Genetic Conservation and Restoration of *Chamaecyparis lawsoniana* (Port-Orford-cedar) in the Face of a Non-native Pathogen and Changing Climate – On the Road to Success[1]

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Challenge

Port-Orford-cedar (POC) (*Chamaecyparis lawsoniana*) is a long-lived conifer native to southwest Oregon and northwest California, occurring from sea level to above 1500 m (5085 ft). It is a foundational species in its native ecosystems and is used world-wide horticulturally. A non-native pathogen, *Phytophthora lateralis*, cause of Port-Orford-cedar root disease, has caused high mortality in native forest ecosystems and ornamental plantings (Betlejewski et al. 2011). The presence of *P. lateralis* has limited the use of POC in managed plantations and urban forests. There is concern about the future viability of the species which has a 'Near Threatened' status on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List (Farjon 2013).

Solution

The U.S. Department of Agriculture Forest Service (USDA FS) and U.S. Department of Interior Bureau of Land Management (USDI BLM) began an applied genetic resistance program in 1997. The program is based at Dorena Genetic Resource Center (DGRC). The program has delineated 13 breeding zones within the native range of POC, and *P. lateralis* resistance screening is underway for many of these zones (Sniezko et al 2012a). A strong focus for the program has been to retain both genetic diversity within the species and its adaptability, while developing populations (not cultivars) of resistant trees. Containerized seed orchards (CSOs) and containerized clone banks (~2100 clones) have been established for most zones, providing genetically resistant seed for restoration and reforestation on federal, state, county, tribal, and private lands. Two soil-based clone banks provide additional *ex-situ* genetic conservation and potentially longer term preservation of the genotypes. Current work is focused on increasing the number of parents in the CSOs, increasing the level of genetic resistance, and roguing the clone banks and orchards as resistance information is accumulated. Field trials have been established in Oregon and California to confirm the level of genetic resistance to *P. lateralis*, and to monitor the durability of resistance in the face of a potentially evolving pathogen and a changing climate (Sniezko et al. 2012b). The field trials will also be used to examine genetic variation in adaptive traits within POC, serve as sentinel plantings with known genetic constitution, and provide *in situ* genetic conservation (Harrington et al. 2012; Sniezko et al. 2012a, 2012b). More recently, DNA-based genetic markers have been developed through a USDA FS Special Technology Development grant (Jennings et al. 2011) to help assist the operational breeding program and evaluate patterns of genetic variation throughout the range of

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[1] A version of this paper was presented at the Gene Conservation of Tree Species – Banking on the Future Workshop, May 16-19, 2016, Chicago, IL.

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POC. This tool and results from its utilization will help guide continued dynamic genetic conservation activities in POC.

Success

Resistant seed is available for several breeding zones; it is being used by various federal, state, tribal, and local agencies, as well as private organizations and individuals (Sniezko et al. 2012a). The current expectation of the IUCN is for POC to be down-listed to "Least Concern" within the next 10 years if current conservation actions are successful and maintained (Farjon 2013). The program for POC conservation represents an emerging success story in forest conservation, and leads us to be cautiously optimistic for POC's future.

Future

Genetic conservation must be dynamic to effectively retain the species in its native range and other suitable areas in the future. The DGRC POC program meets this criteria; it features both *in situ* and *ex situ* genetic conservation. It specifically takes into account a major challenge to the species—the presence of a non-native pathogen—by developing resistance and maintaining genetically diverse CSOs that can easily be updated and from which resistant seed can be collected. Restoration and operational plantings, past and planned, are occurring on a variety of land ownerships: federal (USDA FS, BLM, USDI National Park Service), state (Oregon Department of Forestry, California State Parks, South Slough National Estuarine Research Reserve, tribal (California and Oregon tribes), local (Coos County), and private (small woodlands and industrial). The maintenance of genetic diversity, along with the incorporation of natural genetic resistance, will provide POC with its best opportunity to continue to flourish in our forest ecosystems under a changing climate. Further work in developing resistance is needed, but the work to-date shows the promise in developing and deploying the resistant seedlings.

For a limited time (until roguing of parents at DGRC), the large, easily accessible population of POC available at DGRC offers a unique opportunity for scientists interested in exploring genetics and climate change of a conifer species. Because of the unique range-wide collection of parent trees (as rooted cuttings) available at DGRC, the ease with which POC can be experimentally manipulated (e.g. induction of early flowering, potential of self-pollination, vegetative propagation, etc.), and the availability of disease resistance ratings for many of the clones (qualitative and quantitative resistance), POC has the potential to be used in many ways as a model species for conifers.

Acknowledgments

We acknowledge the support and/or cooperation of many groups, including USDA Forest Service –Forest Health Protection, Dorena Genetic Resource Center, National Forest System; USDI Bureau of Land Management, USDI National Park Service, Oregon Department of Forestry; Oregon State University, South Slough National Estuarine Research Reserve, and other land managers who have contributed to various phases of this program. The initial impetus for an applied operational resistance and genetic conservation program was facilitated by a USDA Forest Service Special Technology Development (STDP) grant in 2007; and a second STDP grant assisted with the projected using molecular markers to examine genetic variation in POC.

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