AMECO Report Summary

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Final Report Summary - AMECO (Assisted Migration of Forests as a climate change economic mitigation strategy)

The main purpose of this proposal was to provide the necessary tools to address a particular case of adaptation and mitigation of forests to climate change in Western Europe: the translocation of tree population to compensate for climate change (Assisted Migration; AM).

Tree populations have been moved with different purposes before, and we started analyzing these particular cases in Europe. In particular, we analyzed a well-document failed case of population translocation of Pinus pinaster Ait from the Iberian peninsula to southern France, which entailed an enormous economic loss that led to the only case where the use of foreign tree populations was prohibited by the European Union, which otherwise promotes the free exchange of seeds between ecologically matched sites (EU Council Directive 1999/105/EC of 22 December 1999). An opinion paper (Restoration Ecology 2013) and a reply letter (Bioscience 2013) are related to these experiences analyzing translocations in the past.

A second step was devoted to propose new scenarios for translocations in the future based on climate data and the fitness (measured as the volume/year as recorded in NFI). To do that, we produced scenarios (theoretical representation) of assisted migration actions for two important candidates for AM in Europe: Pinus pinaster and Pinus halepensis. We harmonized the Spanish and French National Forest Inventories for standing volume and mortality, which allowed us to run models covering Western Europe. Target zones were selected from provenances with high sensitivity and seed zones from provenances with low sensitivity to climate change; the latter can be considered “seed refugia” as the climate changes. Three plausible scenarios for translocation to the target zone were developed on the basis of volume simulations calibrated with different planting Abies alba strategies: 1) seeds only from foreign provenances; 2) foreign provenances plus local seeds; and 3) only local seeds. Our results suggested that volume and mortality trends were not always correlated with seed sources and targets, that projected provenances mortality do not follow always a southern-northern pattern and that seed refugia, if any, may be useful for compensating for the effects of climate change only in a subset of provenances (this approximation has been published in the journal New Forests 2015).

To evaluate which native forests are likely candidates for AM we estimated the vulnerability of the native species in Western Europe including the sensitivity, the exposure and the adaptive capacity of the major tree species in ecological models for creating scenarios for current climatic conditions and future ones. The results of these simulations are considering for publication in the journal Ecological Applications. Our results suggest that management programs should be different for mountain conifers populations occurring at their rear-edge of their distribution that need to be sampled more intensively to preserve their genetic resources compared to lowland widespread temperate species where vulnerabilities seem lower and populations more homogeneous. Likewise, for rear-edge populations, ex-situ programs considering some compensation for climate change (assisted migration) may be essential to preserve the populations for which conditions become too harsh but that may have a better chance in higher latitudes and altitudes.

The adaptation of socio-ecological systems to climate change depends not only on the evolutionary potential of natural

populations but on the decisions taken by social actors that mediate natural processes. To succeed in moving trees to compensate for climate change the development of a decision framework based on variations in tree fitness in relation with climate is a priority. In trees, provenance trials provide new insights to understand the future of populations under climate change. We use data from an European network of 33 provenance tests of Abies alba planted in 5 sites in France to predict spatial variation in tree height at 9 years old in the present and in the near future. We integrated the outputs of the height tree model in combination with the ones of habitat suitability for each of the climate scenarios in a decision framework to guide assisted colonization to compensate for climate change. We apply three decision rules to cope with the uncertain states of the world represented by four climate change scenarios showing that there is no unique ‘best decision’ and that the general recommendation of mixtures of populations, although probably not the most productive, can reduce uncertainty in the long term by allowing natural forests to evolve.

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