Supplementary Material S2. Integrated Serbia-Croatia strategic roadmap for *Quercus robur* (2027-2036) research and conservation aligned with EUFORGEN Dynamic Conservation Unit (DCU) criteria.

Research domain	2027–2030: Gap closure and standardization	2030–2033: Integration and modelling	2033–2036: Deployment and application	EUFORGEN DCU criterion explicitly addressed*	Scientific and operational relevance for DCUs
Nuclear genetic diversity (nSSR)	Harmonize SSR loci, allele binning and sampling design across Serbia and Croatia	Joint modelling of gene flow, connectivity and population structure	Use SSR baselines to validate DCU representativeness and connectivity	Genetic representativeness; within-DCU diversity	Ensures DCUs retain high effective population size and long-term evolutionary resilience
Maternal lineage structure (cpSSR haplotypes)	Extend cpSSR haplotype analysis to Serbian populations using Croatian marker sets	Balkan-wide phylogeographic reconstruction and lineage admixture modelling	Incorporate haplotype layers into DCU delineation and prioritization	Evolutionary history; lineage representation	Prevents loss of refugial maternal lineages with unique adaptive potential
Adaptive genetic variation (SNP–environment associations)	Replicate Croatian SNP–GEA framework in Serbia across hydrological gradients	Cross-border comparison of shared vs. region-specific adaptive alleles	Integrate adaptive SNPs into DCU justification and monitoring	Adaptive genetic diversity	Identifies DCUs harboring alleles critical for drought and water-regime adaptation
Leaf morphometric and functional traits	Harmonize leaf, stomatal and functional trait protocols	Couple trait variation with SNP and climatic data	Use trait–genotype links to refine DCU adaptive profiles	Phenotypic variability within DCUs	Demonstrates functional breadth necessary for adaptive responses
Physiological drought–heat stress responses	Standardize drought and heat-wave simulation assays (WUE, ROS buffering, antioxidant enzymes)	Integrate physiological thresholds with genomic and haplotype data	Define population-specific stress tolerance envelopes for DCUs	Fitness and adaptive performance	Confirms DCUs maintain functional resilience under climate extremes

Phenological responses to drought	Extend phenological monitoring to Serbian populations	Model drought timing effects on multi-year phenological shifts	Use phenological plasticity as DCU vulnerability indicator	Regeneration and adaptive timing	Ensures DCUs sustain regeneration under altered climate regimes
Functional genomics (gene expression)	Extend drought-response transcriptomics from Serbia to Croatia	Integrate expression, SNP and physiology data to validate mechanisms	Select molecular indicators for adaptive genetic monitoring	Maintenance of adaptive processes	Mechanistic validation of adaptive traits underlying DCU designation
Provenance trials and common-garden experiments	Increase Serbian provenance representation in Croatian trials; synchronize measurements	Model growth–stability trade-offs under drought and heat	Designate climate-resilient FRM units linked to DCUs	Sustainable use and management relevance	Aligns DCU conservation with breeding and restoration
Biotic stress and plant–soil interactions (mycorrhizae)	Harmonize ectomycorrhizal sampling and soil protocols	Assess symbiont–host–climate interactions	Integrate soil–biotic resilience into DCU management	Ecosystem integrity	Recognizes belowground processes supporting DCU persistence
Integrated adaptive potential (multi-trait)	Compile genomic, phenotypic and physiological indicators	Model survival probabilities under 2050 climate scenarios	Rank DCUs by long-term adaptive capacity	Long-term evolutionary potential	Moves DCUs from static protection to climate-smart conservation
Monitoring and genetic surveillance	Deploy LIFEGENMON-compatible genetic–physiological monitoring	Establish cross-border monitoring network	Operational long-term DCU surveillance system	Dynamic monitoring requirement	Enables detection of genetic erosion and maladaptation
Data infrastructure and interoperability	Standardize metadata and data formats	Integrate datasets into shared Serbia–Croatia platform	Maintain interoperable DCU-level databases	Transparency and data continuity	Ensures DCUs are supported by verifiable, updateable evidence
Policy and governance interface	Align scientific outputs with national conservation frameworks	Develop DCU-based adaptive zoning scenarios	Embed results into EUFGIS and EUFORGEN guidance	Operational implementation	Translates DCU science into enforceable conservation decisions

* **EUFORGEN Dynamic Conservation Unit criteria**: representativeness of genetic diversity, maintenance of evolutionary processes, adaptive capacity, regeneration potential, ecosystem integrity, long-term monitoring and relevance for sustainable use (Lefèvre et al. 2020).