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PLANT MATERIALS TECHNICAL NOTE NO. 4

PLANT MATERIALS FOR WESTERN RIPARIAN AREAS

Scott M. Lambert
State Plant Resource Specialist
USDA NRCS
Washington State University, Pullman, Washington
Email: lamberts@wsu.edu

This technical paper was presented at the Watershed Management 2000 Symposium in Fort Collins, Colorado. The session was sponsored by the American Society of Civil Engineers. The paper has information on approaches to wetland/riparian improvement, uses of planting stock and direct seed techniques that may he applied in Oregon. References and a table with a partial list of riparian plant species are also included in the paper.

PLANT MATERIALS FOR WESTERN RIPARIAN AREAS

Nancy L. Shaw[1], Scott M. Lambert[2] and J. Chris Hoag[3]

ABSTRACT

Increasing emphasis on improvement of degraded wetlands and riparian areas in the western United States has necessitated development of appropriate plant materials and planting technology. Treatment of damaged wetlands requires restoration of proper hydrologic functioning and reestablishment of native vegetation. Restoration of native vegetation is necessary where remnant plants, vegetative materials and seeds are absent. Flooding, sediment deposition and removal and fluctuating ground water levels present challenges in the selection of appropriate species and classes of planting stock. These decisions are made more difficult as genetic variability, transfer guidelines and requirements for establishment of wetland species are largely unknown. Limited information on propagation techniques complicates production of nursery stock, planting and direct seeding. USDA Natural Resources Conservation Service Plant Material Centers in the western United States are developing source-identified material of common wetland species adapted to specific geographic areas. They are also designing revegetation equipment and formulating planting guidelines. Private, state and federal nurseries are producing increasing quantities of site-adapted planting stock for wetlands. Results of recent research on propagation and establishment of selected wetland species are beginning to appear; their application should improve the success of wetland plantings.

[1]Research Botanist, USDA Forest Service, Rocky Mountain Research Station, 316 E. Myrtle. Boise, ID 83702, nshaw@fs.fed.us; [2]Plant Resource Specialist, USDA Natural Resources Conservation Service, 127 Johnson Hall, Department of Natural Resource Sciences, Washington State University, Pullman, WA 99164, lamberts@wsu.edu; [3]Wetland Plant Ecologist, USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center, Aberdeen, ID 83210, Chris.Hoag@id.usda.gov.

In recent years we have come to recognize wetland and riparian areas as some of the most biologically productive and diverse areas on earth. These highly complex, varied and critically important ecosystems provide vital biological and physical links between upland and aquatic ecosystems. They function to regulate the flow of water, energy, nutrients and sediments; they stabilize banks and filter pollutants. There exists a broad array of wetland types, reflecting unique local combinations of geomorphic settings, climatic conditions, soils and hydrologic regimes. Classification systems recognize wetlands varying from common and often extensive ecosystems such as tidal or freshwater marshes and swamps to smaller and often poorly understood categories such as vernal pools and playa lakes. Riparian areas are wetlands associated with the lateral flow of water. They include floodplains, bottomlands and streambank communities that occur along inland waterways.

Wetland and riparian ecosystems occupy the transition between terrestrial and aquatic habitats. In their undisturbed condition they are characterized by vegetation adapted to a relatively high soil water content. Their plant communities are generally more or less linear and are characterized by high edge to area ratios. As water is readily available, productivity, plant density, species diversity and structural diversity are high (Thomas 1979).

Wetlands provide valuable food, cover and migration and travel corridors for numerous animals. Many smaller vertebrates and invertebrates are obligate in wetland areas, while larger animals are often facultative users of these areas. Thomas et al. (1979) reported that of the 363 terrestrial species known to occur in the Great Basin of southeastern Oregon, 288 are either directly dependent on wetlands or utilized them more than other habitats. Many aquatic and semi-aquatic species are found nowhere else. The role of these areas in the arid southwest is particularly significant. Hubbard (1977) reported that two river valleys in New Mexico supported 16 to 17% of the breeding avifauna of temperate North America.

Wetlands support high endemism and large numbers of endangered species. About 46% of all threatened or endangered species in the United States are wetland associated or dependent on wetland habitat (Boylan and MacLean 1997). Naiman et al. (1995) found 11 to 15% of terrestrial vertebrates are considered rare or extinct while 34% of fishes, 65% of crayfish and *75%* of bivalve mussels fall into these categories.

Humans tend to concentrate their activities near and within wetlands. In many cases the values and uses of these areas have contributed to their degradation. Across the country, wetland loss is directly attributable to water resource development, especially channel modification, water impoundment and floodplain clearing for agriculture and urbanization. Poor regulation of timber harvesting, grazing, mining, recreation and road construction practices have also contributed in major ways to the problem. Within the United States, more than half the 157 million hectares of wetlands present at the time of European contact have been lost and an additional 120,000 are being impacted by human activities each year (Dahl 1990, 1991). Riparian woodlands, which once covered 30 to 40 million hectares in the contiguous 48 states, are one of the country's most heavily modified natural vegetation types. At least two-thirds of their original area has been converted to non-forest uses and it is estimated that only 10 to 14 million hectares of riparian forests remain in a near natural condition (Maddock 1974; Klopatek et al. 1979; Swift 1984). In many states of the arid West, the Midwest and the lower Mississippi alluvial valley, riparian vegetation has been reduced in area by more than 80% (Swift 1984).

Recognition of the important role wetlands play in maintaining coastal fisheries ultimately led to a concerted effort to preserve and restore these habitats. The Clean Water Act of 1972, and Executive Order 11990 mandating wetland mitigation for "no net loss" and Executive Order 11988 requiring agencies to avoid adverse impacts associated with flood plain occupancy and alterations provided Federal protection. Other acts and programs, including the Food Security Act or "Swampbuster" Act, The Conservation Reserve Program, the Wetlands Reserve program and the North American Wetlands Conservation Act were designed to encourage restoration of these critical ecosystems (White et al. 1992; Mitsch and Gosselink 1993; Tzoumis 1998).

APPROACHES TO WETLAND/RIPARIAN IMPROVEMENT

Repairing damage inflicted by heavy human use and abuse of wetland systems requires removing the cause of degradation at the watershed level to permit natural recovery and implementing management practices to improve hydrologic functioning and facilitate reestablishment of native vegetation (Briggs et al. 1994; Briggs 1996). Such measures may be adequate to facilitate recovery if damage has not proceeded to the point that hydrology is greatly altered or plant and seed sources lost. Because of the concentration of water and nutrients in wetlands and riparian areas, their vegetation is often more resilient than that of associated uplands. Many wetland species reestablish by resprouting vegetatively, emerging from long-lived soil seed banks or establishing from off-site wind or water-carried seed sources. Thus recovery is not always dependent upon artificial plantings.

If sites capable of regenerating naturally are planted, it is not unusual for plantings to be overcome by recovering native vegetation (Briggs 1994). Allowing recovery to proceed for one or more seasons sometimes provides an opportunity to better judge whether and where replanting may be necessary. Where a lack of natural seed fall or remnant plants inhibit natural recovery, restoration of natural vegetation becomes necessary.

On more severely degraded sites where hydrology has been drastically altered and species lost, reestablishment of vegetation becomes more problematic (Swenson 1988; Hoag 1992; Rotar and Windell 1996). Seeds or seedlings may be effectively used in some areas. Cuttings and larger planting stock of woody species are often planted to enable root systems to reach lowered water tables. Substitution of upland species adapted to more mesic conditions may be required and invasion by weedy species often becomes an issue. Additional treatments and plantings may become necessary over time to compensate for losses and changing conditions as the system recovers.

Major objectives in stabilizing degraded sites are maximizing root mass and stem densities, thus reducing water velocity and bank erosion (Carlson 1992). Vegetative material such as fascines and shrub/brush mats provide physical armoring before rooting and forming a shrubby barrier. Vegetation that is sod forming, rhizomatous and multi-stemmed dissipates wave energy and reduces shoreline erosion (Hoag 1992).

Other objectives in addition to stabilization include establishment of vegetation to provide favorable habitat for fish and wildlife species. Characteristics of high quality fish habitat include shading to moderate water temperatures, dense root systems to stabilize overhanging banks for protective cover and debris to provide food for insects (USDI-BLM 1991). Vegetative diversity and structure to provide migration corridors, thermal and protective cover, nesting habitat and food are essential habitat components for birds and other wildlife species (Thomas et al. 1979; USDI-BLM 1991).

Wetland and riparian vegetation also forms buffer zones that remove pollutants from surface water. Sediment carried by flood waters is removed as the water slows when passing through the dense vegetation. The thick humus developing in such areas breaks down organic compounds and captures nutrients (Carlson 1992).

Wetlands are frequently constructed for mitigation, filtering agricultural waste water and controlling flood waters (Mitsch et al. 1998; Shabman et al. 1998). Functional performance of any of these projects is difficult to predict, and creation projects are generally the most susceptible to failure. A team approach involving soil scientists, hydrologists, vegetation experts and others is required to plan projects, but partial successes and failures occur due to the great number of variables involved and our incomplete knowledge of the physical and biological functioning of wetlands and riparian areas (Fischel 1988; Schneller-McDonald et al. 1990). This includes our limited knowledge of the plant species that inhabit them.

Plant Materials

Recent emphasis on improving wetland and riparian areas has created considerable demand for suitable transplant stock, cuttings and seeds which is reflected in activities of the commercial seed and nursery industries. A number of nurseries and seed dealers produce wetland plants exclusively. Seventy-five commercial nurseries listed seeds or planting stock totaling 109 grasslike species and 31 willow species or subspecies in the Spring/Summer 1999 issue of Hortus West (Hortus West 1999). Although some species advertised may not be continuously available, these listings do reflect a considerable increase in the diversity of plant materials and taxa required for wetland and riparian restoration and wetland creation in recent decades.

Factors affecting the selection of plant materials for wetlands are somewhat different than those for upland situations. For example, the emphasis over the last 25 years has been on the use of native species in wetland and riparian areas (Lambert 1995; Hughes 1996; Willard and Reed 1986). Extensive development or use of introductions as was the case for upland efforts has not been attempted or required, particularly in the western United States (Carlson 1992). Some introductions are used, particularly for grass and forb seedings, but to a great extent, local species and populations are generally selected for planting.

Vegetation in wetland and riparian areas exhibits high species diversity due to the great temporal and spatial variability in resource distribution. As a result, there has been a greater emphasis on the use of multiple species plantings in wetlands compared to upland sites. As numerous wetland species normally sort out in linear patterns or mosaics, even over short distances, it becomes necessary to deal with relatively large numbers of species for most vegetation restoration projects. If sites have been degraded and the water table lowered, different, often more mesic or early successional species, may be more appropriate, but a mixture of species will still be required. Because of these factors, and the wide variety of wetland and riparian sites and conditions encountered, there is now a demand for seeds or planting stock of hundreds of species.

Some wetland species extend over wide geographic and elevational ranges and a few occur in both salt and fresh water. Knowledge of genetic variation and the range of adaptation for individual species and populations of wetland species, however, is extremely limited as little research has been conducted (see however, Flessner et al. 1992). Consequently, transfer guidelines have not been developed and local populations are frequently used for restoration of wetland vegetation. Artificial seed transfer zones are used in some cases. The Utah State Nursery, for example, keys their accessions to 150 m elevation zones within regions of the state (Beagle, personal communication). This permits the nursery to accumulate seed banks of commonly requested species and provide site information for users. Users may also provide nurseries with seed or vegetative material from areas near the planting site for consignment production.

The USDA Natural Resources Conservation Service (NRCS) has dedicated considerable effort to increase the number of species used in riparian and wetland plantings. NRCS guides for revegetating wetlands and riparian areas as well as uplands emphasize the use of appropriate and more easily established native species of each Major Land Resource Area (see, for example, Lambert 1999) or larger geographic areas (Lambert 1995; Bentrup and Hoag 1998; Ogle et al. 2000). NRCS Plant Material Centers are developing source-identified wetland and riparian plant materials over the last several years. The aim is to provide commercially available sources of seeds, cuttings or plants of adapted material for planting projects. About one-third of the total effort at the USDA-NRCS Aberdeen Plant Material Center in Idaho, for example, is being dedicated to this work (St. John, personal communication). Common garden trials conducted by Plant Materials Centers are providing considerable, and often the only, information on variability in many wetland species (Flessner et al. 1992). Because most of these species have previously seen little or no use in restoration projects, propagation and planting technology are being developed and transferred to the commercial nursery and seed industries and to users (bag 1995).

Planting Stock

Plants adapted to wetlands and riparian areas regenerate and spread vegetatively. This characteristic permits ramets to develop rapidly while remaining anchored to the parent plant. Consequently, cuttings of woody species, rhizome sections and plugs containing mixed species and small plants are easily propagated, grow rapidly and have provided major sources of transplant materials in the past, particularly in unstable areas or areas with fluctuating water tables (Evans 1992; Greytak 1992; Morgenson 1992). Nursery stock and larger plants are often required to insure rapid establishment in the face of seasonal flooding, declining water tables or otherwise unstable or altered conditions. Rooted cuttings and larger planting stock are often used in combination with structural remedies (Carlson et al. 1992). As an extreme measure, large willow and cottonwood poles planted in holes a meter or more in depth are sometimes used when the water table has been lowered (Swenson 1988). Large planting stock of rapidly growing species can also be used to create shade, thereby reducing weed development, a serious problem on many disturbed wetland sites (Carlson 1992).

Direct Seeding

Many wetland species regenerate by dispersing vast numbers of seeds or by maintaining long-lived seed banks (Smith and Kadlec 1983; Vivian-Smith and Handel 1996; Roelle and Gladwin 1999). Dense seedling stands may develop if these seeds are exposed to suitable and stable microsite conditions for germination. Seeds of these species can sometimes be successfully sown on similar microsites where a seed source is lacking (McKnight 1992). Natural or created wetlands and some floodplain areas are common candidates for direct seeding. Many such sites are not accessible to equipment, consequently seeds are usually broadcast following the period of high water in spring (Harris and Marshall 1960). Some alternative approaches include application of marsh hay, topsoil and seed blankets. This can result in the application of a number of native species, possibly in high densities, with the expectation that some seeds of each species will be exposed to suitable microsite conditions for establishment. Levels of success vary, largely due to a lack of information on microsite requirements and high variability in site conditions.

Many wetland and riparian disturbances are unstable and seed cannot be used without great risk. Adequate quantities of vegetative material are not always available for production of nursery stock and field collection may cause environmental damage. Scheduling and the logistics of harvesting, storing and propagating vegetative material and its possible contamination with weedy species present additional problems for growers. Consequently, many nurseries are attempting to produce more and more stock from seed.

A number of problems are associated with seed propagation. First, although a few species have been produced from seed for some time, many other species have received little study and have rarely been propagated. For the latter, such fundamental information as the season of seedling emergence may be unknown.

Second, species in demand represent a wide range of plant families and growth forms. Thus the types of fruits and seeds, and consequently the seed and seeding technology involved, are highly varied. Scheduling for collection, storage and propagation of large numbers of species can be very challenging.

Third, some important wetland and riparian genera are taxonomically complex, and include many species. The sedge genus (*Carex* spp.), which include about 140 species in the Intermountain area (Hurd et al. 1998) is, perhaps, the of these. Those involved in species selection as well as seed dealers and nurserymen may encounter difficulties in determining which species they are or ought to be planting.

Available literature on seed biology, seed technology and natural or artificial seedling establishment of most wetland species is extremely limited (see, for example, O'Neill 1972; Hurd and Shaw 1992). Standard germination testing procedures are not available for use by state or private seed testing laboratories. Thus, to a great extent, seed dealers and nurserymen have had to develop technology for individual species, likely with many workers attempting to solve the same problems. Information required includes harvest dates, characteristics of mature seed, cleaning procedures, storage requirements, pregermination treatments and viability testing procedures. The NRCS and public nurseries have made much of their information available to other users in the form of reports and publications, thus helping to increase the production and availability of a wider range of species and plant materials (see, for example Evans 1992; USDA-NRCS 1998; Ogle et al. 2000).

FUTURE NEEDS

There is a need to review the available literature on the biology, regeneration, propagation, and reestablishment technology for western wetland and riparian species. This information is needed to aid in assessing the ability of degraded sites to recover naturally and to determine when site restoration is required. It is also needed to aid in selecting appropriate seed or planting stock and planting technology for individual sites. Summaries of available data are also needed to provide technical assistance for the wetland seed and nursery industries. And lastly, this information can be used to improve management for sustaining wetland and riparian areas. Identification of knowledge gaps would aid in efforts to conduct research for technology development on a local or regional basis in cooperation with USDA-NRCS Plant Material Centers, other plant material specialists and individuals working in related fields. Prioritizing work is essential to maximize the impact of research dollars and improve the availability of needed plant materials.

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Table 1. Partial List of Native Conservation Trees and Shrubs for Riparian Sites in the Northwestern United States[a]

Alder, red *(Alnus rubra* Bong.)
Alder, Sitka *(Alnus viridis* ssp. *sinuata* [Regel] A. & D. Love)
Alder, thinleaf or mountain *(Alnus incana* [L.] Moench)
Alder, white *(Alnus rhombifolia* Nuft.)
Ash, Oregon *(Fraxinus latjfolia* Benth.)
Aspen, quaking *(Populus tremuloides* Michx.)
Birch, bog *(Betula glandulosa* Michx.)
Birch, paper *(Betula papyrifera* Marsh.).
Birch, water *(Betula occidentalis* Hook.)
Box-elder *(Acer negundo* L.)
Buffaloberry, russet *(Shepherdia canadensis* EL.] Nutt.)
Buffaloberry, silver *(Shepherdia argentea* [Pursh} Nutt.)
Cascara *(Rhamnuspurshiana* DC.)
Cedar, Nootka *(Chamaecyparis noolkatensis* [D. Don] Spach.)
Chokecherry, western *(Prunus virginiana* L.)
Clematis, western white *(Clematis ligusticjfolia* Nutt.)
Cottonwood, black *(Popufus balsamifera* ssp. *trichocarpa* [T. & G. cx Hook.] Brayshaw)
Cottonwood, Fremont's *(Populusfremontii* S. Wats.)
Cottonwood, narrowleaf *(Populus angustifolia* James)
Currant, golden *(Ribes aureum* Pursh)
Currant, wax *(Ribes cereum* Dougl.)
Dogwood, bunchberry *(Cornus canadensis* L.)
Dogwood, Pacific *(Cornus nuttallii* Audubon ex Torn. & Gray)
Dogwood, western redosier *(Corn us sericea* ssp *occidentalis* [Ton. & Gray] Fosberg)
Douglas-fir *(Pseudotsuga menziesii* [Mirb.J Franco)
Elderberry, blue *(Sambucus cerulea* Raf.)
Hackberry, netleaf *(Celtis reticulata* Torn.)
Hawthorn, Douglas *(Crataegus douglasii* var. *douglasii* Lindl.)
Hazelnut, western *(Corylus cornuta* var. *californica* [DC.] Sharp)
Hemlock, western *(Tsuga heterophylla* [Raf.] Sarg.)
Juniper, Rocky Mountain *(Juniperus scopulorum* Sarg.)
Maple, bigleaf *(Acer macrophyllum* Pursh)
Maple, bigtooth *(Acer grandidentatum* Nutt.)
Maple, Douglas' *(Acer glabrum* ssp. *douglasii* [Hook.] Dippel)
Maple, vine *(Acer circinatum* Pursh)
Mockorange (syringa) *(Philadeiphus lewisii* Pursh)
Ninebark, mallow *(Physocarpus malvaceus* [Greene] Kuntze)
Ninebark, Pacific *(Physocarpus capitatus* [Pursh] Kuntze)
Oceanspray *(Holodiscus discolor* [Pursh] Maxim.)
Table 1. (continued)
Osoberry *(Oemleria ceras~fonnis* [Ton. & Gray cx Hook. & Am.] Landon)
Pine, ponderosa *(Pinus ponderosa* P & C. Lawson)
Redcedar, western *(Thujaplicata* Donn cx D. Don.)
Rose, clustered wild *(Rosa pisocarpa* Gray)
Rose, Woods' *(Rosa woodsii* Lindl.)
Rose, Nootka *(Rosa nutkana* Presl.)
Salmonberry *(Rubus spectabilis* Pursh)
Serviceberry, Cusick's *(Amelanchier alnifolia* ssp. *cusickii* [Fern.] C.L. Hitchcock)
Serviceberry, Utah *(Amelanchier utahensis* Koehne)
Serviceberry, western *(Amelanchier alnjfolia* ssp. *semiintegrifolia* [Hook.] C.L. Hitchcock)

Snowberry, common *(Symphoricarpos albus* [L.] Blake)
Spirea, birchleaf(Spiraea *betulifolia* Pall.)
Spirea, Douglas' *(Spiraea douglasii* Hook.)
Spruce, Sitka *(Picea sitchensis* [Bong.] Can.)
Sumac, smooth *(Rhus glabra* L.)
Sumac, lemonade *(Rhus trilobata* Nutt.)
Twinberry, black (honeysuckle) *(Lonicera involucrata* [Rich.] Banks)
Viburnum, oval-leaved *(Viburnum ellipticum* Hook.)
Willow, anoyo *(Salix lasiolepis* Benth.)
Willow, Bebb's *(Salix bebbiana* Sarg.)
Willow, Columbia River *(Salixfluviatilis* Nutt.)
Willow, coyote or sandbar *(Salix exigua* Nutt.)
Willow, Drummond's *(Salix drummondiana* Barratt cx Hook.)
Willow, erect or strapleaf *(Salix ligulifolia* [Ball] Ball cx Schneid.)
Willow, Geyer's *(Salix geyeriana* Anderss.)
Willow, greenleaf *(Salix lucida* ssp. *caudata* [Nutt.] E. Mun.)
Willow, Hooker or coast *(Salix hookeriana Barralt ex Hook.)*
Willow, Lemmon's *(Salix lemmonii* Bebb)
Willow, Mackenzie's *(Sal ix prolixa* Anderss.)
Willow, Pacific *(Salix lucida* ssp. *lasiandra* [Benth.] E. Mun.)
Willow, Peachleaf *(Salix amygdaloides* Anderss.)
Willow, Scouler's or mountain *(Salix scouleriana* Barratt ex Hook.)
Willow, Sitka *(Salix sitchensis* Sanson cx Bong.)
Willow, yellow *(Salix lutea* Nutt.)

[a]Common names and taxonomy follow USDA-NRCS (1999).