Site" signs are available that can be attached to the cord with wire (see chapter 5, *Tools of the Trade and Other Resources*, for a source of signs).

Figure 3–85a—While string fences can rope off large expanses or block a trail, they require perpetual maintenance.

Figure 3–85b—Small Lexan or Rite-in-the-Rain paper "Restoration Site" signs are available that can be attached to the cord with wire.

Figure 3–85c—Specially marked stakes are more durable.

3.8 Blending Restoration Projects Into Wilderness

Some readers may be mortified after reading a discussion of recontouring sites and installing barriers and Flintstone furniture. These techniques seem quite manipulative and too structured for many wilderness settings. The challenge is to determine when these techniques really are the minimum tool, then designing the project so it blends with local landscape features as much as possible.

3.9 Common Wilderness Campsite and Trail Problems

Parallel Trails

When parallel trails are not deeply eroded, the unneeded trails usually can be obliterated by using plantings, rocks, and logs to deter continued use (figure 3–86). The "real" trail is left open and improved to correct any problems that may have led to the formation of parallel trails. Usually, the problem was that the trail was muddy when wet or was too rough or narrow to invite continued use.

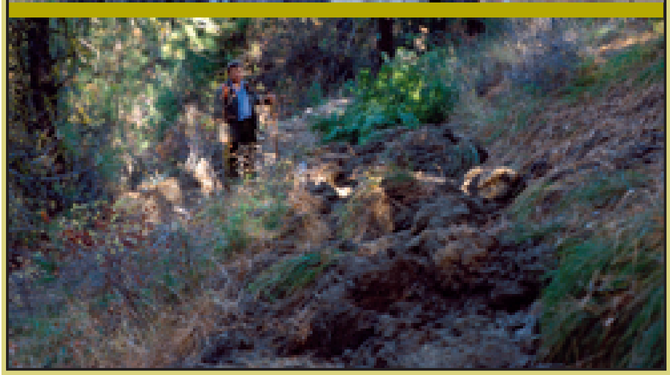
Figure 3–86—If a parallel trail is not deeply eroded, it can be blocked with rocks or logs and planted to repair the damage. This trail is in the Eagle Cap Wilderness, OR.

With a large enough budget, restorationists could install lots of checkdams and backfill parallel trails with imported fill, returning them to the original slope contour.

Many Forest Service projects don't have the funding to allow such approaches, and the agency is less likely to use a helicopter to support a wilderness restoration project. A compromise solution is to create a broad swale by digging up and rearranging the raised ridges of vegetation separating each parallel trail.

Digging up and moving surviving vegetation is not completely desirable. Do so only if the result seems more desirable than leaving the visual lines and erosion channels of the parallel trail trenches.

Human use might be directed onto a relocated trail, which contours the slope at a sustainable grade. Alternatively, rock or log steps that serve as siltdams could be installed to allow the trail to be improved at its original location (figures 3–87a and 87b). If your trail is used by stock or bicyclists,



Figures 3–87a and 3–87b—Several steep, parallel trails (top) plunged down an embankment at Snow Lake in the Alpine Lakes Wilderness, WA. One trail was hardened by installing rock steps. Other trails (bottom) were closed and restored.

make sure that each step is longer than the length of a horse or bicycle, and short enough that a chain sprocket will not hang up.

Deeply Eroded Trails

Deeply eroded trails are difficult to erase without adequate fill and substantial labor. The permanent scar of the old trail—often partially filled with rock or wood chunks to slow the movement of water and trap silt—is evidence of many trail relocation projects.

Ideally, checkdams will be installed in the old trail and backfilled at ground level. If surface erosion is being directed toward the trail, it may be possible to trap additional sediment behind checkdams.

In forested or brushy areas, a compromise solution would be to stabilize the trail with lower angle checkdams and backfill, then to design the vegetative treatment to include some taller plants that will break up the visual effect of the trench. If the trail includes large step-downs caused by headcutting, the slope angle will need to be laid back. If the project location supports riparian vegetation, a bioengineering treatment—such as the trench pack—might help. If the trail cannot be treated successfully, give serious consideration to hardening the trail.

Trails That Contour

Sometimes a trail that contours is slated for restoration. If the trail has had little or no erosion, pull the berm or fill at the outer edge of the trail back into the tread as much as possible. If the trail is more deeply eroded, determine whether it is more effective to pull the berm in—exposing a large raw area but reestablishing the contour—or to use a series of checkdams and backfill. If the tread remains incised, be sure to include drain dips or waterbars as you would for a system trail. Controlling ongoing erosion by directing water off the trail will be important to the project's success.

Excavated Campsites

Some campsites have an excavated cutbank where the site was carved into the hillside. If the fill is still available on the downhill edge of the site, it can be moved back into the cut. Logs or rock can be arranged to stabilize the new contour. Without treatment, many sites will continue to erode back into the slope because of rodent activity or wind action.

Eroded Campsites

A site on a slope might continue to erode from water, wind, human use, or even animal activity. Checkdams or siltbars can be installed to stabilize the slope in shallow benches and fan out running water (figure 3–88) to slow it down. Be sure to evaluate whether the water should be directed away from the uphill side of the site. For example, a well-placed drain on the trail accessing the site may prevent water from coursing through the site. This same approach can be used to stabilize a campsite you wish to keep open for use, leaving large enough flat areas to serve as tent pads. As with an excavated campsite, if erosion is continuing to eat back into a slope, design a way to stabilize the erosion, such as laying rock or organic debris against the eroding cut.

Figure 3–88—Rocks and logs used as low-angle siltbars stabilize the tent space on this campsite at Lake Mary in the Alpine Lakes Wilderness, WA.

3.10 Plant Selection, Collection, and Propagation Techniques

This portion of the guide lays out the factors to consider when you are selecting the plant species to treat restoration sites, the manner in which you collect the plant material, and the propagation methods you might employ. The botanist or plant ecologist (figures 3–89a and 89b) on your team will help you through this process. This guide focuses on the

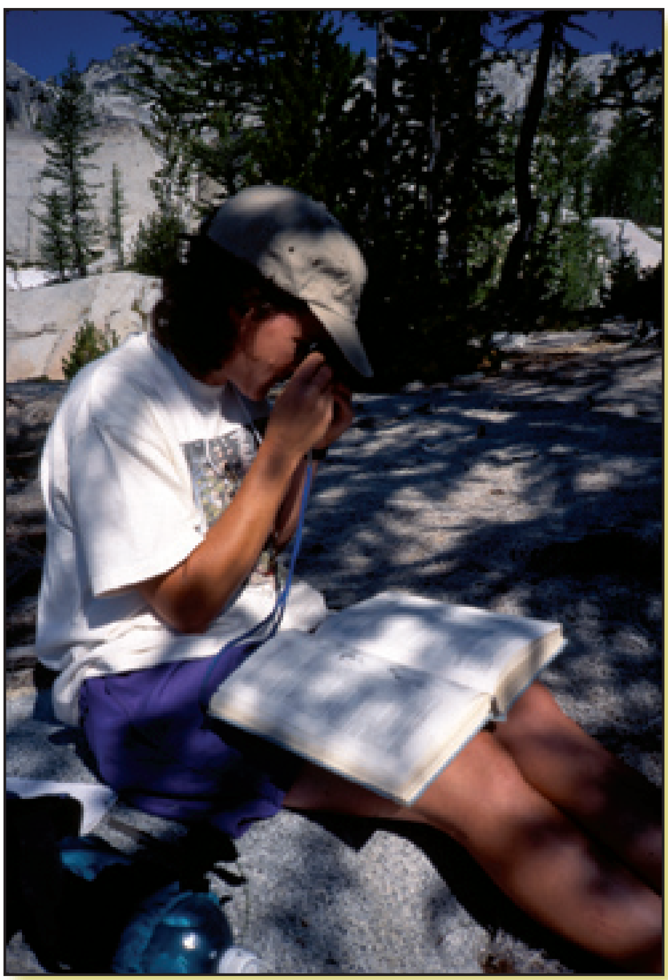


Figure 3–89a—You will appreciate the help of the botanist or plant ecologist on your team when you need to identify and select appropriate plant species for a restoration treatment.

Carex nigricans

Figure 3–89b—“Dang, these sedge flowers have small plant parts!” Drawings courtesy of the University of Washington Press (Hitchcock and Cronquist 1976).

information needed to do work successfully onsite, as well as the knowledge needed to coordinate with a professional nursery. Appendix B, *Propagation and Establishment Requirements for Selected Plant Species*, summarizes additional species-specific information.

3.10.1 Genetic Considerations for Restoration Projects

The design of a restoration project should consider the genetic implications of selecting, moving, and propagating plant materials. Plant movement guidelines define the area over which plant materials, such as seed or cuttings, can be collected relative to the project location to assure restoration success and maintain the genetic integrity of the local plant population. In addition, plant propagation techniques can result in an unintentional selection against a portion of the total genetic material (certain genotypes) represented in the plant material collected for propagation. This section explains these concepts and offers suggestions for minimizing changes to the genetic structure of the area being restored.

Selecting plant material appropriately increases the probability that the plants will survive, grow to maturity, and reproduce with new individuals suited to the local environment. Increasingly, even projects in highly modified environments, such as highway corridors, are using locally adapted native plants (Smith 1994).

Most plants are precisely adapted to their immediate environment. Many species that are widespread are grouped into ecotypes, each of which is adapted to a specifically defined ecological situation within one or more subareas of the species' range. Subpopulations are usually continuous, but maintain their integrity through ecologically specified selection pressures, despite gene flow from the other neighboring "ecological" races (Potash and Aubry 1997). For example, western shrub species (figure 3–90) show strong ecotypic variation in morphology, growth rate, flowering times, cold hardiness, germination patterns, and so on (Meyer and Monsen 1992).

Figure 3–90—Rabbitbrush (*Chrysothamnus* spp.) in Mesa Verde National Park, CO.

Nonlocal stock, especially of native species, can introduce different maladapted genotypes (the total genetic information contained in the plant) into the gene pool of the local plant population. Changes can occur in a number of traits, including plant size and shape, growth rate, seed production, and survival. These changes could be temporary or permanent. Too little is known about possible changes in most plant species to predict the outcome. The degree to which these changes occur depends on the difference between any two subareas, such as alpine, subalpine, or lower elevation environments (Guinon 1992; Potash and Aubry 1997).

In wilderness or other remote sites, there is also an ethical imperative to maintain the genetic integrity of the local plant community. The goal for restorationists should be to use locally adapted plant materials that will not change the genetic composition of the plant community.

Maintaining genetic integrity is an important planning challenge, because specific scientific parameters that could be used to define a seed collection zone are not known for most plant species. Conifer species are an exception. The Forest Service has been refining a seed zone concept for conifers since the 1950s. Professional opinions range widely regarding just how far other species of plants should be moved. For example, some projects have moved plants over hundreds of miles based on ecotype (Redente 1993; Smith

1994). Other projects collected plant materials from within a few feet of the actual site to be treated.

Some agencies have incorporated plant movement guidelines into policy or procedures. Using these policies and working with a geneticist is an important starting point in deciding species-specific plant movement guidelines. In wilderness or other relatively natural settings, err toward preventing unwanted genetic movement, rather than going farther afield to collect plant materials.

3.10.1a Determining a Local Collection Area

Lacking better information, a local collection area is defined as the combined distance that pollen would be likely to travel plus the distance that seeds would be dispersed. The following considerations will help determine the radius of genetic isolation (Albright 1994; Millar 1992).

The life history of a plant affects genetic diversity. Plants that are wind-pollinated, such as conifers (figure 3–91), alders, cottonwoods, and graminoids (grasses, rushes, and sedges) cross-pollinate over much wider geographic areas than plants that are cross-pollinated by insects. For example, corn pollen generally travels up to a quarter mile (0.4 kilometer), and can travel much farther, depending on wind patterns. Materials from wind-pollinated species can be collected from a larger area without affecting genetic diversity. This is not the case for materials of plants that self-pollinate or that reproduce vegetatively.

The seed-dispersal mechanism, which is generally easy to identify, also has significant bearing on genetic movement. Seed that becomes airborne or that is dispersed by animals (figure 3–92) is likely to travel farther than seed that falls to the ground below the plant or that is transported short distances by ants or rodents. For example, the seed of willows, aspen, poplar, and fireweed can be dispersed for at least 1 mile (1.6 kilometers) by the wind. The heavier seed of paper birch, alder, and spruce can be dispersed up to a quarter mile (0.4 kilometer, Densmore and Vander Meer 1998).

In some cases, changes in a plant's morphology (physical appearance) based on its location can be observed readily. While it is important to collect materials from a variety of

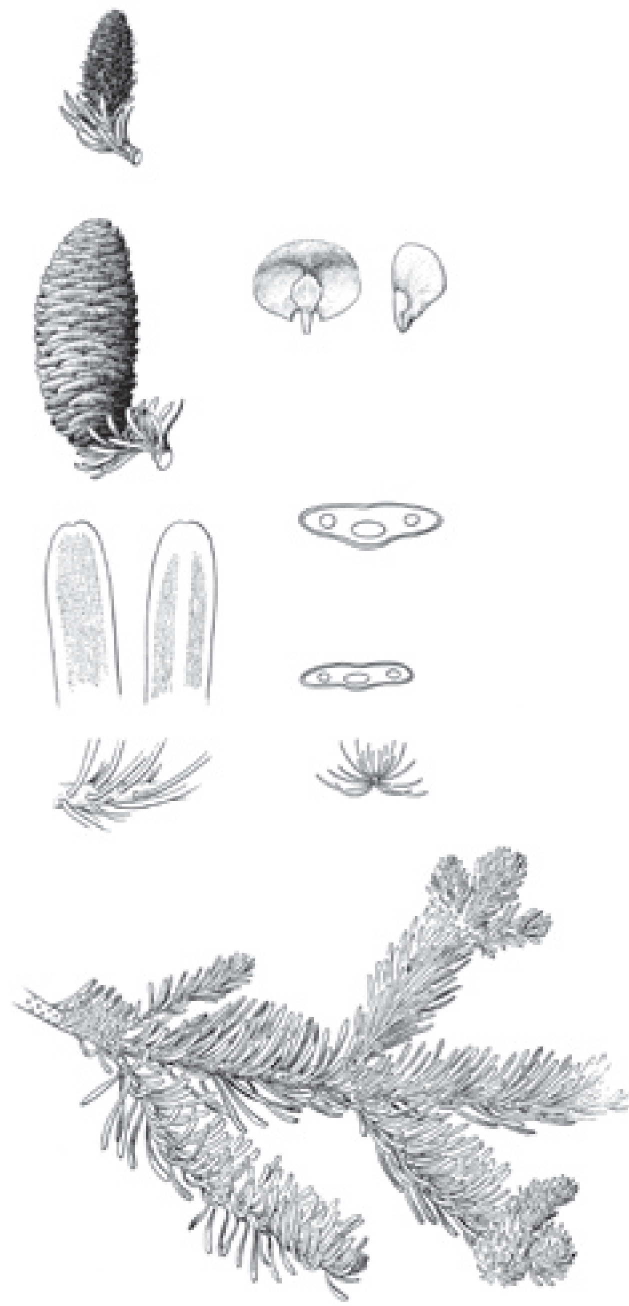


Figure 3–91—The windblown pollen of conifers such as subalpine fir (*Abies lasiocarpa*, above) distributes genetic material far from the parent plant. Drawings courtesy of the University of Washington Press (Hitchcock and Cronquist 1976).

Figure 3–92—The hooked and sticky seed pods of trail plant (*Adenocaulon bicolor*) travel long distances while stuck to the fur of mammals, distributing genetic material farther than the seed of species that may be blown a short distance or that fall to the ground near the plant. Drawings courtesy of the University of Washington Press (Hitchcock and Cronquist 1976).

individuals, if morphological changes are based on identifiable ecological or geographic differences, plants morphologically unlike those at the restoration site should be considered genetically separate and should not be collected.

Ecological barriers may restrict genetic movement. Identify localized breaks in geology, topography, climate, vegetation type, or other ecological extremes. For example, genetic information is more likely to remain in a basin (figure 3–93) than to migrate across ridges. Limit plant collection to an area with the same environmental characteristics as the project area. The more diverse the local habitat of a plant, the greater the local genetic variation (Linhart 1995).

Figure 3–93—Seed or pollen is more likely to remain within a basin than to cross ridges.

3.10.1b Preventing Unintentional Selection

Even if collection distances are carefully determined and followed, the genetic structure of plants can be changed when they are collected for propagation. For instance, too few plants could be collected to assure some genetic diversity, or the plants that were collected could be too closely related. In such situations, propagated plants would run the risk of inbreeding depression and subsequent population decline (Guinon 1992).

Plant materials should be gathered from throughout the collection area. The collector should be familiar with the pollination method of each species, in order to surmise how far to go to gather individuals likely to be unrelated. Small annuals may be unrelated if they are 5 to 11 yards (4.6 to 10 meters) from each other. Forest trees may need to be 110 to 220 yards (101 to 201 meters) away to be unrelated (Linhart 1995). If seed or cuttings are collected from a variety of individuals, a minimum of 30 to 50 parent plants are needed to help preserve all the genetic options available to the population in the project area. If mortality is anticipated at any stage of the propagation process, collect from more donor plants (Potash and Aubry 1997). An equal amount of seed (figure 3–94) or cuttings should be gathered from each plant; overcollecting from heavy seed producers can cause a genetic shift (Meyer and Monsen 1992).

Figure 3–94—When collecting seed and other plant materials, consider how far genetic material would be likely to travel naturally, and emulate that pattern. Here, seed is being collected in the Alpine Lakes Wilderness, WA.

Collect from every microhabitat represented at the project site. Donor plants should not be selected for uniformity or other characteristics such as heartiness; rather, collections should be from individuals that exhibit an array of size, growth form, vigor, and so forth. A trait that may appear to be undesirable could ultimately be the trait that enables a plant to survive in a slightly altered environment. If too few plants are available in the collection area, collections should be made at other sites by matching donor and project site characteristics as closely as possible (Guinon 1992).

The type of plant material collected also will affect the genetic outcome. Seed, which is the product of cross-pollination, is much more diverse genetically than cuttings or plant tissue. Genetic integrity also is maintained by collecting from the wild local population, rather than from offspring grown in a nursery or produced through seed-increase programs that may cause a genetic shift (Meyer and Monsen 1992).

Timing of collection also can be a factor in maintaining genetic variation. Ripening times of seed can vary on the same plant, with each seed lot having different characteristics. When this is the case, seed should be collected at several different times (Meyer and Monsen 1992).

Seed handling and germination procedures affect survival rates, selecting for and against certain traits. Avoid overcleaning seed, which removes smaller seed that may differ genetically from seed of average size. Ensure that seed is cured and stored properly (more on this in the section on handling seed). The best insurance against unintentional selection is to use presowing treatments that break dormancy completely in every viable seed and then to assure the survival of the delicate seedlings. When thinning, do not routinely remove the smaller plants; leave plants with a variety of sizes and other traits (Meyer and Monsen 1992). Ideally, every plant should be saved and used.

Finally, it is important to document where plant materials were collected. This will be considered later when evaluating monitoring results. An example of a collection documentation sheet is included in appendix E, *Forms.*

Native Plant Collection Guidelines for the Mt. Baker-Snoqualmie National Forest

The following example is the summary of a policy developed by a geneticist for a national forest in western Washington based on local ecosystems (Potash and Aubry 1997). This policy is a good illustration of applying the principles described in this section.

Summary of *Guidelines for Native Plant Collection to Ensure Genetic Diversity and Adaptation to Planting Environment*

- Collect from 30 to 50 unrelated plants.
- Collect an equal number of seeds or cuttings from each plant.
- For upland tree species, collect seed and cuttings within (predetermined) seed zones and 500-foot (152-meter) bands of elevation or not more than 250 feet (76 meters) above and below the project site.
- For shrubs, forbs, grasses, and riparian tree species, collect seeds and cuttings within watersheds and 500-foot (152-meter) bands of elevation or not more than 250 feet (76 meters) above and below the project site.

In practice, wilderness restoration practitioners exercise caution in limiting the distances they go to collect plant material. Mount Rainier National Park collects most of its plant material within 200 feet (61 meters) of the project site (Rochefort 2002). The Wenatchee River Ranger District of the Wenatchee National Forest collects from within the same lake basin, up to half a mile (0.8 kilometer) away at the most and no more than 200 feet (61 meters) in elevation above or below the site to be treated. Care is taken to collect from throughout the basin to avoid limiting the gene pool too much and to avoid overharvesting individual stands of plants. Successive collections are taken when possible, and each plant material batch is combined with others of the same species to avoid any genetic bias when propagating or planting.

3.10.1c Additional Information on Genetic Considerations

For more information on genetic considerations for restoration projects, refer to the *Mt. Baker-Snoqualmie National Forest Native Plant Notebook* (Potash and Aubry 1997), *Genetic Considerations* (Meyer and Monsen 1992), and *Promoting Gene Conservation Through Seed and Plant Procurement* (Guinon 1992).

3.10.1d Nonnative Plants, Agronomic Varieties, or Native Cultivars

Thinking about the use of nonnative plants or agronomic varieties for restoration projects has been evolving. Agronomic varieties and native cultivars have been developed from native plants selected for certain desirable traits, such as forage value, drought hardiness, tolerance of alkalinity, or increased seed production. Some grass species have had many agronomic varieties developed from a single species, with each variety specially suited to a specific environment. Agronomic varieties, as the name suggests, are literally farmed, grown in commercial fields to provide a relatively abundant, inexpensive source of seed. These varieties, as well as nonnative plant species, have been used extensively at a landscape scale for many decades, usually to reclaim mines or overgrazed range, or to stabilize slopes after wildland fires (Aubry and others 2005; Monsen 1975; Owen, no date).

The decision to use nonnative plants, agronomic varieties, native cultivars, or even nonlocal native stock usually is based on economy, because these plants are available readily at a lower cost per unit—usually per pound (half a kilogram) of pure live seed per container—than the cost of propagating local native stock. Some have argued that the lower cost of nonnative plants is false economy because the purchase cost does not include the cost to the ecosystems involved (Dalpiaz 1994; Kratz and others 1994; Owen, no date). A number of the most aggressive pest plants in North America were introduced to reclaim erosion or improve forage, including kudzu, purple loosestrife, reed canarygrass (figure 3–95), African lovegrass, tamarisk, and Scotchbroom.

Figure 3–95—Reed canarygrass (*Phalaris arundinacea*) is a native plant in North America. It has been bred as an agronomic variety and used extensively for pasture improvement and streambank stabilization. Because it has underground tillers, reed canarygrass can spread quickly and become invasive, displacing local native plant communities.

To quote a briefing paper from the Rocky Mountain Region of the USDA Forest Service, “We do not know the impacts of exotic plants on animals, insects, and the soil microflora and microfauna” (Kratz and others 1994). According to Berger (1993), the introduction of nonindigenous species may disrupt native ecosystems either through effects on competition or predation, through the introduction of disease vectors, or by affecting mutualistic relationships, such as when insect and plant invaders drastically alter community structure by displacing native plants. The growing body of literature on this topic suggests the following conclusions:

1. Selecting nonlocal native plant material or nonlocal native cultivars is potentially the most destructive course of action because cross pollination and outcrossing are likely to occur, “polluting” the gene pool of the local native plant community (Kratz and others 1994). Selecting nonnatives that are closely related to local natives also is a poor choice because of the possibility of hybridization.
2. Nonnative species, especially agronomic varieties, often will be vigorous for several years before declining in numbers (Brown and Johnston 1979). A number of studies have shown that the introduced species will prevent the initial establishment of native plants (Amaranthus and others 1993; Schoennagel 1997). In addition, some introduced species, depending on growing conditions, are persistent and can outcompete native plant communities. For example, red fescue (*Festuca rubra*) was selected for use at Mt. Rainier National Park based on the prediction that it would not be persistent and would allow natives to invade. The fescue was used extensively for erosion control before it was discovered that it was reproducing both vegetatively and from seed and was too invasive to allow natural succession (Hingston 1982).
3. For projects where nonlocal natives are not available in sufficient quantity and some other plant material must be selected, a sterile, nonpersistent, and noninvasive species would be the best choice (Keigley 1988; Kratz and others 1994). In this approach, the introduced species often is used as a cover crop to improve soil conditions, allowing natives to invade. Restoration research scientist Jayne Belnap advocates the use of a cover crop to maintain soil microbial populations on a disturbed site when

planting with native stock needs to be delayed. Sterile hybrids can help stabilize slopes, especially when natives may be slow to establish extensive root systems (Belnap and Furman 1997). This approach will force the planner to do some careful consulting with geneticists, plant ecologists, or other restoration practitioners to determine the species and seeding rates that might meet these criteria for the project location.

The use of annual ryegrass (*Lomium multiflorum*) as a cover crop to implement approach number 3 has worked in some cases and failed in others. In Rocky Mountain National Park, annual rye was used successfully as a nonpersistent, noninvasive cover crop that allowed future transplants of containerized natives onto the disturbed site. The annual rye also improved soil moisture retention, available nitrogen, and slope stability (Keigley 1988). However, when annual rye was seeded after a wildland fire in a sugar pine (*Pinus lambertiana*) forest type in southern Oregon, the native species cover and richness were reduced, with possible long-term negative effects on slope stability, productivity, and reestablishment of conifer seedlings (Amaranthus and others 1993).

For small projects, such as those addressed by this guide, it would be uncommon to consider using anything other than nonlocal native plants. Larger projects have the potential for even greater ecosystem disturbance when they resort to using nonnative plant materials. The alternative, which involves planning ahead, is to develop adequate sources of appropriate native plant material over time. For large-scale projects, this would start with defining ecotypes for species of interest, and starting large-scale propagation programs such as a seed-increase program to develop an adequate supply of seed for project needs.

Decisions on using nonnative or nonlocal native plant stocks depend on the project's goals. If the goal is to allow for the eventual establishment of a native plant community that approximates the vegetative mosaic before disturbance, local native plant stock should be used. If the goal is merely to revegetate an area for other human benefits, it may be appropriate to consider using nonnative plants. In designated wilderness, where land managers are legally mandated to manage for "untrammeled" landscapes, the latter approach conflicts with the philosophy of the Wilderness Act of 1964, and in some cases, runs counter to agency policy.

3.10.2 Plant Selection for Restoration Projects

The process of selecting plants for a restoration project is essentially a ecological and horticultural feasibility study that begins by selecting a reference site, as described at the start of this chapter. Often, the plant community that is desired to meet long-term goals for the area is not within immediate reach because of any number of limiting factors, including environmental conditions, the degree of disturbance at the site, continuing patterns of destructive use, difficulties in propagation, and budgetary constraints.

The very first consideration is whether natural revegetation might be possible as the minimum tool. This concept was described more fully in chapter 2. Natural revegetation may be possible, for example, if the soil has a known seedbank, if other live plant material could revegetate the site, or if the environment is lush and recovers quickly. Sometimes plants are not the dominant feature of the landscape. The appearance of restoration can be accomplished by other means, such as recontouring and replacing missing features (rock, for instance). Vegetation can be allowed to recover naturally. This approach can be successful in environments such as deserts or alpine fellfields (rocky habitats with a cover of low plants on exposed alpine summits and ridges).

Wilderness Restoration and the Colorado Fourteeners

The Leadville Ranger District of the San Isabel National Forest developed an interesting partnership for managing scrambling routes on the Colorado Fourteeners (peaks higher than 14,000 feet [4.27 kilometers]). Despite being in a "trailless" zone, many of these peaks were scored by steep, eroding parallel trails. Volunteers organized by the Colorado Fourteeners Initiative (*http://www.14ers.org*), are establishing one stable trail to each peak. The remaining routes are being obliterated and allowed to revegetate naturally (figure 3–96). Wilderness rangers have observed limited establishment of native seedlings on some of these routes after use has been eliminated.

Figure 3–96—Mount Belford (elevation 14,197 feet, 4,327 meters) is one of more than 50 Fourteeners in Colorado. The trail is recovering naturally after being closed.

If your project team decides that natural revegetation is infeasible, a vegetative prescription must be developed. The botanist or ecologist will help you determine the plants that could serve as an appropriate mix for restoration. You also should review the scientific literature and consult with practitioners who have worked with the same plant species or in similar environments. The outcome will be the selection of plant species, treatment methods, and propagation methods "most likely to succeed" in reaching project goals. This section lays out one approach for determining the plants that will be most successful.

Consider carefully planned experimentation (otherwise known as trial and error) to cut losses and learn more about successful treatments that can be used in future projects.