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Back to the Future: Genetics and our Northwest Forests

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Trees in our native and urban forests and forest plantations are invaluable for our survival and well-being. Understanding and utilizing the natural genetic variation that exists in our tree species allows us to manage some of the impacts from the biotic and abiotic stresses that trees face and to guide our future reforestation and restoration efforts.

The October 1995 issue of the *Western Forester* focused on forest genetics and its application in management of our nation's forests, particularly in the Pacific Northwest (PNW). This vital work has continued in the ensuing 22 years, and in this 2017 issue some of those efforts are presented and expanded to include some work in the Inland Empire. With several PNW groups recently celebrating 50 years (and even 100 years for early research) of forest genetic and tree improvement related activities (see articles by St. Clair, Erickson, Crawford, Yanchuk), it is timely to note accomplishments and continued needs. With a changing climate and continuing accidental introductions of destructive non-native insects and diseases, it is the natural genetic variability within our native tree species that will be the basic resource to help restore unhealthy forests, maximize productivity of plantation forests, and help meet the diverse future needs of society.

Growing public awareness of genetics in general has brought forest genetics onto the list of forest resources that require active management and stewardship. Concepts of adaptation, innate disease or insect resistance (or susceptibility), and growth potential are now commonly understood to be largely controlled by genetic factors. Genetic conservation strategies are an important component of managing our food crop species, and they are equally important for our tree species. However, unlike most crop species, genetic considerations for some tree species involve not only their potential commercial use, but also the need for these species to continue to persist and evolve for generations in natural ecosystems. The awareness of forest genetics and value of tree improvement has been embraced by federal, state, county, tribal, and private land managers.

As an investment, applied forest

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PHOTO COURTESY OF JIM SMITH

Thirty-year-old Douglas-fir progeny test 10 years after thinning on Drift Creek near Toledo, Ore. Fertilizer and thinning effects were studied along with the impact of harvest machine travel. From this and subsequent tests at multiple sites, the best parent of the 47 tested here will produce 51% greater volume than average wild sources.

In This Issue: 50 Years of Forest Genetics in the Northwest

Genetics and our Northwest Forests

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tree breeding programs are unique in that they are cumulative. Once parents of interest are identified and incorporated into seed orchards, gains achieved in traits such as growth rate, stem form, or disease resistance will be available for the next forest plantation without annual input, unlike recurring costs such as planting or fertilizing. Using tested parents as the basis for the next generation of improvement provides an ever-increasing catalog of data to help make future selections. What we do now will influence forests well into the future.

The seed collected, the field trials established, and the data gathered in forest genetic tests and tree improvement plantings provide baseline information on genetic variation in each of our native tree species and which sites the different populations (provenances or geographic sources) within a species may be best adapted (Harrington, Howe). As part of applied forest genetics programs, seed has been collected from tens of thousands of individual parent trees in the Pacific Northwest and Inland Empire, and many of the parent trees have been cloned by grafting into seed orchards or clone banks (Cress). Most of these selections are from the conifer species of highest economic importance, such as Douglas-fir and ponderosa pine, but extensive collections of seed and vegetative materials (for grafting or rooted cuttings) have also been made for species such as whitebark pine and Port-Orford-cedar. The seed of many of these species can be stored for at least several decades and provides a means of ex situ genetic conservation (a backup plan in case of disasters). The stored seed of individual trees provides an immediate source of material to evaluate genetic variation within these species as new disease or insect threats arise or as abiotic stresses from a changing climate become apparent.

While the level of federal funding for many applied tree improvement programs has seen severe cuts since the 1980s, the contributions of both genetic materials and expertise developed in those programs have continued to be major factors in the region.

The large federal and state-owned acreage in the regions is well represented with selections of most major tree species, which often formed the nucleus of cooperative breeding programs for their neighbors in the private sector (see various articles on cooperatives). While most agencies have been limited in their ability to provide financial support in recent years, availability of resources and in-kind arrangements have been vital to the success of many co-ops. In many cases, thanks to these programs, a reliable supply of genetically diverse seed is available to meet the needs of each breeding zone for some of the commercial species. The federal agencies generally have their own sources of seed as do members of cooperatives,

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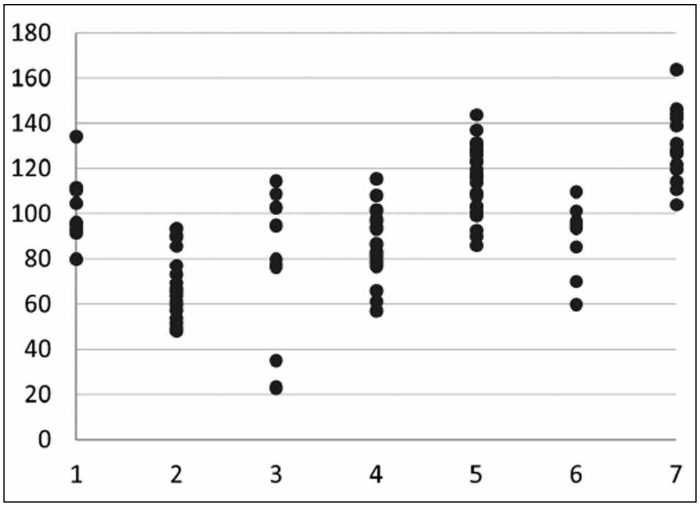
Next Issue: Evolution of Land Ownership and Management Implications

PHOTO COURTESY OF RICHARD SNIEZKO

Pacific madrone (*Arbutus menziesii*) provenance trial on Starker Forests land is assessed for growth, survival, and foliage blight in fall 2015, four years after planting. A common set of 105 families representing seven ecoregions from central California to British Columbia were planted on sites in California, Oregon, Washington, and British Columbia to evaluate the adaptive genetic variation in this hardwood species and serve as sentinel plantings. The project has been an informal cooperative project of several pathologists (WSU, ODF) and geneticists (USFS and British Columbia Ministry of Forests, Lands and Natural Resource Operations), with field sites provided by several organizations.



DATA SUMMARY FROM DORENA GENETIC RESOURCE CENTER

Shown on the y axis, variation in fourth-year height (cm) within and between Pacific madrone families from the seven ecoregions (x axis) represented in the provenance trial at the Starker Forests site (1-7 represent Cascades, Central CA Foothills and Coastal Mountains, Coast Range, Klamath Mountains, Puget Lowland, Sierra Nevada, and Willamette Valley ecoregions, respectively). Note the large variation in height among families within the same ecoregion (family = seedlings originating from seed of one mother tree).

but for other landowners, there are options such as Oregon Department of Forestry's Seed Bank (see sidebar on page 4).

Most of the early work in forest genetics was undertaken with species of the highest commercial importance. However, understanding the genetic variation in other tree species such as whitebark pine, Port-Orford-cedar, foxtail pine and Pacific madrone have also been recently undertaken. The expertise and infrastructure developed for the commercially important species has helped make the work with these species more efficient. In some cases, such as with whitebark pine, restoration plantings on federal lands also serve as genetic trials and as sentinels to monitor the impacts of new biotic agents and abiotic events. Although cooperatives have been key organizers of tree improvement efforts for major commercial tree species (Jayawickrama, Rust), the USFS has been the lead in programs to develop genetic resistance to non-native diseases such as white pine blister rust and Port-Orford-cedar root disease resistance (Sniezko). But, even in these cases, cooperators and partners have been key in the progress, and the importance of sharing the result (resistant seed) is paramount to maintaining these species in our forests. Ongoing work in these resistance programs will produce seed with even higher levels of resistance for restoration or reforestation.

Articles in the 1995 issue (posted at www.nwoffice.forestry.org/northwest-office/western-forester/2017) covered topics of importance to forest genetics and provides a synopsis of the early history, progress, and considerations in many of the forest genetic and tree improvement efforts needed to maintain healthy and productive forests.

Forest genetic and tree improvement programs are large and long-term undertakings (Lipow). Organizations have banded together in the form of cooperatives to carry out much of this work. In this issue, articles provide overviews of tree improvement programs, genetic resource management, and research efforts to provide the reader with knowledge of the history, benefits, and findings to help inform future decisions.

By its nature, the future is often uncertain. However, the needs of society for products from our forests, and the

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Special Thanks

The *Western Forester* thanks George McFadden of the Bureau of Land Management for the idea to publish an issue focusing on 50 years of forest genetics in the Northwest.

George, BLM's Oregon/Washington silviculturist, spearheaded the theme idea, coordinated authors and topics, and provided financial support to publish this expanded 32-page issue.

The efforts of George and all the authors is another example of the cooperative spirit in the forestry and scientific community. ◆

need for healthy forests for recreation and other services will continue to grow. Experience has taught us that we will likely see new destructive non-native pathogens and insects in our forests. A changing climate will place stress on our forests. Knowledge of the genetic variation of our tree species helps us to meet the increasing future needs of society and reduce the impacts of biotic and abiotic stresses that will come. For the most part, past tree improvement efforts in western North America utilize classical selective breeding techniques to increase genetic gain in traits of interest, but in the future a detailed understanding of genomic resources will help provide more precise knowledge to guide breeding efforts (Howe). Trees are on the landscape for decades and even hundreds of years or more. Foresters and those working to maintain forest health need to be thinking well into the future to ensure forests have the best chance to meet ecological and societal needs. Most of our planted forests have been influenced positively by the stewardship and contributions of the forest genetic community. The past record has been encouraging, and with continued support of the organizations involved, forest geneticists and tree breeders working with colleagues in silviculture, ecology, forest health, and other disciplines will ensure this continues. ◆

Seed Available through the Oregon Seed Bank

The Oregon Seed Bank has long-standing agreements that allow it to obtain seed from a variety of breeding programs in the PNW including Oregon State University, US Forest Service, BLM, and Oregon Department of Forestry programs. These advanced genetic selections may be selected for disease resistance, enhanced adaptability, increased growth rates, enhanced timber qualities, or a combination of traits. In addition, the Seed Bank has statutory authority to purchase seed from any seed orchards established at the Oregon Department of Forestry Schroeder Seed Orchard complex. These arrangements provide family forest landowners equal access to seed. The Seed Bank sells seed of these advanced genetic selections, along with natural seed collections, from a variety species and seed zones to nurseries in Oregon. These nurseries then produce seedlings that are available for sale to family forestland owners and other customers. Additional information about the program along with listings of seed availability is located at www.oregon.gov/ODF/Working/Pages/Seed.aspx. ◆

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