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Review

The development of British Columbia's tree seed transfer guidelines: Purpose, concept, methodology, and implementation

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Abstract

The development of forest tree seed transfer research, guidelines, regulations and policy has a long history in Canada, as well as in many other parts of the world. While the implicit assumptions of what is involved in developing seed transfer limits, guidelines and policy are generally accepted, the scientific and biological processes that underpin their validity are not readily available to most foresters. We provide an overview of the historical and current technical approaches to the development of seed transfer in British Columbia, and the overall framework which incorporates key biological, statistical and administrative issues in regulating the movement of forest tree seed. An example of how seed transfer information is developed from field experiments to guidelines or limits is provided from the lodgepole pine provenance tests in BC. Seed transfer research as it relates to the movement of wild or seed orchard seed will need to factor in the complications being predicted with climate change. As such, seed transfer research will continue to evolve as field experiments mature, new tests are established, statistical approaches and geographic information systems improve, and climate prediction tools attain greater resolution.

Keywords: Seed transfer; Genecology; Seed zones; Climate change

Contents

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1. Introduction

Nearly 80 years ago, Thrupp (1927), a Canadian forestry scientist, published a paper titled ''Scientific Seed Collection'' in the Forestry Chronicle in which he cautioned against the indiscriminate use of seeds from different geographic origins. He referred to the tremendous range of environment occupied by such species as Douglas-fir (*Pseudotsuga menziesii*), and the large differences seen in hardiness and growth of various seed sources. One year later Bates (1928), in a paper delivered at the meeting of the Canadian Society of Forest Engineers, and published also in the Forestry Chronicle, called for regulating seed movement in reforestation, and in his words, ''It may appear an unpleasant thing to say, and no doubt certain commercial interests will object to my saying it, but it is, nevertheless, altogether probable that we in the United States have a right to look with suspicion on most Canadian forest tree seed, and you have the identical right to demand the use in Canada of 'home grown' seeds. There are undoubtedly many cases in which seed may be sent across the border with no harm whatever, but almost certainly the general outcome of a better knowledge of the matter will be to restrict the transport of seed to comparatively short distance.'' He also suggested the need to expand seed origin tests to address the above concern. Dr. Bates was an American forest scientist, and to our knowledge, was the first to explicitly call for restriction on seed transfer in published records in North America. His words are as relevant today as they were then.

In British Columbia (BC), the practice of restricting seed movement, voluntarily or regulated, has a long history. Records of its practice are scattered in government regulations and policy papers or buried in meeting minutes. Moreover, the scientific basis and reasoning behind seed transfer guidelines are dispersed in technical journals, which are not readily accessible or read by the majority of practitioners. In this paper we attempt to provide a background summary of the evolution and development of BC's seed transfer guidelines. We will give a brief historical account of different stages of their evolution, focusing on advances in scientific knowledge and analytical methods that have been used. As such, construction of seed transfer guidelines is a dynamic process with advances in scientific knowledge and practical experience, particularly in the context of global warming. We hope this review will help advance the understanding of the concept and process, in other words the science, behind BC's seed transfer guidelines.

What is a seed transfer guideline? The ultimate goal of reforestation is to establish plantations that can yield their genetic potential within the environmental limits of climate, weather and soil. To achieve this goal, we must quantify a 'match' of planting stock with environments where the trees are suitably adapted. Seed transfer guidelines are one such tool which facilitates achieving this goal. Administratively, the current seed transfer guidelines are a set of statements that delimit the geographic range bounded by latitude, longitude, and elevation, within which a seed source may be used for reforestation. Biologically, the above physiographic descriptors serve as surrogates for the physical environment (e.g., climate) within which seedlings can grow to their genetic potential. Moving seed beyond this limit may result in maladaptation; e.g., cold injury, drought and susceptibility to disease and insects causing growth loss or mortality. Provenance and progeny testing results have amply demonstrated that seed sources from different geographic locations of the species' distribution have different growth potential and ranges of site environments where they can grow well (e.g., Campbell, 1986, 1987, 1991; Parker, 2000; Rehfeldt, 1983b, 1984, 1988, 1989, 1994; Sorensen, 1992, 1994; Morgenstern, 1996). In this paper, we primarily discuss the development of wild-stand seed transfer guidelines. Adaptive differences between wild and orchard seed are likely to become different as breeding cycles advance, and the latter may require different sets of seed transfer guidelines. But the rationale for constraining their movement is the same for both.

2. BC's seed transfer guidelines: a brief historical account

The initial seed zones in BC were delineated only for Vancouver Island and the south coast mainland in the 1940s (BC Forest Service, 1946; Lester et al., 1990). We found no official or published record of the practice of seed transfer until 1962 when Haddock, a professor of the Forestry Faculty of the University of British Columbia, recommended a seed collection zone map for Douglas-fir (Haddock, 1962). The map delineated seven seed zones for both the coastal and interior form of the species based on general climate and geophysiological attributes within the species' distribution range (Fig. 1). As reforestation expanded into the interior, a province-wide seed zone map was constructed in the early 1970s; 67 zones were delineated as the basis to guide seed collections (Fig. 2). Delineation of these zones also incorporated the preliminary approximation of ecological classification of forest lands. However, we did not find or do not recall any official records or documents that mandated the use of these zones in terms of seed movement: like many silvicultural regulations of that period, these seed zones were used only as references aiding foresters' decisions on the use of seed sources. The size of reforestation programs before 1970 was small (annual planting only a few million seedlings) and the use of local seeds was a common practice.

Rapid expansion of the reforestation program in the 1980s, which reached over 200 million seedlings of annual planting (Cuthbert, 1990), required critical selection of seed sources in order to safeguard healthy and productive plantations. The advance of the biogeoclimatic classification (BEC) of forest land in the 1980s (Pojar et al., 1987) also indicated the necessity for some seed zone realignment. Moreover, results from the maturing provenance and progeny testing for major commercial species (Ying and Morgenstern, 1987) also supported the theoretical expectations that local populations are not necessarily genetically optimum (Namkoong, 1969). Convergence of these factors prompted a formal review of seed transfer guidelines and seed zones in 1983 jointly by Silviculture Branch and Research Branch of BC Ministry of