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Spatio-temporal dynamics of four pine species recolonization in Southern Europe human-disturbed forestlines

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In this study we compared the encroachment patterns of four pine species across anthropogenic forestlines in Southern Europe. Using a synchronic approach, we studied structure and recent spatio-temporal patterns of pine recruitment at upper forestline ecotones in Albania, Italy, Montenegro and Spain. Within altitudinal transects we mapped and sampled 964 living individuals of *Pinus heldreichii*, *Pinus peuce*, *Pinus sylvestris* and *Pinus uncinata* growing above the current forest line. We measured their basal diameter, total height, and counted the number of seed cones. We differentiated seedlings (height < 0.5 m) from saplings (0.5m≤height < 2 m) and trees (height≥2 m). From individuals with basal stem diameter>4 cm we extracted one increment core for cambial age determination and tree-ring width measurements. On smaller specimens, we estimated the age by counting annual internodes (terminal bud scars) along the whole stem. We compared the ground cover around each pine, applied point pattern analyses, modelled the probability of seed cone production and estimated the average distance of seed dispersal. The four pine species exhibited heterogeneous density values and the overall averaged means ranged 2–7 cm for basal diameter, 54–106 cm for total height and 9–20 years for cambial age, suggesting a recent encroachment process. None of these structural variables decreased with increasing relative altitude and distribution patterns exhibited a few higher density spots but not cohort spatial structure. Ground cover differed between species and more significantly between size classes. Grass was the most frequent type at all sites except for *P. sylvestris* where shrubs prevailed. Basal area increments increased from 1990 and stabilized in recent years at all species except for *P. peuce*. Height and basal diameter predicted cones production better than cambial age. *P. heldreichii* and *P. peuce* dispersed seeds at longer distances than *P. uncinata* and *P. sylvestris*, suggesting different potential for further encroaching. Pine recruitment above the forestlines is quite synchronic at all sites (last 30 years), but in some cases it appeared as a high altitude tree densification process, whereas in others as a starting forestline advance.