Guiding Douglas-fir Seed Selection in Europe Under Changing Climates

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Introduction

Douglas-fir is an important tree species in its native range in North America, and in Europe, where it is was introduced more than 185 years ago for its high productivity and wood quality. Many early plantations have known seed source origins, which today allow them to serve as a unique experimental test bed to investigate how trees react to being transferred to new climate conditions.

Objective

Here, we test if models developed to guide assisted migration of Douglas-fir in North America under climate change can accurately predict the success of provenance transfers to Europe. We then use a validated model to guide seed transfer under climate change in Europe.

Methods

We evaluate more than 700 Douglas-fir provenances from 13 North American regions at 120 European test sites (Fig 1). Model predictions of where the 13 North American regions find their best climate match in Europe under current and future climate were carried out with the RandomForest ensemble classifier, a widely used bioclimate envelope modeling approach.

Results & Applications

Model predictions of optimal climate matches for western and central Europe conformed well with observed provenance performance (Fig 2, first 10 rows, Finland to Italy). Under eastern Europe's continental climates, however, the results were mixed (Fig 2, rows 11-17), and a safe strategy would be to use slightly less productive provenances with reasonable climate matches (provenances that are both above average in Fig 2a and toward the right in Fig 2b).

Given adequate model performance at least for western Europe, model projections for observed and projected climate change may provide guidance for Douglas-fir plantation forestry (Fig 3). Both recent climate change trends and projections for the 2020s suggest that European foresters should switch to provenances from more southern or drier origins in North America.

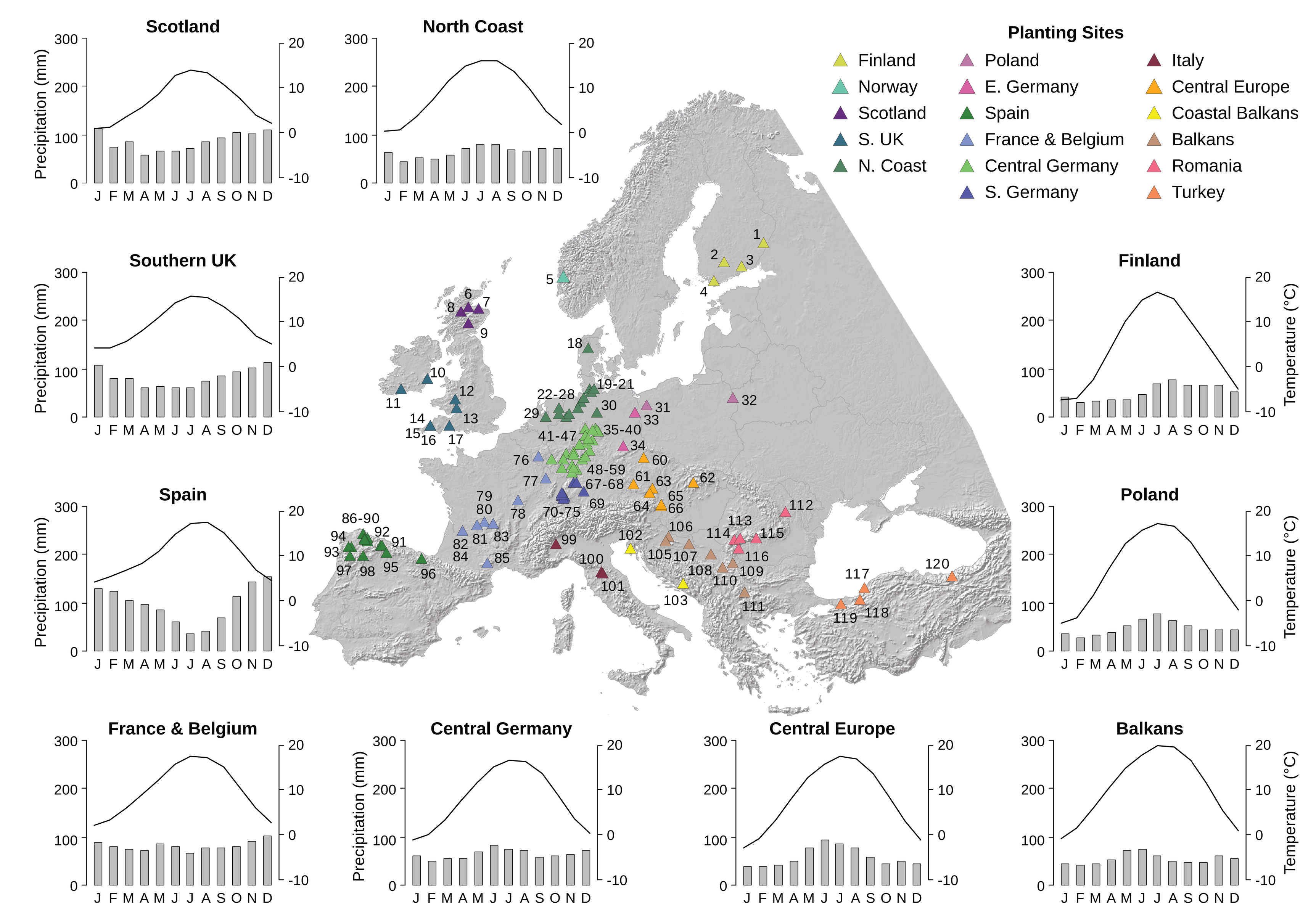

Fig 1. Map of Europe with numbered planting sites coloured by region, with climate diagrams displaying average monthly temperature (°C) and average

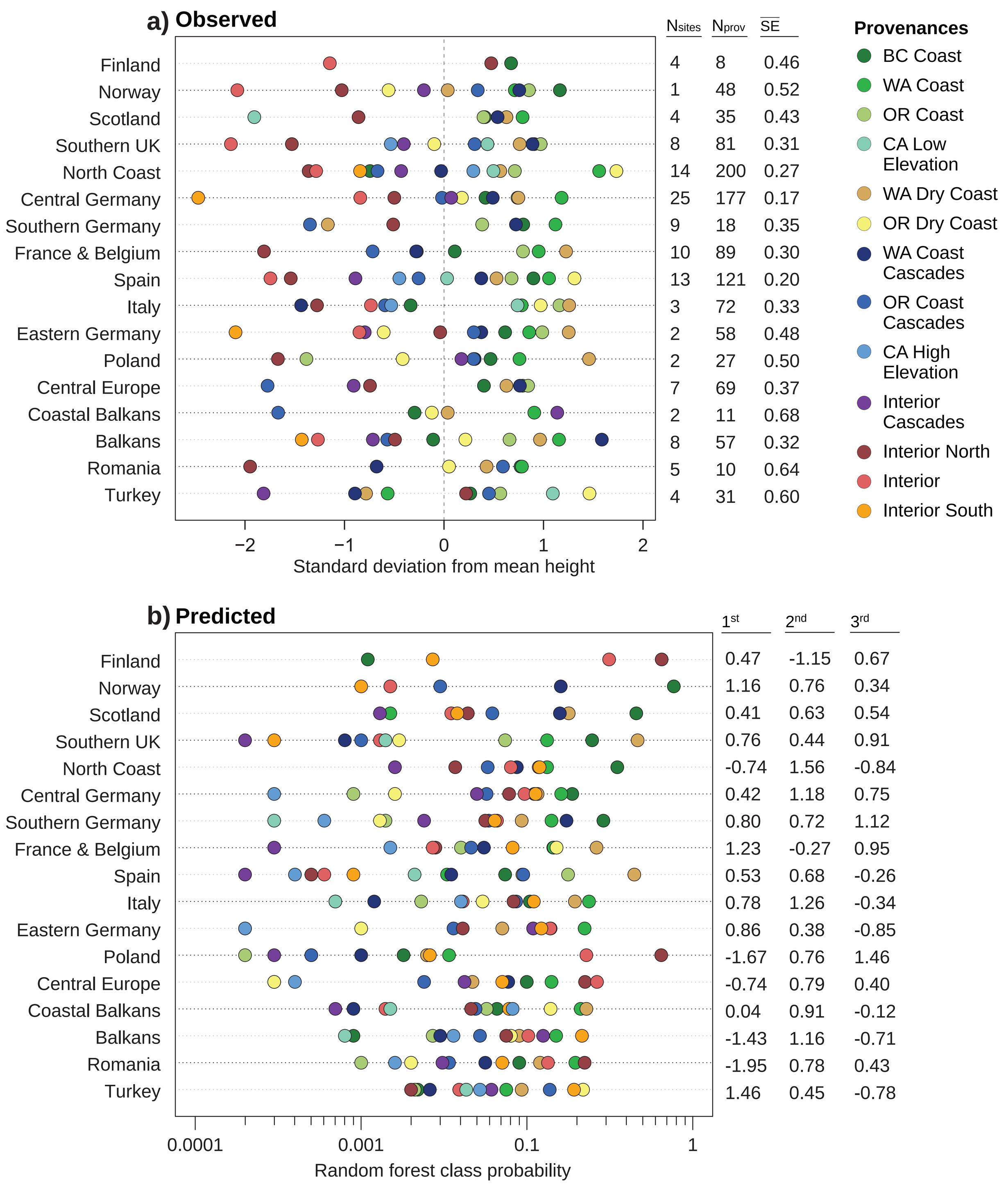

Fig 2. The upper dot plot (a) displays the observed performance of North American populations in European regions. Performance is reported in units of standard deviation from the site mean. Statistics on the right indicate the number of planting sites, the number of provenances and the average standard error for dot plot entries in each row.

The lower dot plot (b) displays the predicted North American populations based on the best climate match (better match on right). The columns on the right indicate the relative productivity gain or loss if the first, second, or third model recommendation would be planted based on provenance trial performance.

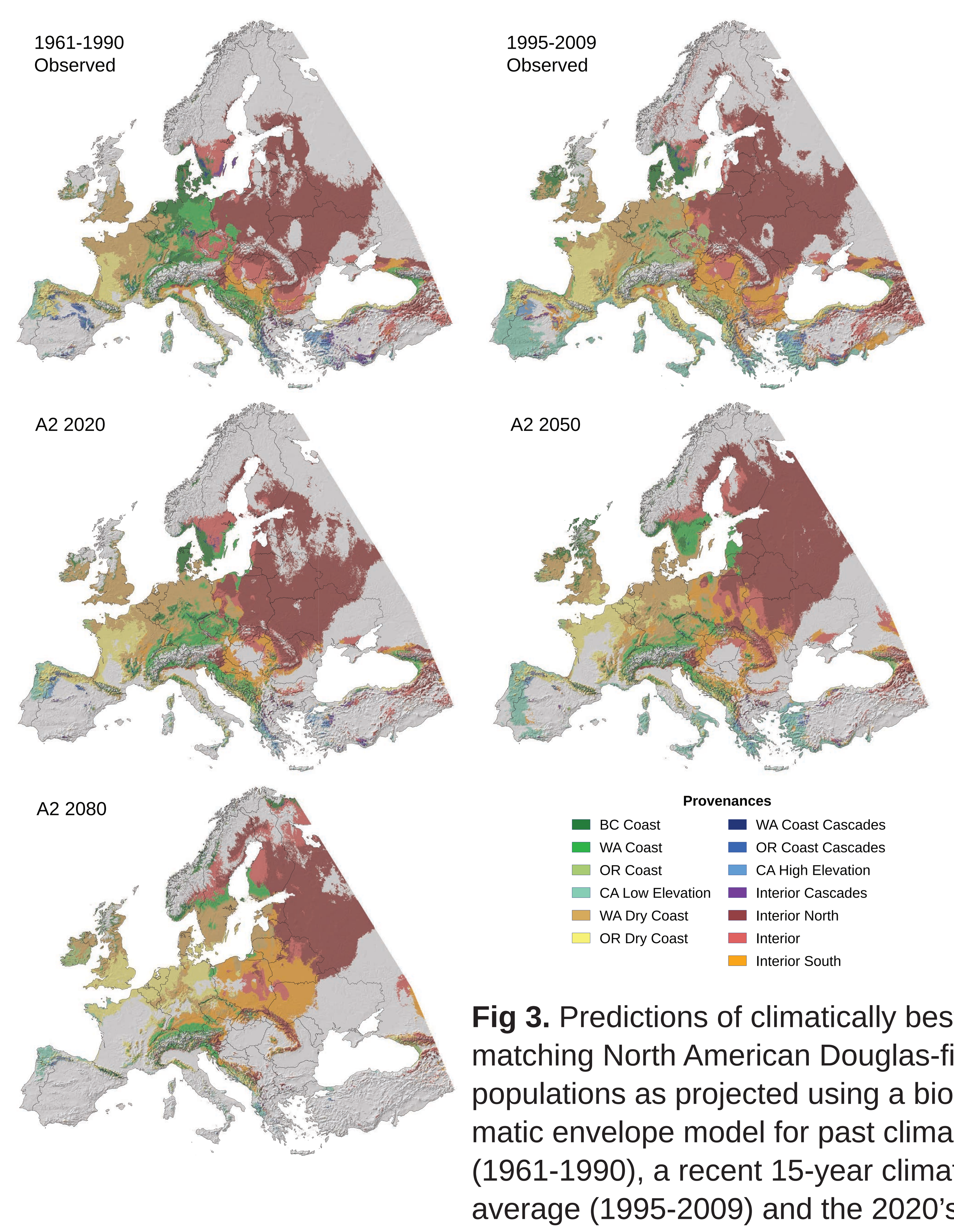

Fig 3. Predictions of climatically best matching North American Douglas-fir populations as projected using a bioclimatic envelope model for past climate (1961-1990), a recent 15-year climate average (1995-2009) and the 2020's, 2050's and 2080's under an A2 scenario.

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