**Table 1.** Characteristics of sampled plot. Lat = latitude; Long = longitude. Dbh and height of all trees, Basal Area (BA), Density and SRD (Size ratio proportional to distance) are computed for all trees within a 10-m radius of focal trees (see methods). Temp.: annual average of mean monthly minimun and maximum temperatures. Values shown here correspond to site averages. Standard deviations are shown in parentheses. Different letters indicate statistically significant differences between sites (Kruskal-Wallis test followed by Dunn’s test, p<0.05). Stands were monospecific, hence all results correspond to oak data.

|  |  |  |  |  |  |  | ***Cored trees*** | | | | ***Stand competition*** | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site** | **Lat (°)** | **Long (°)** | **Elevation (m)** | **Slope (°)** | **Prec. (mm)** | **Temp. (° C)** | **# trees (# cores)** | **Dbh (cm)** | **Height (m)** | **Age (years)** | **Dbh all (cm)** | **Height all (m)** | **BA (m**2 **ha**-1**)** | **Density (trees ha**-1**)** | **SRD** |
| CA-High | 36.97 | -3.42 | 1846 - 1884 | 12.11 (3.28) | 731 | 3.4-13.8 | 15 (30) | 69.8 (20.5) a | 15.4 (1.8) a | 161.0 (32.2) a | 34.1 (24.3) a | 10.8 (4.4) a | 39.13 (24.31) a | 348.0 (147.1) a | 0.91 (0.63) a |
| CA-Low | 36.96 | -3.42 | 1691 - 1751 | 12.86 (2.98) | 658 | 4.7-15.6 | 15 (30) | 45.9 (8.6) a | 12.6 (1.6) b | 148.5 (16.5) a | 21.7 (14.4) b | 9.0 (2.8) b | 18.02 (7.11) ab | 409.6 (226.0) a | 0.89 (0.44) a |
| SJ | 37.13 | -3.37 | 1322 - 1474 | 27.33 (5.59) | 555 | 4.9-16.35 | 20 (48) | 31.9 (3.7) b | 11.8 (2.3) b | 72.6 (11.1) b | 20.6 (8.1) b | 9.7 (3.6) ab | 11.64 (5.47) b | 339.0 (130.3) a | 1.11 (0.52) a |

##### 

**Table 2.** Characteristics of the mean tree ring chronologies. Values of length between parentheses indicate number of years replicated with more than five series. RW = mean annual ring width (standard deviation in parenthesis). MS = mean sensitivity. AR(1) = mean autocorrelation of raw series. Rbt = mean correlation between series. EPS = mean expressed population signal. EPS and Rbt were calculated for the mean residual chronologies of growth indices.

| **Site** | **First year** | **Last year** | **Length (years)** | **# trees** | **# cores** | **RW (mm)** | **MS** | **AR(1)** | **Rbt** | **EPS** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CA-Low | 1836 | 2016 | 181 (164) | 15 | 30 | 1.253 (0.781) | 0.208 | 0.799 | 0.520 | 0.897 |
| CA-High | 1819 | 2016 | 198 (188) | 15 | 30 | 1.500 (0.879) | 0.203 | 0.827 | 0.522 | 0.907 |
| SJ | 1921 | 2016 | 96 (90) | 20 | 48 | 1.725 (1.207) | 0.319 | 0.692 | 0.637 | 0.959 |

##### 

**Table 3.** Robust two-way ANOVAs of the resilience metrics of greenness (EVI) and tree-growth (BAI) for the two drought events (in 2005 and 2012) and site.

|  |  |  | **Resistance** | |  | **Recovery** | |  | **Resilience** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Factor** |  | **F** | **p** |  | **F** | **p** |  | **F** | **p** |
| EVI | Drought event |  | 799.900 | *< 0.001* |  | 312.000 | *< 0.001* |  | 207.200 | *< 0.001* |
| Site |  | 153.200 | *< 0.001* |  | 105.400 | *< 0.001* |  | 29.800 | *< 0.001* |
| Drought event:Site |  | 234.700 | *< 0.001* |  | 364.300 | *< 0.001* |  | 6.100 | 0.014 |
| BAI | Drought event |  | 6.000 | 0.019 |  | 29.500 | *< 0.001* |  | 44.300 | *< 0.001* |
| Site |  | 59.300 | *< 0.001* |  | 53.100 | *< 0.001* |  | 1.300 | 0.534 |
| Drought event\*Site |  | 32.200 | *< 0.001* |  | 4.400 | 0.134 |  | 30.000 | *< 0.001* |

##### 

**Table S1.** Robust measures of central tendency of resilience indices for greenness (EVI) grouped by drought events, site and interaction. Measures of central tendency are M-estimators based on Huber’s Psi (see material and methods). 95 % confidence intervals using 3000 bootstrap are included between parentheses. *Total* corresponds to the average of 2005 and 2012.

|  |  | **2005** | | |  | **2012** | | |  | **Total** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Oak populations** |  | **Resistance** | **Recovery** | **Resilience** |  | **Resistance** | **Recovery** | **Resilience** |  | **Resistance** | **Recovery** | **Resilience** |
| *Northern slope* |  | 0.819 | 1.169 | 0.955 |  | 0.947 | 1.042 | 0.986 |  | 0.884 | 1.102 | 0.970 |
|  | (0.814 - 0.824) | (1.161 - 1.177) | (0.951 - 0.960) |  | (0.942 - 0.952) | (1.036 - 1.047) | (0.980 - 0.990) |  | (0.878 - 0.889) | (1.096 - 1.108) | (0.967 - 0.974) |
| *Southern slope* |  | 0.902 | 1.066 | 0.962 |  | 0.939 | 1.071 | 1.004 |  | 0.921 | 1.069 | 0.983 |
|  | (0.896 - 0.907) | (1.058 - 1.074) | (0.957 - 0.966) |  | (0.934 - 0.944) | (1.067 - 1.075) | (1.000 - 1.008) |  | (0.917 - 0.925) | (1.065 - 1.073) | (0.980 - 0.986) |
| *All* |  | 0.858 | 1.120 | 0.958 |  | 0.943 | 1.057 | 0.995 |  |  |  |  |
|  | (0.854 - 0.863) | (1.113 - 1.126) | (0.955 - 0.962) |  | (0.940 - 0.947) | (1.054 - 1.060) | (0.991 - 0.998) |  |  |  |  |

##### 

**Table S2.** Robust measures of central tendency of resilience indices for tree-growth (BAI) grouped by drought events, site and interaction. Measures of central tendency are M-estimators based on Huber’s Psi (see material and methods). 95 % confidence intervals using 3000 bootstrap are included between parentheses. *Total* corresponds to the average of 2005 and 2012.

|  |  | **2005** | | |  | **2012** | | |  | **Total** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sites** |  | **Resistance** | **Recovery** | **Resilience** |  | **Resistance** | **Recovery** | **Resilience** |  | **Resistance** | **Recovery** | **Resilience** |
| *CA-High* |  | 0.892 | 0.887 | 0.790 |  | 0.753 | 1.107 | 0.813 |  | 0.816 | 0.996 | 0.798 |
|  | ( 0.809 - 0.975) | ( 0.800 - 0.973) | ( 0.691 - 0.888) |  | ( 0.686 - 0.820) | ( 1.026 - 1.188) | ( 0.741 - 0.885) |  | ( 0.755 - 0.876) | ( 0.917 - 1.075) | ( 0.744 - 0.851) |
| *CA-Low* |  | 0.901 | 0.832 | 0.730 |  | 0.926 | 0.952 | 0.876 |  | 0.921 | 0.897 | 0.817 |
|  | ( 0.813 - 0.989) | ( 0.733 - 0.932) | ( 0.612 - 0.849) |  | ( 0.900 - 0.953) | ( 0.889 - 1.015) | ( 0.839 - 0.913) |  | ( 0.883 - 0.958) | ( 0.843 - 0.951) | ( 0.755 - 0.879) |
| *SJ* |  | 0.445 | 1.112 | 0.489 |  | 0.769 | 1.446 | 1.031 |  | 0.612 | 1.282 | 0.769 |
|  | ( 0.375 - 0.516) | ( 1.000 - 1.224) | ( 0.421 - 0.556) |  | ( 0.684 - 0.853) | ( 1.322 - 1.569) | ( 0.930 - 1.132) |  | ( 0.539 - 0.685) | ( 1.179 - 1.386) | ( 0.652 - 0.886) |
| *All* |  | 0.721 | 0.946 | 0.653 |  | 0.819 | 1.161 | 0.911 |  |  |  |  |
|  | ( 0.644 - 0.798) | ( 0.879 - 1.013) | ( 0.585 - 0.721) |  | ( 0.776 - 0.863) | ( 1.081 - 1.240) | ( 0.865 - 0.957) |  |  |  |  |

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**Table S3.** Drought events for the 1901-2016 period for Sierra Nevada ranked according to drought severity calculated from the SPEI index (12 months scale). See methods for details.

| **Duration  (months)** | **Intensity** | **Severity** | **Lowest  SPEI** | **Months** | **Year** |
| --- | --- | --- | --- | --- | --- |
| 11 | -1.957 | 21.524 | -2.585 | Jan - Nov | 1995 |
| 11 | -1.581 | 17.392 | -2.024 | Nov - Sep | 1913-1914 |
| 9 | -1.823 | 16.409 | -2.427 | May - Jan | 1945-1946 |
| 9 | -1.764 | 15.880 | -2.056 | Dec - Aug | 1998-1999 |
| 8 | -1.482 | 11.859 | -1.654 | Feb - Sep | 1983 |
| 6 | -1.728 | 10.367 | -1.906 | Mar - Aug | 2012 |
| 5 | -1.905 | 9.527 | -2.300 | Jan - May | 1925 |
| 5 | -1.522 | 7.611 | -1.571 | May - Sep | 2005 |
| 5 | -1.493 | 7.463 | -1.537 | May - Sep | 1985 |
| 5 | -1.385 | 6.926 | -1.444 | Apr - Aug | 1991 |
| 4 | -1.714 | 6.855 | -1.833 | May - Aug | 1931 |
| 4 | -1.363 | 5.453 | -1.441 | May - Aug | 1927 |

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**Table S4.** Review of the forest and management history of the samplin site. An exhaustive review of historical documents was done to compile information about socio-economical activities affecting forest. Several documentary sources were reviewed: historical documents and maps (*e.g.* Titos 1990); detailed mining reports (*e.g.* Maestre 1858); official information about recent wildfires events and forest management practices (Bonet et al. 2016); livestock farming (*e.g.* Moreno-LLorca et al. 2016); traditional irrigation ditches (Ruiz-Ruiz 2017) and other studies reviewing the socioeconomic dynamics of forest of Sierra Nevada at different scales (Jiménez-Olivencia et al. 2015, Moreno-LLorca et al. 2016).

[Catastro (1752); López (1776); Madoz (1846); Maestre (1852); Maestre (1858); Cruz (1991); Titos (1990); Titos Martínez (1997); Ferrer (1999); Mesa-Torres (2009); Bonet et al. (2014); Navarro et al. (2014); Martín-Civantos (2014); Martín-Montañés et al. (2015); Jiménez-Olivencia et al. (2015); Zoido and Jiménez Olivencia (2015); Wing (2015); Bonet et al. (2016); Moreno-LLorca et al. (2016); Ruiz-Ruiz (2017); Consejería de Medio Ambiente. Junta de Andalucía (2018); Calatrava and Sayadi (2019); J. Navarro and F.J. Cano-Manuel *personal communications*]

Catastro (1752); Mesa-Torres (2009); Bonet et al. (2014) Bonet et al. (2014); Moreno-LLorca et al. (2016); Consejería de Medio Ambiente. Junta de Andalucía (2018) Bonet et al. (2016); Moreno-LLorca et al. (2016); J. Navarro and F.J. Cano-Manuel *personal communications* Cruz (1991); Wing (2015) Jiménez-Olivencia et al. (2015); Zoido and Jiménez Olivencia (2015); Moreno-LLorca et al. (2016); Calatrava and Sayadi (2019) Maestre (1852); Maestre (1858); Titos (1990); Mesa-Torres (2009) Navarro et al. (2014) Martín-Civantos (2014); Martín-Montañés et al. (2015); Ruiz-Ruiz (2017) Catastro (1752); López (1776); Madoz (1846); Titos Martínez (1997); Ferrer (1999); Mesa-Torres (2009); Bonet et al. (2014) Jiménez-Serrano and Serrano-Gutiérrez (2004); Romero-Zurbano (1909); Arnedo (2007)

|  | **Cáñar (CA sites)** | **Güejar-Sierra (SJ site)** | **References** |
| --- | --- | --- | --- |
| **Acorn** | Ancient references indicated traditional exploitation of acorn resources. Auctions of public forests to collect acorns (1927; 1954) |  | [@Catastro1752; @MesaTorres2009; @Bonet2014\_conama] |
| **Fires** | Several small fires. 1979: 44 Ha. of Pyrenean oak forests (near "Casa Forestal"). 1984: 189 Ha. of Pine plantation and Holm oak forests ("El Jaral"). 1994: 65 Ha. of Pine plantation ("Puente Palo") | Not recorded in the area since 1975 | [@Bonet2014\_conama; @MorenoLlorca2016; @CMA2018] |
| **Forest Managment Practices** | \* Nearby areas were afforested (pine plantations) to avoid soil erosion in 1925, 1928, 1950 and 1970. \* Selective thinning during 2007 in small area near \*Casa Forestal\*. \* Tree cleaning near trails-path (2009-2010) | \* Afforestation of the upper areas of the Genil River basin (1942) \* Tree cleaning (2006 - 2007) near our sudy site (\*La Hortichuela\*) \* Puntual afforestation (creation of small \*dispersal islands\*) (2008) | [@Bonet2016obsnev\_forest; @MorenoLlorca2016; J. Navarro and F.J. Cano-Manuel \*personal communications\*] |
| **Forest structure** | Inventories of trees made by the Spanish Navy during the second half of 18th century: \*new trees\*: 2010200 \*growing trees\*: 10791 \*old trees\*: - For Cáñar site more than two millions of trees were reported, most of them \*news\*, and no \*old\* trees were counted, suggesting recent wood fellings. Less quantity were reported for San Juan location (circa 700 000 trees), which 220 \*old\* trees and 56 700 \*growing\* [@Cruz1991]. | Inventories of trees made by the Spanish Navy during the second half of 18th century: \*new trees\*: 639550 \*growing trees\*: 56700 \*old trees\*: 220 | [@Cruz1991; @Wing2015] |
| **Land uses** | Oak Woodlands mixed with a high percentage of croplands even reached high elevation (mainly barley, rye and potatoes). Irrigated crops near the village (\*regadío de vega\*). | Grasslands and shrublands for cattle farming located at high elevations. Then forests formations (oak woodlands) with some croplands (herbaceous mainly and potatoes). Irrigated terraces with tree crops (chestnut trees, cherry trees) | [@JimenezOlivencia2015; @2015Zoido; @MorenoLlorca2016; @Calatrava2019] |
| **Mining activities** | Not mining activity in the area, only punctual particular excavations | Intermitently explotation through history. Historical documents indicated two periods of intense mining activity: the second half of the 19th century after the publication of detailed mineralogical reports and during the first decades of the twentieth century until 1960, which is the last year in which there is evidence of the existence of mining activity. Evidences of existence of several furnaces to melt minerals (Cooper) | [@Maestre1852; @Maestre1858; @Titos1990; @MesaTorres2009] |
| **Quarries** |  | Explotation of serpentinites quarries from 16th to 19th century (\*Jaspe Verde\*) | [@Navarro2014] |
| **Traditional irrigation channel** | There is a ditch (\*Acequia de la Era Alta\*) located uphill the CA-High site, which functions from March to June. | Several historical irrigation channels, know as \*acequias de careo\*, that was used since Middle Age to cultivated these valleys. Most of them are abandoned and deteriorated. | [@MartinCivantos2014; @MartinMontanes2015; @RuizRuiz2017] |
| **Wood** | Traditional charcoal ("\*carboneo\*") and firewood extraction activities through history. Several references indicated the firewood activity of this site since 1572. At the beginning of the last century, 3 - 4 woodcutters collected firewod from Pyrenean forests dialy. | Algunas referencias a la extracción de leñas para subsistencia (1826) (1847). Massive logging during the first decades of 20th century. Several pictures shown areas without trees where there are oak forests today (1925; 1932) | [@Catastro1752; @Lopez1776; @Madoz1846; @Titos1997; @Ferrer1999; @MesaTorres2009; @Bonet2014\_conama] |

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