Abstract

Climate change poses a significant threat to the survival of many species. Although protected areas can slow down biodiversity loss, they often lack systematic planning and do not integrate genetic diversity. Genetic diversity is a key prerequisite for species survival and the ability to tolerate new conditions. Using population genetic and distribution data from 96 plant species in the Third Pole (encompassing the Tibetan Plateau and adjacent mountains), we mapped patterns of genetic diversity, projected climate-driven range dynamics and future genetic erosion, and designed an optimal conservation framework for the region. We identified several patches of high haplotype diversity (HD), with a relatively high number of haplotypes in southeastern Third Pole. Regression models revealed that climate and topography have interacted to shape patterns of genetic diversity, with latitude and precipitation being the best predictors for HD of cpDNA and nrDNA, respectively. Ecological niche modeling predicted an approximate 43km northwestward and 86m upward shift in suitable habitats under future climate scenarios, likely leading to a significant loss of up to 13.19% and 15.49% of cpDNA and nrDNA genetic diversity, respectively. Alarmingly, 71.20% of the newly identified conservation priority areas fall outside of the existing protected areas and planned National Park Clusters. Therefore, we recommend expanding the network by 2.02×105km2 (5.91%) in the Third Pole, increasing the total conserved area to 1.36×106km2 (39.93%) to effectively preserve the evolutionary potential of plants. This study represents an innovative attempt to incorporate genetic diversity into biodiversity conservation efforts.