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Adaptive Responses of Trees

Recently documented sources on quaternary evolutionary history, observations from population and species transfers and provenance experiments shows that trees may have resources and mechanisms to respond to climate change. Trees have specific mechanisms at different levels – from single trees to populations and on to communities – that contribute to evolutionary changes tracking environmental change. These mechanisms, including plasticity, adaptation, dispersion and facilitation, depend on the amount of diversity (either genetic or epigenetic) residing at these different levels and the extent of gene flow among populations.

Individual adaptation by plasticity can be seen in the temporal variation of fitness related traits observed during the lifetime of trees. Examples of population adaptation are supported by results of provenance tests showing large population differentiation for adaptive traits. On the other hand, past seed dispersion data obtained by fossil pollen records suggest that the speed of future natural dispersion may not be able to match with climate shifts in the future.

Learning from these records, we can study how these mechanisms may be acting during the ongoing and future climatic changes and propose options to enhance forest adaptation to climate change. We are anticipating strong differences between species having continuous distribution and species with scattered distribution, the former benefiting more from positive interactions between natural selection and gene flow. The rate of adaptive change may also be quite different between the leading edge and the rear end of distribution. Populations at the northern and eastern limits will be at the leading front of range shifts and may benefit from immigrating genes via pollen flow from southern latitudes; whereas adaptation may be more constrained at the rear edge, where populations are deprived of gene flow from "preadapted" populations.

Trials needed on enrichment planting

Hence, we suggest that adaptation to climate change should be enhanced by silvicultural practices during the regeneration phase (either natural or artificial) aiming at increasing reproductive potential, fecundity, population size and genetic diversity. In order to maintain high levels of genetic diversity, seedlings coming from different seed stands can be mixed. Introducing new reproductive material should be seen as complementing local seed sources and never as replacing local material. Enrichment planting in naturally regenerated stands can introduce plants with different genetic characteristics and will be important sources of adaptive capacities, not only at the rear edge of the species but also throughout a species' range. Mixing would increase the opportunities for new genetic associations to increase the fitness of the planted or seeded population. Assisted migration via enrichment sowing or planting should be based on results of provenance tests.