Ruminations And Ramblings About Native Plant Propagation

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Abstract

Native plant nurseries face different challenges than traditional forest and conservation nurseries. They must educate their customers to the practical limitations of propagating native plants such as the poor availability of seeds or vegetative propagation material. The unusually long amount of time to collect propagules, treat seeds or cuttings, and grow the seedlings emphasizes the need for crop planning well in advance of the outplanting date. The concept of "source-identified, locally-adapted" planting stock must continually be stressed when dealing with native plant customers. New products mean new markets so nurseries should try to produce a range of species and stock types and show them to prospective customers. Native plant nurseries and customers should establish networks to better exchange information. Although there are few incentives to do so, both nurseries and seedling users should strive to share techniques about collecting seed and cuttings, seed treatments, and cultural techniques. Attending professional meetings and presenting propagation and outplanting information is one of the most effective ways to network. Publishing propagation protocols on the Internet is an exciting new way to share technical information.

Keywords

seed, seedlings, nursery, technology transfer, restoration

Introduction

Increasing interest in the propagation and use of native plants has produced some interesting challenges to the forest and conservation nursery community. In traditional reforestation, nurseries work with professionals who generally understand the entire process whereas native plant nurseries must deal with customers who often do not. In addition, reforestation nurseries have access to a substantial library of technical information and can rely on a established cadre of professional support. Native

plant nurseries, on the other hand, are more isolated and need to establish their professional networks.

Educate Customers

Native plant propagation has some rather unique requirements compared to other crops. For this reason, nurseries should continually strive to educate current and prospective customers to these limitations.

Availability of Propagules

First of all, customers need to realize that many native plants produce good seed crops irregularly, so it may be impossible to obtain enough seed in time for an outplanting project. This is especially true for emergency projects, such as fire rehabilitation, when crops must be grown in a very short time. They cannot simply buy the seed either because native plant seed dealers can stock only a limited number of species and seed sources. Prospective customers need to realize that they will have to either collect seed themselves or contract to have it done before the desired seedlings can be grown.

Availability problems also apply to vegetative propagation because, unlike ornamental crops, it is usually necessary to visit the outplanting site to collect cuttings. This can involve long distances and limited access, especially at high elevations with late snowpacks and muddy roads.

Time Required to Produce Crops

The additional time needed to obtain seeds or cuttings was just mentioned but prospective customers also need to understand that many native plants will require more than one season to produce. In Northern Idaho, the USDA Forest Service Coeur d' Alene nursery has been asked to grow whitebark pine (*Pinus albicaulis*) seedlings to help restore grizzly bear habitat. The large seeds are a favored food because their high fat content helps bears store energy for hibernating, and seed caches are available when many other food sources are scarce.

Seed propagation of whitebark pine, however, has some real problems. When the first seeds arrived at the nursery, X-ray examination showed that many had immature embryos and therefore needed warm, moist stratification to allow the embryo to finish developing. After a battery of stratification trials, a 21-day warm, moist stratification followed by a 60-day cold, moist stratification proved to be the best. With this rather lengthy stratification treatment, a propagation protocol was developed that required two growing seasons (Figure 1). After stratification, seeds are hand scarified and placed in germination trays with the cut side down to reduce moisture loss. Germinants are then hand-sowed into Ray Leach Super Cell containers [164 cm^3 (10 $in.^3$)] and are grown for two years. After planting in the spring of the first season, they are allowed to grow in a fully-controlled greenhouse until fall when they are moved to a shelterhouse for natural hardening and overwinter storage. At the start of the second year, the seedlings are brought back into the greenhouse where they resume growing until they are hardened-off for late summer-early fall outplanting (Burr, 1997).

"Source-Identified, Locally-Adapted"

I came up with this descriptive term while working on a marketing strategy with the Lone Peak Conservation Center in Utah. The idea was emphasize that quality native plant seedlings should be identified as to their genetic origin as well as be adapted to the environment on the outplanting site. Putting this concept into practice, however, is often difficult from a practical and economical standpoint. Customers need to appreciate this fact.

Source-Identified

All of us are aware of the importance of using source-identified seeds or cuttings when propagating native plants. The hazards of poor survival and growth have been best documented for forest trees in "off-site" plantations. These observations of poor growth lead to the development of seed zones for commercial forest tree seed. Because of their economic value, we have been able to determine seed zones for most commercial tree species and then test their validity. In some cases, we have been able to relax seed zones. Recent common garden tests have shown that western white pine is much more widely-adapted than Douglas-fir. In western Oregon, this research has proven that only 5 seed zones are needed for western white pine and there are no elevation bands within these zones. By contrast, similar tests have shown that

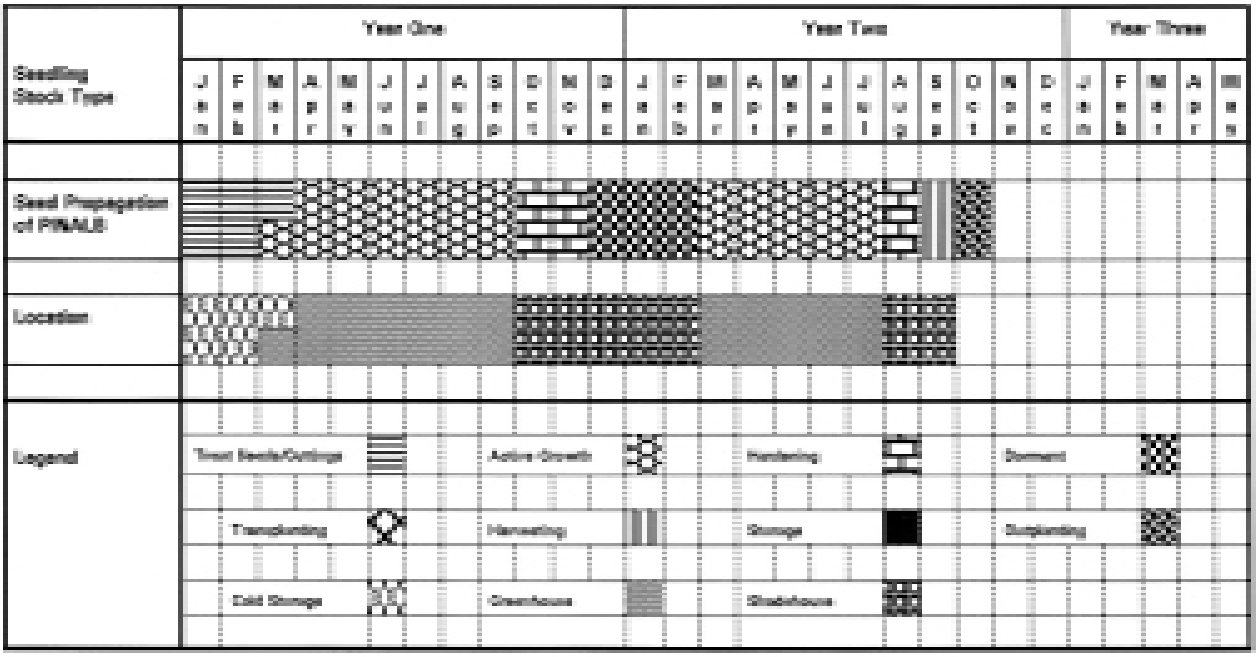

Figure 1. A crop production schedule for seed propagation of Pinus albicaulis, whitebark pine at the USDA-Forest Service, Coeur d' Alene Nursery

Douglas-fir requires 16 seed zones in the western Oregon with up to 3 elevation bands in each zone—a total of 34 different zones (Randall 1996).

Inherent variability in phenology, growth rate, and cold hardiness has also been observed between ecotypes of many other grasses, forbs, and shrubs (Meyer and Monsen 1993). Even though seed dealers and nursery managers are all aware that this genetic variation exists in all native plants, this fact is sometimes overlooked in their marketing. When advertising, seed dealers and nurseries should always give the best information that they have regarding genetic source. For example, the Lone Peak Conservation Center in Utah lists both geographic location and elevation of collection for all the species in their plant catalog. If you aren't sure of the exact source of a seedlot, then give as much information as you have: e.g. Quaking aspen (*Populus tremuloides*) - Colorado source.

Native plant customers must also be practical about their expectations regarding genetic source. If they expect to be able to find a local source of a particular species for their outplanting project, then they must understand that it is going to take time to obtain seeds or cuttings and then grow a crop on contract. Customers can't expect to be able to call up a nursery and find all the plants that they need "on the shelf". This concept is not easy, however. I don't know how many times I've had potential customers call up with a list of native plant species that they want to buy for their project. They always sound incredulous when I tell them that they probably aren't going to have any luck. They like it even less when I explain that they will probably have to have their stock grown on contract and that there may not be any source-identified seed available.

Locally-Adapted

The concept of "locally-adapted" raises some interesting questions. We all realize that the phenotype of a seedling is a function of its genotype (seed source or origin of cutting) and the environment of the nursery in which it was grown. Actually, the nursery environment is a composite of its geographic location, type of propagation facility, and the cultural practices used to raise the seedling (Figure 2). When the same seedlot of a species is grown at different nurseries, even in the same geographic area, the seedling morphology of the crops is often visibly different.

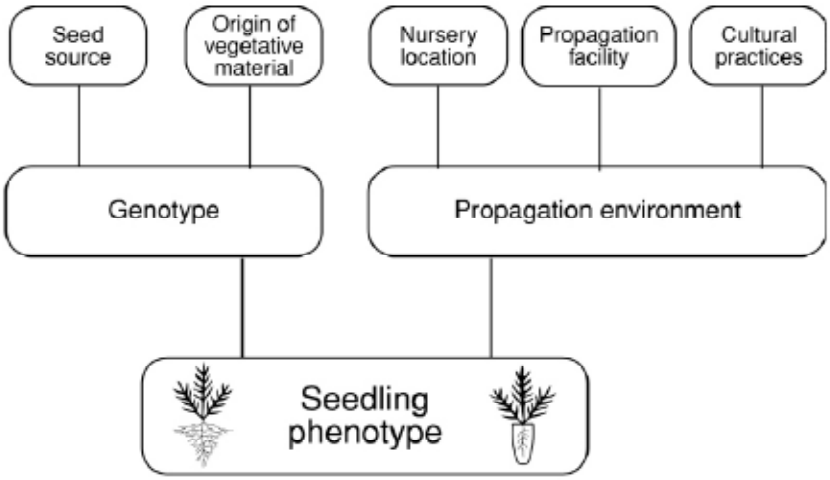

Figure 2 - The physical appearance of a seedling (phenotype) is a function of its genetic makeup (genotype) and the propagation environment, which includes nursery location, type of facility and even cultural practices.

Native plants grown at different nurseries may also be physiologically different. This response has been called the "nursery effect" and is an example of environmental imprinting, by which seedlings are influenced by nursery site conditions or cultural practices. Nursery imprinting is evident in day-to-day nursery and reforestation activities. Foresters who have planted seedlings from the same seed source that were grown at different nurseries have noticed differences in survival and growth. One study in Alaska compared container Sitka spruce (*Picea sitchensis* (Bong.) Carr.) seedlings from a local nursery to others grown from the same seed source in an Idaho nursery (Zasada et al. 1990). The Idaho seedlings suffered significantly more animal browsing and frost damage the first several growing seasons compared to the local nursery stock. In an another study with lodgepole pine (*Pinus contorta* Dougl.), Ying and others (1989) noted significant differences in outplanting performance from different nurseries but concluded that the effect is relatively short term (~15 years). Regardless, these differences may be enough to affect initial seedling establishment.

This brings us to the next point - how far *can* or *should* native plant seedlings be shipped? It used to be that all seedlings were bareroot and, before the advent of refrigeration, nurseries had to be close to the outplanting site. That insured that seedlings were locally-adapted. Now, we have fully-controlled greenhouses where we can grow seedlings all year long and seedlings are never exposed to the outside environment at all. In addition, we can ship seedlings with refrigeration anywhere in North America in a few hours. But, just because we can ship seedlings for thousands of miles, should we? I'm not sure what the answer to this questions is but I personally think that regional nurseries should be used whenever possible.

Produce a Variety of Species and Stock Types

Forest and conservation nurseries are growing a wide variety of native plants that can be used for almost any outplanting project. Unfortunately, many potential customers have no idea what is possible and so it is necessary to demonstrate the range of species that can be propagated. Growing new species takes time and effort and each new species or stock type affects nursery operating costs. Therefore, nurseries grow most of their stock on contract for purely economic reasons. It is a good idea to grow a few examples of many different species for purely marketing purposes, however. Take samples of your plants to professional meetings or when you meet prospective clients—remember, seeing is believing! By showing the full range of plants that you can produce, you will reach new customers.

New products mean new markets so native plant nurseries should demonstrate new stock types as well as new species. For example, riparian restoration projects are fueling the need for a variety of plant materials such as willows and other riparian trees and shrubs all across the West. A variety of different stock types are being used: bareroot, containers and transplants. Several Northwest nurseries are growing wetland plants in containers such as sedges and native grass plugs that are being used to restore riparian habitats in meadows. Riparian shrubs such as red-osier dogwood are also being grown in containers both by seed and from cuttings. On woodland streams,

large container stock and container transplants are being used to stop soil erosion and provide instant shade for cooling the water temperature in salmon spawning areas. In Southern California, Tree of Life nursery is producing willow and cottonwood seedlings in a range of stock types: large (6 to 8 ft tall) bareroot seedlings, small paperpot containers, and large container stock (1 gallon, 5 gallon, and 15 gallon). These large stock types are popular because they provide "instant habitat" for birds such as the endangered Least Bell's vireo (Evans 1992).

Network More Effectively

Networking is just a new age term for sharing. Our parents always told us that we should share, right? Putting this advice into practice is difficult, however, especially considering the fact that many native plant nurseries are private and often in competition with each other. State and federal government nurseries, on the other hand, have technology transfer as one of their mandates and so are excellent sources of information

What to Share

What can native plant nurseries share? What about how to propagate a new plant species? Often, formally published propagation information is very limited and therefore nurseries need to develop their own techniques. Unfortunately, many growers end up "reinventing the wheel".

Collecting Seeds or Cuttings

As we mentioned earlier, this can be challenging due to irregular seed crops or poor access. Sometimes, you need to adapt existing horticultural concepts to meet the unique demands of native plant propagation. A good example is the collection of cuttings for vegetative propagation. The traditional classification system for cuttings is based on the type of tissue: hardwood, semi-hardwood, softwood, and herbaceous (Hartmann et al. 1997). This traditional nomenclature works just fine when collecting from stock plants or stooling beds in the nursery. However, most conservation and restoration projects require collecting cutting material on remote project sites where access to donor plants is a severe limitation. For example, hardwood cuttings may need to be collected from remote, high-elevation donor plants during the summer or fal because most subalpine and alpine plants are low in stature and buried by snow during the winter and early spring. In addition, repeated browsing often eliminates the type of plant tissue that can be collected at field locations.

Therefore, a more practical terminology for collecting cuttings from forest and conservation plants would include the season of collection along with the type and dormancy status of the tissue (for example, "late-fall dormant hardwood" or "summer softwood"). The staff of the native plant nursery at Glacier National Park and the Bridger Plant Materials Center have used this type of cutting collection system with good results. Scianna and others (1998) also found that it was useful to distinguish between first-year tissue and second-year hardwood tissue when collecting cuttings at high-elevation sites. For example, cuttings from first-year hardwood tissue of *Ribes* spp. showed 61% rooting success compared with 21% from second-year wood.

Seed Treatments

Many native plant seeds are notoriously hard to germinate so growers have come up with some good innovations. For example, many plant species have adapted to fire and their seeds will only germinate when triggered by either heat or chemical products of combustion. Species with serotinous cones, such as lodgepole pine, are good examples of this fire adaptation and heat has been used to open the cones since the turn of the century. Seeds of some natives do not respond to heat, however, so researchers began experimenting with combustion chemicals. Smoke treatments were first demonstrated to stimulate seed germination of a fire-adapted shrub in South Africa but have recently been demonstrated for plants of other fire-adapted communities including the chaparral of California. Smoke treatments produced a highly significant increase in germination for 22 of the 34 annual forbs and shrubs that were tested and, although the strength of the response varied considerably, it was very impressive with most species (Figure 3). Although the exact mechanism is not know, tentative evidence suggests that a membrane inside the seedcoat is altered by the smoke treatment (Keeley and Fotheringham 1998).

Cultural Techniques

As already mentioned, poor seed germination of many native plant species can result in wasted space, supplies, and

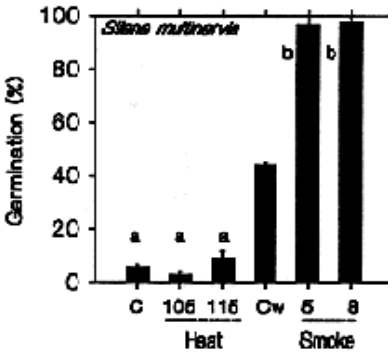

Figure 3- Treating seeds of fire-adapted plants with smoke treaments of 5- or 8-minute exposures was more effective than charred wood (Cw), heat exposure at two different temperatures, or the control (C). (Modified from Keeley and Fotheringham 1998).

labor. A relatively new seed propagation option is to direct sow the seeds in small volume containers ("miniplugs") or peat pellets which are then transplanted. Miniplugs are particularly applicable for very small seeds which are difficult to handle, and transplanting saves valuable seed and makes thinning unnecessary. Miniplugs have been successfully used for bareroot transplants for several years but this transplanting is still rather new in containers. This technology has particular application for nurseries growing large container stock because valuable growing space can be conserved by growing the miniplugs in a greenhouse. Once they are transplanted, the large containers can be moved to shadehouses or open growing compounds which are much less expensive to operate.

The following miniplug technique has been developed at the Los Lunas Plant Materials Center in New Mexico (Dreesen 1998), and has proven effective for several species (Table 1). The seed is sown directly into plug trays which are then placed under refrigeration to receive cold, moist stratification. After stratification, the plug trays are moved to the greenhouse where they germinate and grow for several months. Once the seedlings have become established, the plugs can be removed and transplanted into the growth container - in this case, a RL Supercell. Transplanting is usually done by hand but spatulas and dibbles make the procedures easier and faster.

Propagation Protocols

Of course, the most valuable type of information to share would be a comprehensive procedure on how to collect seeds or cuttings and grow a native plant species. I call these complete recipes "propagation protocols" and have developed a standard format (Landis et al. 1999). A typical protocol starts with target seedling specifications and then discusses seed and/or vegetative propagation information, from collecting seeds or cuttings through season of outplanting. I also like to include a crop production schedule (Figure 1), which gives a visual calendar of the propagation process. Propagation protocols are discussed in detail in the Native Plant Network section of this paper.

Table 1. Native plants propagated from seed using the mini-plug system at the Los Lunas Plant Materials Center, NM

New Mexico Olive	*Forestiera neomexicana*
Threeleaf Sumac	*Rhus trilobata*
Rabbitbrush	*Chrysothamnus* sp.
Apache Plume	*Fallugia paradoxa*
Cliffrose	*Cowania mexicana*
Mountain Mahogany	*Cercocarpus montanus*
Sagebrush	*Artemisia* sp.
Arizona Sycamore	*Platanus wrightii*
Gooseberries and Currants	*Ribes* sp.
Rose	*Rosa* sp.
New Mexico Locust	*Robinia neomexicana*
Jointfir	*Ephedra* sp.
Buffaloberry	*Shepherdia* sp.
Wolfberry	*Lycium* sp.
Elderberry	*Sambucus* sp.

Source: Dreesen (1998)

Feedback from Seedling Users

Practical experience with commercial forest tree species has shown that seedling quality can only be defined on the outplanting site. One of the principal characteristics of native plant stock is that it will be outplanted in relatively harsh environments without irrigation or other subsequent care. This concept is foreign to traditional ornamental nurseries, whose seedlings are outplanted in more favorable landscapes where they receive irrigation and fertilization (Landis et al. 1995). Thus, the true benefit of any cultural procedures or propagation technique cannot be proven at the nursery so native plant users should

provide regular feedback about survival and growth.

Where To Share

Now that we've discussed the type of information that can be shared, let's look at the best way to communicate.

Trade journals

The traditional way to share technical information is to publish an article in a journal. You can find some relevant information in the standard nursery and horticultural journals but there are more and more periodicals that cater specifically to native plants, including Tree Planters' Notes, Hortus West, Restoration Ecology and Reclamation Review. I was curious about where articles were being published so did a literature search of the Forest Nursery Notes database, which now contains almost 9,000 accessions. The search yielded 43 different journals but the top four contained some surprises. By far, the most native plant propagation articles can be found in the Proceedings of the regional forest and conservation nursery meeting which are published by the government. The Proceedings of the International Plant Propagators' Society was in second place (Table 2). These results emphasize the importance of sharing information on workshop and meetings which will be discussed in the following section.

Professional Meetings

Professional nursery meetings are an excellent place to share technical information on how to propagate native plants. As shown in Table 2, the meetings of the regional Forest and Conservation Nursery Associations and the International Plant Propagators' Society (IPPS) are great places to start. There are currently three forest and conservation nursery associations in the United States: the Western Forest and Conservation Nursery Association, the Northeastern Forest and Conservation Nursery Association, and the Southern Forest Nursery Association. If you are interested in more information, future meetings are listed in each issue of Forest Nursery Notes or just give me a call.

Table 2. Most common journals in Forest Nursery Notes database that publish native plant articles

Order Total	Name of Journal	% of
1st	Workshop Proceedings (Government)	30 %
2nd	International Plant Propagators' Society Proceedings	12 %
3rd (tie)	American Nurseryman	7 %
	Other Government Publications	7 %
4th (tie)	Tree Planters' Notes	3 %
	Hortus West	3 %

The IPPS is organized into 9 regions from around the world. In the United States, there is a Western Region, a Southern Region and an Eastern Region. I am an IPPS member and one of the best things that I like about this organization is their motto—"To Seek and Share". In fact, IPPS members must regularly attend meetings and present papers to maintain their membership. At only $40 per year, IPPS is a technology transfer bargain.

Native Plant Network

One feature of the Reforestation, Nurseries, and Genetics Resources (RNGR) home page on the Internet is the native plant network which contains propagation protocols using a standard format. The URL is <willow.ncfes.umn.edu/snti/snti.htm>. Publishing on the Internet has several advantages: first, it is relatively inexpensive compared to trying to publish in hard copy; second, it is quick; and third, computer files are easy to update.

The native plant network consists of 3 sections: some basic plant propagation information, followed by protocols organized by plant family and state, and finally a listing of native plant nurseries. At the present time, most of the propagation protocols on our home page have been provided by the native plant nursery staff at Glacier National Park in Montana. Over a year ago, I learned that they were producing over 200 species of native plants for restoration and reclamation projects in the Park. Like most nursery people, however, they just didn't have time to publish any of this information. So, I managed to scrape-up enough funding to pay for

one of their propagators, Tara Luna, to write-up propagation protocols for over 100 native plants ranging from ferns to trees. I am now working with other nursery people around the country and gathering more protocols for a wider variety of native plants.

As an example, the current listings for the willow family are given in Table 3. Note that there are 3 different protocols for quaking aspen—listing them by state allows for variation in propagation techniques. The Colorado State Forest Service nursery (POPTRE-CO) propagates aspen by seed to maintain maximum genetic diversity. The Native Plant Nursery at Glacier Park (POPTRE-MT) propagates specific genotypes of quaking aspen by rooting shoots that are excised from root sections. In New Mexico, the Los Lunas Plant Materials Center (POPTRE-NM) propagates the same species to maintain unique genotypes adapted to a specific high elevation mine reclamation project. They have developed an innovative pot-in-pot system that produces 22 to 36 root cuttings per stock plant that are then rooted and transplanted into containers (Dreesen 1998).

This native plant network will continue to grow in usefulness as we are able to upload more propagation protocols. This will be relatively slow as progress will be determined by availability of time and funding.

Conclusions and Recommendations

1. Nurseries should make a special effort to educate current and potential customers about the unique requirements and limitations of native plant propagation.
2. Because seedling quality can only be defined on the outplanting site, native plant users should provide regular feedback to nurseries about survival and growth.
3. Both nursery managers and native plant customers should be honest and practical about the origin of nursery stock.
4. Because we know so little about the nursery effect on outplanting performance, customers should use regional nurseries whenever possible and keep seedling transportation distances to a minimum.
5. Native plant propagation is a relatively new discipline and therefore research into topics such as seed dormancy treatments, seedling fertilizer response, and outplanting procedures is sorely needed. Realistically, however, there is no federal government funding or support so nurseries and native plant users must meet this need by free exchange of technical information.

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Table 3. Propagation protocols are listed by plant family and state on the Native Plant Network on the Reforestation, Nurseries, and Genetic Resources home page

Plant Family	Scientific Name	Common Name	Species Code	State
Salicacae	*Salix arctica* Pall.	Arctic willow	SALARC	MT
Willow family	*Salix commutata* Bebb	Undergreen willow	SALCOM	MT
	Salix exigua Nutt.	Sandbar willow	SALEXI	MT
	Salix nivalis Hook.	Snow willow	SALNIV	MT
	Salix scouleriana Barratt.	Scouler willow	SALSCO	MT
	Salix vestita Pursh	Rock willow	SALVES	MT
	Populus trichocarpa T.&G.	Black cottonwood	POPTRI	MT
	Populus tremuloides Michx.	Quaking aspen	POPTRE	MT
	Populus tremuloides Michx.	Quaking aspen	POPTRE	CO
	Populus tremuloides Michx.	Quaking aspen	POPTRE	NM

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