Table S1. A summary of the basic strategies of drought responses of co-occurring pine and oak species. Studies are arranged chronologically within regions.

Pine and Oak Species/Pair	Site/Country (Reference)	Findings
Plant Water Balance in Relation to Drought		
P. pinaster; Q. petrea	France [92]	At the end of the drying cycle, Ψ_{PD} = -1.5 MPa in the pine and -3.3 MPa in the oak.
P. ponderosa; Q. gambelii	Camp Navajo, Arizona, USA [93]	The pine closed its stomata at Ψ -1.9 MPa and the oak kept it open till -2.5 MPa Ψ.
P. halepensis; Q. coccifera; Q. ilex	Teruel, Spain [33]	During the drought, Ψ_{PD} values were similar in the pine, while there was a significant decline (~50%) in the two oaks.
P. halepensis; Q. ilex	Spain [94]	The pine showed faster increase in iWUE in response to water stress than the oak.
P. oaxacana; Q. acuifolia; *Q. castanea*	Mixteca Alta region, Mexico [95]	Ψ_{PD} declined to -3.8 MPa in the oak, hindering survival in open edges; the pine with Ψ_{PD} >-2.9 MPa, showed better survival and had faster leaf turnover. Far more carbon (C) depletion occurred in the pine than in the oak because of prolonged stomatal closure.
P. halepensis; Q. coccifera, Q. ilex	Spain [96]	The pine follows a water-saving strategy characterized by early and prolonged stomatal closure, whereas the *Quercus* spp. maintained higher stomatal conductance and lower Ψ_{stem}.
P. roxburghii; Q. leucotrichophora;Q. floribunda; Q. lanata	Uttarakhand Himalaya, India [97]	The pine may not be adversely affected by a warmer and drier condition, as it shuts its stomata while water potential is still high, but oaks which keep stomata open up to a considerably lower soil water potential may suffer. In pre-monsoon (April–May), Ψ_{PD} = -0.78 MPa in the pine and -0.85 to -0.96 MPa in the oak. Ψ_{Δ} (Ψ_{PD} - Ψ_{PD}) = 0.73 MPa in pine, 0.90 MPa in *Q. leucotrichophora,* and 0.85 in *Q. floribunda.*
P. halepensis; Q. ilex	Spain [49]	Drought decreased stomatal conductance by 42% in the pine and by 28% in the oak. Net photosynthesis rates were higher in the oak than in the pine during summer.
P. sylvestris; Q. pubescens	Switzerland [98]	The pine closed stomata early with increasing drought. Oak had higher stem flow resistances and lower minimum crown Ψ (-4.8 MPa) than pine (-2.7 MPa). The oak withdrew more water from the plant storage pools and lowered leaf Ψ. However, the extreme drought led to a considerable amount of leaf loss in the oak.
P. halepensis; Q. coccifera	Spain [99]	The pine showed higher (less negative) Ψ_{leaf}, leaf water content, lower stomatal conductance, and net assimilation rate than

		the oak. The pine also avoided chronic and intense photoinhibition. The lowest Ψ_{stem} was -1.5 MPa in the pine and -2.5 MPa in the oak. Photoinhibition was low in the pine and high in the oak.
P. halepensis; Q. coccifera	Spain [100]	The pine closed stomata while Ψ was moderately high, while the oak showed water-spending mechanisms, such as keeping stomata open in the face of increasing drought. In both, a decrease in Ψ_{PD} was accompanied by a decrease in sap flow rates.
P. pseudostrobus; Q. canbyi	Mexico [101]	The oak had higher Ψ_{PD} and Ψ_{MD} on the northern aspect than the pine on the southern aspect. Overall, the pine showed isohydric water status regulation, while the oak showed anisohydric traits.
P. halepensis; Q. calliprinos	Israel [102]	The oak leaves had significantly lower Ψ_{leaf} than the pine leaves (-2.8±0.38, and -2.4±0.43 MPa, respectively) and higher stomatal conductance (0.17±0.06 vs. 0.08±0.01 mol H_2O $m^{-2}s^{-1}$). On average, iWUE yielded 108.5±58.6 and 62.8±15.1 μmol CO_2 mol^{-1} H_2O for the pine and oak, respectively.
P. sylvestris; Q. ilex	Poblet Forest Natural Reserve, Spain [103]	The variation of Ψ_{MD} with declining Ψ_{PD} confirmed that the pine was more isohydric than the oak. The oak experienced more negative Ψ and higher xylem embolism.
P. pinea; Q. ilex	Spain [104]	The pine exhibited higher predawn and midday Ψ than the oak. The oak had access to deeper soil. In July 2011, Ψ_{Δ} ($\Psi_{midday} - \Psi_{predawn}$) was 0.39 MPa for the pine and 1.69 MPa for the oak. The oak showed significantly higher transpiration rate and higher stomatal conductance than the pine ($p<0.001$), thus showing anisohydric trait against the isohydric trait in the pine.
P. rigida, P. echinata; Q. alba, Q. prinus, Q. velutina	New Jersey, Pinelands, USA [105]	The oaks had significantly lower intrinsic water-use efficiency ($WUE_{inst.}$) than the pines because of higher transpiration/stomatal conductance (gs, 0.26 mol $m^{-2}s^{-1}$ for oak species and - 0.18 mol $m^{-2}s^{-1}$ for pine species) and c_i/c_a inst. ratios (ratio of CO_2 inside leaf to CO_2 ambient air based on carbon isotope discrimination) than pines (but similar maximum assimilation rate 16.2 vs. 16.4 μmol $m^{-2}s^{-1}$). The pines had lower photosynthetic nitrogen-use efficiency. The leaf-specific transpiration rates (E_L) of oaks were about 2.5 times greater than the pines.
P. tabuliformis; Q. variabilis	China [106]	The pine followed an isohydric approach, showing a strong stomatal regulation over

		water loss. The oak kept stomata open but did not cavitate. Both depended on deep water during water stress, but when surface water was available, oak used it more efficiently.
P. sylvestris; Quercus spp.	Germany [107]	The pine seedlings lost less than 10% of stomatal conductivity and maintained Ψ_{STEM}, −1.5 MPa.
P. nigra; Q. ilex spp. ballota; Q. faginea	Alto Tajo Natural Park, Spain [61]	*P. nigra* followed drought avoiding strategy, yet it experienced severe drop in hydraulic efficiency in gas exchange at the leaf level. The two *Quercus* species maintained more profligate water use at the leaf and tree level. The two oaks showed effective osmoregulation and maintained leaf turgor even under the lowest midday leaf water potential (Ψ_{midday}).
P. nigra; Q. ilex ssp. *ballota*; *Q. faginea*	Alto Tajo Natural Park, Spain [108]	Water-use efficiency (WUE) of the pine was significantly higher (2.31-3.23) in the pine than in *Q. ilex* (0.40-0.69) and *Q. faginea* (0.59-1.14).
P. nigra; Q. ilex	Tarragona, NE Spain [109]	During the driest period (early September), midday Ψ_{leaf} in *Q. ilex* was significantly lower (-4.21 MPa) than in *P. nigra* (−2.27 MPa).
P. massoniana; Q. griffithii; Q. acutissima	China [110]	The oaks showed more negative Ψ_{MD} (-1.8 to -2.28 MPa) than pine (-1.48 to -1.56 MPa) and greater Ψ_{Δ} from 1.45 to 1.5 in oaks and 0.81-0.97 in the pine.
P. virginiana; Q. alba, Q. falcata	Virginia, USA [111]	The pine strongly regulated stomata, hence less cooling effect and higher canopy temperature (by 1.3°C) than in the oak canopy, and higher vapor pressure deficit (higher by 0.3 KPa) in the afternoon; g_s of the pine under dry conditions was noticeably lower than under wet conditions, while it was similar for *Q. alba* under dry and wet conditions and higher in dry period than wet period in *Q. falcata*. Under dry conditions, sap flow density (J_S) in the pine decreased by ~25% during midday, but increased in the oaks (~5% in *Q. alba* and 25% in *Q. falcata*).
P. strobus; Q. rubra, Q. velutina	New Hampshire, USA [112]	Sap flux density (J_S) in the pine declined abruptly at soil moisture threshold of 0.15 m^3 m^{-3}, oak's threshold was lower at 0.11 m^3 m^{-3}, but once threshold was surpassed, the decline in oak was rapid. The oaks tolerated a moderate drought and were vulnerable only to extreme droughts. Mean pine Ψ_{leaf} = −1.9 MPa and oak Ψ_{leaf} = −2.2 MPa and mean stomatal conductance in pine 0.08 mol m^{-2} s^{-1} as compared with 0.23 mol m^{-2} s^{-1} in oak.

		The Ψ_{50} for oak was −3.31 MPa, and for the pine −5.25 MPa, with the safety margin being 1.41 MPa and 3.35 MPa for oak and pine, respectively.
P. nigra subsp. pallasiana, P. brutia; Q. infectoria	Turkey [113]	Pines are more sensitive than the oak during summer drought, the lowest Ψ_{MD} in July–August being -2.29 MPa for *P. nigra,* -2.45 MPa for *P. brutia,* and -3.08 MPa for the oak.
P. koraiensis, P. densiflora, P. thunbergia; Q. acutissima	South Jeolla Province, Republic of Korea [114]	Ψ_{Δ} values are significantly more in the oak (average, 0.55-0.92 MPa) than in pines (average, 0.04-0.20 MPa) and increased (in the oak) during severe drought (from 0.55 to 0.,76 MPa).
P. sylvestris; Q. pyrenaica	Spain [115]	iWUE was higher in pines (106.7 ± 9.9) than in oak (83.5 ± 7.3 μmol CO_2·mol H_2O^{-1}). Oaks had two times as many NSCs (7.8 ± 3.5%) as pines (3.9 ± 1.7%).
P. halepensis; Q. ilex	South-eastern France [116]	Nine years of rainfall exclusion caused continuous decline of sap flow and growth. Leaf area reduced more in the pine than in the oak. In the pine, Ψ_{Δ} decreased linearly down to zero at Ψ_{PD} -3 MPa, while in the oak, Ψ_{Δ} decreased exponentially then became constant at -0.5 MPa when Ψ_{PD} was lower than -3 MPa.
P. pinea; Q. ilex, Q. faginea	Spanish Northern Plateau [117]	In water-stressed co-occurring seedlings, Ψ was less negative in pine (-1.5 MPa) than *Q. faginea* (-1.9 MPa) and *Q. ilex* (-1.8 MPa).
P. halepensis; Q. ilex	France [118]	The water potential at which 50% loss of stem hydraulic conductivity (Ψ_{50}) occurred was −4.67 MPa in pine and −7.13 MPa in oak. For each species, these Ψmin potential values corresponded to an average level of percentage loss of conductivity (PLC) due to embolism (e.g., 61% in the pine).
P. roxburghii; Q. leucotrichophora	Uttarakhand Himalaya, India [71]	The oak showed far more daily change of ~1.4 MPa than pine (0.90 MPa) during pre-monsoon drought, thus obtaining more C gain. However, oak faces mortality when drought is extremely severe.
Water Stress and Carbon Reserve		
P. pinaster; P. sylvestris; Q. robur; Q. ilex	France [119]	The gross primary production increased from 1960 to 2100 but slowed down after 2020 because of water stress. The C sink strength globally decreased for pines (-8%), increased moderately for *Q. ilex* (+34%), and strongly increased for *Q. robur* (+67%), largely because of the lengthening of the foliated period.
P. halepensis; Q. ilex, Q. faginea	Spain [120]	Stomatal closure in the pine resulted in depletion of carbon reserves to support

		respiration, while in the oaks, drought reduced growth but not carbon reserves, so growth was not limited by carbon availability.
P. sylvestris; Q. ilex	France [121]	The oak stand displayed low gross primary productivity (GPP) and low diurnal variability in GPP than the pine even under high solar radiation, suggesting strong stomatal control under water stress. The mature forest showed a consistent GPP–radiation relationship without water stress, likely to be due to the consistent access to the water table.
P. sylvestris; Q. subpyrenaica	Spain [122]	The pine showed tighter stomatal control, reduced carbon assimilation, and non-structural carbon concentration (4.0%). The oak had higher NSC (7.8%) and more C exchange. The oak had much lower (-2.27 MPa) Ψ_{MD} because of high transpiration but had high $\Psi_{PD,}$ indicating access to deeper water or ability to quickly recover Ψ_{PD} (0.8 MPa).
P. taeda; Q. stellata; Q. marilandica	Bastrop County, Texas, USA [123]	The oak utilized osmotic adjustment to gain C.
Recovery after Drought		
P. halepensis; Q. ilex	Spain [124]	The oak resprouted with vigor after drought-induced disturbances, but not the pine.
P. sylvestris; Q. pubescens	Switzerland [125]	This study on xylem adaptation shows that drought reduced the conduit area of the oak but increased the radial lumen diameter of the conduits in the pine. In both species, radial increment decreased but more was observed in the pine.
P. sylvestris; Q. pubescens	Central Valais, Switzerland [73]	The pine currently lives at physiological limit to withstand increasing temperature and drought intensity (hot drought), whereas the oak performed distinctly better in this respect. At the regional level, the pine has declined rapidly, whereas the oak has significantly increased in the past three decades. The pine closes its stomata disproportionately more than the oak. In brief, under the influence of climate change, the pine is likely to be replaced by oak in Switzerland.
P. nigra; Q. faginea	Plateau of Iberian Peninsula [126]	During a 50yrs drought, spring growth declined by 60% in the oak and 36% in the pine, but the oak recovered more than the pine: sap flow decreased by 25-50% in oak and 69-90% in pine.

P. ayacahuite; Q. xalapensis	Mexico [127]	In the pine, leaf loss began as early as 13 days after drying (-4.13 MPa), and in oak after 25 days (-4.34 MPa). Thus, oaks tolerate drought longer.
P. halepensis; Q. ilex,	Barcelona, northeastern Spain [128]	Drought caused early leaf senescence in the oak and increased leaf mass per unit area (LMA) in both oak and pine.
P. sylvestris; Q. pyrenaica	Spain [129]	Xylem formation ceased 1-3 weeks earlier in the pine and formed fewer but larger tracheids, and reduced the proportion of latewood, while the oak did not suffer early wood hydraulic diameter changes but experienced cumulative reduction in latewood width.
P. sylvestris; Q. petraea,	France [130]	During the drought, the oak had a higher circumference increment (0.47 mm ± 0.23) than in the pine. The drought resistance in oak increased from 72.1% in pure stands to 98.6% in mixed stands, whereas it decreased from 84.2% in pure stands to 79.3% in mixed stands in pine.
P. sylvestris; Q. faginea	Spain [131]	The pine rapidly closed stomata, while the oak continued to transpire and maintained other physiological activities under dry conditions, thus dehydrating the stem. After soil rewetting, the pine recovered pre-drought Ψ quickly, but the oak took longer to refill stem storage tissues and to recover pre-drought Ψ.
P. cembroides; P. leiophylla; P. engelmannii; Q. grisea	Mexico [132]	This study on xylogenesis showed that an earlier growth peak in the oak and a higher responsiveness to spring–summer water demand in the pines contributed to their coexistence.
P. sylvestris; Q. petraea	Northeast Germany [133]	At dry sites, the pine reduced water consumption more in response to decreasing soil moisture than the oak.
Root Traits and Below Ground Adaptations		
P. nigra; Q. ilex	Ports district of Castello´ province, Spain [134]	The pine roots had access to deep soil water and conducted hydraulic lift, while the oak was less effective.
P. halepensis; Q. faginea; Q. petrea	Spain [135]	Mycorrhization increased Ψ: it was -1.42 MPa in pine and -2.18 MPa in oak. $\Psi_{\text{osmotic zero turgor}}$ -2.16 MPa for the pine and -2.98 MPa for the oak. Mycorrhizal inoculation increased cell wall elasticity.
P. halepensis, Q. coccifera	Spain [136]	Plant growth promoting rhizobacteria and microbes increased Mg concentration in the pine but not in the oak. In both leaf, conductance decreased with increasing water

		stress, but more in the oak than in the pine. The mycorrhizal treatment did not affect it.
P. cembroides; Q. potosina	Sierra San Miguelito', Mexico [137]	A combination of redistribution mechanisms of water stored in weathered bedrock and hypodermic flow accessible to the oak provided the source of water supply to shallow soils, where most of the actively growing roots occurred, including those of the pine.
P. palustris; Q. laevis, Q. margarettae	Georgia, USA [138]	The pine used more water than oaks. All had access to ground water but used shallow water when available.
P. cembroides; Q. potosina	Central Mexico [81]	The oak roots with Ca oxalates in epidermis have ability to explore deep rock fractures and crevices, reaching additional water, while the pine depends on shallow soil water. The oak keeps its stomata open, and the pine may close stomata even when Ψ is not low or VPD is not high.
Climate Change Regeneration and Growth		
P. halepensis; P. pinea; P. pinaster; P. nigra; P. sylvestris; P. uncinate; Q. suber, Q. ilex, Q. petraea, Q. robur, Q. faginea; Q. pyrenaica	Spain [28]	Recruitment failure in the six pines affected 54–71% of the surveyed plots. While the oak species (six) expanded to 41% of the plots, the pines expanded only to 10% of the plots. The recruitment failure was much lower in oak localities (29%) than pine localities (63%). The increase in basal area of *Q. ilex* saplings choked the regeneration of pines. Climate change is predicted to negatively affect pines by promoting the expansion of *Q. ilex* and increase in droughts and fires.
P. sylvestris; Q. pyrenaica	Spain [76]	Climate change is predicted to cause drought-induced decline in pine than oak in the Mediterranean *Q. pyrenaica–P. sylvestris* island. Though oak is more vulnerable to drought than pine, oak can rapidly recover, but the pine takes more time. Mortality is higher in pine in spite of even faster growth.
P. cembroides; Q. emoryi	Texas [139]	Climate change impact: drought in the Chisos Mountains killed more pine seedlings and trees (55%) than those of oak (20.7%).
P. pinaster; Q. pyrenaica	Spain [84]	Based on stem radial growth, warming may favor pine, but associated water stress may offset the advantage.
P. halepensis; Q. ilex	Iberian Peninsula [140]	The pine and oak showed distinct hydrological niches during dry season, leading to limited competition between them. Competition with pine modulated the climate response of oak, while pine climate response was unaffected by competition with oak.

P. sylvestris; *Q. petraea*	Germany [83]	Warming would adversely affect the root growth of the Scots pine and Douglas fir (*Pseudotsuga menziesii*), but not of the sessile oak.
External Factors		
P. sylvestris; Q. petraea	Switzerland [141]	Because of thicker boundary, the larger oak leaves were warmer than pines, which might affect leaf conductance.
P. pinaster; Q. pyrenaica,	Spain [69]	Response along the soil moisture gradient was affected by irradiance, the pine performed well at high irradiance and the oak under moderate shade.
P. sylvestris; Q. petrea	Mediterranean Basin [142]	The pine showed no adjustment in hydraulic architecture and change in percentage loss of stomatal conductivity along an aridity gradient during a severe drought, while the oak showed high adjustment. In the pine, all xylem tissues were functional, while in the oak, even the inner ring was non-functional at the extremely dry site. The lack of change in hydraulic trait along the aridity gradient shows the pine's drought avoidance strategy.
P. pinea; Q. ilex	Italy [143]	The pine had a tighter stomatal control and more effective wood with regard to hydraulic conductivity with the strong intra-annual density fluctuation frequency (43%) than oak (28%).
P. sylvestris; Q. petraea	France [144]	In pure stands, both pine and oak utilized soil water near the surface, but in mixed stands there was a partial niche complementarity resulting in a less negative water potential for both species compared to pure stands.
P. strobus; Q. rubra	Canada [145]	The oak tolerated periodic browsing events even when water availability was reduced, while pine could tolerate only water stress.